

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 01 51 00 - Temporary Facilities and Controls.

1.2 USE OF SYSTEMS

- .1 Use of new permanent heating and ventilating systems for supplying temporary heat or ventilation is permitted only under the following conditions:
 - .1 Entire system is complete, pressure tested, cleaned, flushed out.
 - .2 Specified water treatment system has been commissioned, water treatment is being continuously monitored.
 - .3 Building has been closed in, areas to be heated/ventilated are clean and will not thereafter be subjected to dust-producing processes as declared by Departmental Representative.
 - .4 There is no possibility of damage from any cause.
 - .5 Supply ventilation systems are protected by 60 % filters, which shall be inspected daily, changed every 2 weeks or more frequently as required.
 - .6 Return systems have approved filters over all openings, inlets, outlets.
 - .7 All systems will be:
 - .1 operated as per manufacturer's recommendations or instructions.
 - .2 operated by Contractor.
 - .3 monitored continuously by Contractor.
 - .8 Warranties and guarantees are not thereby relaxed.
 - .9 Regular preventive and all other manufacturers recommended maintenance routines are performed by Contractor at his own expense and under supervision of Departmental Representative.
 - .10 Before static completion, entire system to be refurbished, cleaned internally and externally, restored to "as - new" condition, filters in air systems replaced.
- .2 Filters referred to herein are over and above those specified elsewhere in this specification.
- .3 Dedicated exhaust systems are not included in any approvals for temporary heating ventilation.

1.3 COMMISSIONING

- .1 Building Commissioning is a requirement of this project in order to comply with sections of Division 01 – General Requirements. A Commissioning Agent has been engaged and will provide all systems commissioning in conjunction with all trade contractors. The Commission Agent will provide a Commissioning Plan with commissioning start-up and test procedure sheets to be performed and completed by the various trade contractors.

PART 2 PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 EXECUTION

3.1 NOT USED

.1 Not Used.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 00 – Common Work Results – Mechanical.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material, in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal facility as approved by Departmental Representative.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

1.3 SECTION INCLUDES

- .1 Provide all labour, materials, facilities, equipment and services to thoroughly clean the ductwork and fans for the supply air systems and all the related return and exhaust air systems installed in this contract.
- .2 The cleaning work shall include but not be limited to the following:
 - .1 All supply, return and exhaust ductwork.
 - .2 All diffusers and grilles.
 - .3 Return and exhaust fans.
 - .4 Supply air units including the unit enclosure, heating and cooling coils, fans and drain pans, etc.
 - .5 Outside air intake plenums and exhaust air plenums.
 - .6 Ducted and non-ducted indoor VRF units and associated ductwork.
- .3 Provide all labour and services to obtain access to HVAC Systems and associated components including removal of ceiling tiles.
- .4 Replace or repair any damage to mechanical components, ceilings or walls caused during the duct cleaning.
- .5 Scope of work to include the following:
 - .1 Carry out field inspection and review to determine the method of cleaning the HVAC systems and its components. Submit to the Departmental Representative

the proposed methods for cleaning and their efforts to the system.

- .2 Reset all balancing dampers to original settings if moved during cleaning. Be sure to mark original position so that during the final inspections original settings can be field verified.
- .6 Report to the Departmental Representative, any system defects discovered during the cleaning operation (e.g., equipment, ductwork, dampers, registers, etc.).

1.4 COORDINATION

- .1 Refer to Division 01, 21, 22, 25 and 26 for other requirements as included and outlined in other sections of the specifications.

1.5 QUALITY ASSURANCE

- .1 Ductwork shall be cleaned in compliance with mechanical cleaning of Non-Porous Air Conveyance System Components NADCA 1992-01.
- .2 All duct and fan system surfaces must be visibly clean and capable of passing the NADCA vacuum test. The weight of debris collected by the NADCA Vacuum Test as outlined in Appendix "A" shall not exceed 1.0 mg/100cm².

PART 2 PRODUCTS

2.1 NOT USED

PART 3 EXECUTION

3.1 PRE-CLEANING PREPARATIONS

- .1 Prior to start of work, the HVAC system is to be carefully inspected and checked for all conditions affecting the cleaning. Defects are to be reported in writing to the Departmental Representative and work will not proceed until defects have been documented.
- .2 Fire protection devices such as smoke detectors, etc. shall be protected prior to cleaning procedures.
- .3 The contractor shall have samples collected by gathering the gross debris from the surface of the duct at a minimum of three (3) locations per system prior to and after cleaning. This shall be accomplished by utilizing protective clean surgical gloves to handle the surface debris. A 100 cm² area shall be scraped and the debris placed in a 4 oz. sterile container with screw cap. The container shall be adequately marked as to sample location, date and time. The total weight will be established per 100 cm².

3.2 CLEANING AND REMOVAL METHODS

- .1 The following general ductwork cleaning procedures are to be used as a guideline. Determine which method should be used in each area and submit detailed description of the procedures to the Departmental Representative.
- .2 Debris Collection Equipment:
 - .1 Equipment used shall be portable and sized to enter the areas easily. Electrical requirements shall be the responsibility of the cleaning contractor.
 - .2 The collection system shall be self-contained units, with the appropriate components to adequately collect dirt and debris loosened from the ductwork. Air duct cleaning is to be performed by a high powered vacuum system with three stages of filtration. The final stage to be a HEPA filter.
 - .3 The collection system shall be capable of producing a minimum of 100 Pa (0.42") water gauge negative static pressure and 62 Pa (0.25") water gauge velocity pressure in the area of ductwork to be cleaned.
- .3 Agitation Equipment:
 - .1 Air power cleaning of all interior ductwork, fan housings and HVAC units performed by a high pressure compressed air system which will be directed through small access doors in the ductwork. The size and the number of access doors required for cleaning shall be determined by this Section and the access doors shall be as per Section 23 33 00 - Air Duct Accessories.
 - .2 Air powered lances, extended whip sections or oscillating brush systems shall be used as a means of dislodging the debris.
 - .3 Where ductwork is large enough and able to support the weight of a worker, hand tools and vacuum may be used. If workers enter the inside of the duct they must follow the OSHA confined space requirements.
 - .4 Open Ductwork: During the cleaning process, provide temporary closure of metal or taped polyethylene on open ductwork to prevent the dust during the cleaning process from dispersing throughout the work area.
 - .5 Debris removed during the cleaning process shall be collected and tagged as to its origin within the duct system.
 - .6 Air Handling Unit Surfaces:
 - .1 The interior of air handling units shall be brushed and mechanically vacuumed such that all metal surfaces are visibly clean.
 - .2 Air handling cleaning shall include all plenums, filter sections, mixing boxes, access sections, etc.
 - .7 Coils shall be vacuumed such that they are visibly clean. Coil drain pans shall be subject to cleaning as per NADCA standards.
 - .8 Volume and Fire Dampers: Duct mounted volume and fire dampers are to be marked to their current settings and cleaned if necessary.

3.3 VERIFICATION

- .1 General verification of cleanliness will be determined after the completion of cleaning process.
- .2 All duct and air handling unit surfaces must be visibly clean and capable of passing the NADCA vacuum test.

- .3 The weight of debris collected by the NADCA vacuum test shall not exceed 1.0 mg/100cm².
- .4 The contractor shall include the cost of four (4) vacuum tests per fan system in the new building to be performed at the time and location as directed by the Departmental Representative. If any areas fail, the system of the failed test shall be recleaned and retested at no cost to the PSPC.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .3 Section 01 78 00 - Closeout Submittals.
- .4 Section 09 91 23 - Interior Painting.
- .5 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

1.2 EQUIPMENT LIST

- .1 Complete list of equipment and materials to be used on this project and forming part of tender documents by adding manufacturer's name, model number and details of materials, and submit for approval.
- .2 Submit for approval at time of tender within 48 h within 10 days after award of contract.

1.3 TRIAL USAGE

- .1 Departmental Representative may use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Trial usage to apply to following equipment and systems:
 - .1 Heating Systems
 - .2 Cooling Systems
 - .3 Ventilation Systems
 - .4 Controls

1.4 PROTECTION OF OPENINGS

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

1.5 PAINTING

- .1 To Section 09 91 23 - Interior Painting.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged too extensively to be merely primed and touched up.

1.6 SPARE PARTS

- .1 Furnish spare parts in accordance with Section 01 78 00 - Closeout Submittals 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.
- .6 One set spare belts for each belt drive.
- .7 One pressure gauge of each type.
- .8 One thermometer of each type.

- .2 Departmental Representative to sign for spare parts.

1.7 SPECIAL TOOLS

- .1 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.8 DEMONSTRATION AND OPERATING AND MAINTENANCE INSTRUCTIONS

- .1 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.
- .2 Where specified elsewhere in Mechanical Sections, manufacturers to provide demonstrations and instructions.
- .3 Use operation and maintenance manual, as-built drawings, audio visual aids, etc. as part of instruction materials.
- .4 Instruction duration time requirements as specified in appropriate sections.
- .5 Where deemed necessary, Departmental Representative may record these demonstrations on video tape for future reference.

1.9 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Operation and maintenance manual to be approved by, and final copies deposited with, Departmental Representative before final inspection.
- .3 Operation data to include:
 - .1 Control schematics for each system including environmental controls.
 - .2 Description of each system and its controls.
 - .3 Description of operation of each system at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for each system and each component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.

- .4 Maintenance data shall include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
- .5 Performance data to include:
 - .1 Equipment manufacturer's performance data sheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified elsewhere.
 - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .6 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 so directed by Departmental Representative.
 - .2 Make changes as required and re-submit as directed by Departmental Representative.
- .7 Additional data:
 - .1 Prepare and insert into operation and maintenance manual when need for same becomes apparent during demonstrations and instructions specified above.

1.10 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop drawings and product data shall show:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances. eg. access door swing spaces.
- .3 Shop drawings and product data shall be 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 as to current model production.
 - .5 Certification of compliance to applicable codes.
- .4 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.

.5 List of Requested Shop Drawings:

- .1 Interference drawings.
- .2 Pipe hangers and supports.
- .3 Lynk seal wall penetration.
- .4 Each type of thermometer and pressure gauge (submit sample).
- .5 Silencers and HTL ducting.
- .6 Thermal insulation for piping, ductwork, refrigeration pipe and equipment.
- .7 Sprinkler product cuts, hydraulic calculations and layout drawings.
- .8 Compressor, dryer, filters, PRV valves and outlets.
- .9 Plumbing specialists.
- .10 Plumbing fixtures and trim (all products).
- .11 Domestic water heaters and hook up details.
- .12 HVAC water treatment hardware, glycol data sheets, testing and flushing procedures.
- .13 Refrigeration connecting materials, valves, sight glass and filters drier.
- .14 Air-to-Air VRF Heat Pumps.
- .15 Valves and fittings: plumbing, hydronic steam.
- .16 Hydronic specialities: air vents (each type), expansion tank, air separator, drains, glycol fill tank and pump set and strainers.
- .17 Expansion joints, anchors and guides.
- .18 Pumps - plumbing and hydronic.
- .19 Heat Exchangers.
- .20 Heating terminal units: reheat coils, radiation, unit heaters and cabinet heaters.
- .21 Hot water baseboard radiation and unit heaters.
- .22 Flexible duct sample.
- .23 Fans (each type).
- .24 Air handling units.
- .25 Filters and filter gauges.
- .26 Access doors: wall, ceiling and duct.
- .27 Dampers: volume, fire, automatic, control and backdraft.
- .28 Humidifier manifolds, humidifiers.
- .29 Terminal units - HVAC.
- .30 Louvers, grilles and diffusers.
- .31 Variable speed drives.
- .32 EMCS system controls and components.
- .33 Pre-action Sprinkler system.
- .34 Boiler accessories for existing boilers.
- .35 Chimneys and Stacks.
- .36 Vibration Isolation.

1.11 CLEANING

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

1.12 AS-BUILT DRAWINGS

- .1 Site records:
 - .1 Departmental Representative will provide 1 set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of the work. Mark there on all changes as work progresses and as changes occur. This shall include

- changes to existing mechanical systems, control systems and low voltage control wiring.
- .2 On a weekly basis, transfer information to reproducibles, revising reproducibles to show all work as actually installed.
- .3 Use different colour waterproof ink for each service.
- .4 Make available for reference purposes and inspection at all times.
- .2 As-built drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing (TAB), 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 TAB to be performed using as-built drawings.
 - .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .3 Submit copies of as-built drawings for inclusion in final TAB report.

1.13 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Divert unused metal and wiring materials from landfill to metal recycling facility approved by Departmental Representative.
- .3 Dispose of unused paint material at official hazardous material collections site approved by Departmental Representative.
- .4 Do not dispose of unused paint material into sewer system, into streams, lakes, onto ground or in other locations where it will pose health or environmental hazard.
- .5 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .6 Dispose of corrugated cardboard, polystyrene and/or plastic packaging material in appropriate on-site bin for recycling in accordance with site waste management program.

1.15 BREAKDOWN OF COSTS

- .1 Refer to Section Tender Form.
- .2 Contract breakdown will be broken down by systems and by labour and material.
- .3 Submit prior to first monthly billing. Format to be approved by Departmental Representative.

1.16 AS INDICATED

- .1 Means that the item or items specified are shown on the drawings.
- .2 The word "provide" shall mean "Supply and Install".

1.17 STANDARD OF ACCEPTANCE

- .1 Means that item named and specified by manufacturer and/or catalogue number, forms part of specifications and sets standard regarding performance, quality of material and workmanship and when used in conjunction with a referenced standard, shall be deemed to supplement the standard.
- .2 Provide materials, equipment, and plant of specified design quality and of current models with published ratings for which replacement parts are readily available.
- .3 The codes and standards referred to in the specifications establish the minimum requirements only. The most stringent requirements of the specifications, drawings, codes and standards shall govern. Refer to the latest editions of all applicable codes and standards.

1.18 EQUIPMENT REQUIREMENTS AND INSTALLATION

- .1 Provide unions and flanges to permit equipment maintenance and disassembly and to minimize disturbance to connecting piping and duct systems and without interference from building structure or other equipment.
- .2 Provide accessible means for lubricating equipment including permanent lubricated bearings.
- .3 Pipe all drain lines to floor drains.
- .4 Equipment, cleanouts, floor drains and like equipment shall be on the axis of the building.

1.19 ANCHOR BOLTS AND TEMPLATES

- .1 Supply anchor bolts.
- .2 Drill and grout anchor bolts using templates.
- .3 Installed anchors shall perform to criteria required.

1.20 PROTECTION OF OPENINGS

- .1 Protect equipment and systems' openings from dirt, dust and other foreign materials during trial usage until accepted by the Departmental Representative. Provide plastic shut wrap over open ducts at end of each day.

- .2 Clean and refurbish all equipment and leave in first class operating condition including replacement of all filters as approved by the Departmental Representative.

1.21 ELECTRICAL

- .1 All control wiring shall be by Division 23 sections unless noted otherwise. The Div 26 contractor will leave spare 120 volt circuits in each electrical panel for the Div 23 trades to use for power source for control wiring to sensors, and actuators. The Div 23 trades shall install controls wiring to the standards set out in Div 26 wiring specs.
- .2 Coordinate with Division 26 to ensure that all controlled equipment is correctly connected for operation in accordance with plans and specifications, including supplying all necessary electrical interconnection information and location to Division 16.

1.22 MOTORS

- .1 Provide all motors for mechanical equipment as specified. All motors shall be high efficiency type.
- .2 If delivery of specified motor will delay delivery or installation of any equipment, install a motor for temporary use. Final acceptance of equipment will not occur until specified motor is installed.
- .3 All motors shall be 1750 rpm unless noted otherwise.
- .4 Motors under ½ HP continuous duty built-in overload protection, resilient mount, single phase, 120V, unless otherwise specified or indicated.
- .5 Motors ½ HP and Larger: EEMAC Class B, squirrel cage induction, continuous duty, drip proof, ball bearings, three phase, 575V unless noted otherwise.
- .6 Where equipment is provided with variable speed drives, electrical motors shall be suitable for the application.
- .7 Motors 30 HP or larger or a motor requiring 10 seconds or longer to reach the full speed shall be provided with thermistor protection.

1.23 BELT DRIVES

- .1 Fit reinforced belts in sheave matched to drive. Multiple belts on unit to be matched set.
- .2 Use cast iron or steel sheaves secured to shafts with removable keys.
- .3 For motors up to 10 HP: use standard adjustment pitch drive sheaves, having ± 10% range. Use mid-position of range for specified rpm.
- .4 For motor over 10 HP: use sheave with split tapered busing and keyway having fixed pitch unless specifically required for item concerned. Provide additional sheaves and belts of correct size to suit balancing where required.
- .5 Use minimum drive rating of 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on all prime move shafts.

- .6 Motor slide rail adjustment plates to allow for center line adjustment.
- .7 Tension belts to manufacturer's recommendations before start-up and after first (100) hours of operation using calibrated belt tensioning gauge. Submit report showing the recommended and actual tension on all units.
- .8 Provide additional sheaves and belts as required for air balancing.
- .9 Fans provided with variable speed controllers shall be balanced at the lowest motor RPM achievable with the specified motor. In general, the fans shall be balanced with motors operating at 70% speed for supply fans and 90% speed for exhaust and return fans. Speeds for supply fans with clean air filters at the time of air balancing may be even lower than as stated above. Provide additional sheaves and belts to achieve the above stated requirement.

1.24 GUARDS

- .1 Provide guards for drives including all fans.
- .2 Meet all the safety standards of Provincial Department of Labour and local authorities having jurisdiction.
- .3 Guards for drives shall have:
 - .1 Expanded metal screen welded to 25mm steel angle frame.
 - .2 18 ga. thick galvanized sheet metal tops and bottoms.
 - .3 Removable sides for servicing.
 - .4 38mm diameter hole on shaft centres for insertion of tachometer.
- .4 Provide means to permit lubrication and use of test instruments with guards in place.
- .5 Install belt guards to permit movement of motors for adjusting belt tension.
- .6 For flexible couplings, provide removable, "U"-shaped, 16 ga. thick galvanized mild steel guards.
- .7 Provide 19mm galvanized expanded metal screen on all unprotected fan inlets and outlets. Net free area of the guard to be not less than 80% fan openings.

1.25 EQUIPMENT SUPPORTS

- .1 Equipment support products supplied by equipment manufacturers are specified with equipment elsewhere in Division 23.
- .2 Equipment supports not supplied by equipment manufacturer: fabricate from structural grade steel meeting requirements of Section 01 51 00. All equipment supports provided by Division 23 shall be prime painted.
- .3 Mount base mounted equipment on chamfered edge housekeeping pads a minimum of 100mm high and 75mm larger than the equipment dimensions all around. Housekeeping pads to be provided by others. This trade contractor to provide drawing showing locations and sizes of housekeeping pads.

- .4 Submit shop drawings for all fabricated supports and bases. Shop drawings to include loads of the equipment to be supported, capacity of the supports and bases and design deflection. Indicate the weight of the equipment at each point of support in the shop drawings.

1.26 SLEEVES

- .1 Provide pipe sleeves at all points where pipes pass through masonry or concrete walls or slabs.
- .2 Refer to Item 3 Cutting and Patching in this Section.
- .3 Sleeves to be prime coated prior to installation.
- .4 Sizes:
.1 Provide 12mm clearance all around between sleeve and pipes or between sleeve and insulation. Clearance around pipes penetrating fire rated walls and floors to be as required for fire stopping.
- .5 Terminate sleeves flush with surface of concrete and masonry walls, concrete floors on grade and all finished areas; and 50mm above floors in mechanical rooms and service spaces.
- .6 Fill voids around pipes.
.1 Refer to paragraph 28 Penetration of Walls and Floor Slabs.
.2 Refer to Section 07 84 00, Fire Stopping and SmokeSeals.
- .7 Temporarily plug all openings during construction.
- .8 Provide sleeves in all cut or drilled openings in mechanical room floors. Sleeves to be schedule 40 steel pipe. Sleeve to terminate 50mm above floor. Seal the space between the sleeve and slab opening and make it water tight.

1.27 ESCUTCHEONS AND PLATES

- .1 Provide on all pipes passing through finished walls, partitions, floors and ceilings.
- .2 Use chrome or nickel plated brass, split type with set screws for ceiling or wall mounting.
- .3 Inside diameter shall fit around finished pipe. Outside diameter shall cover opening or sleeve.
- .4 Secure to pipe or finished surface but not to insulation.
- .5 Where sleeves extend above finished floor, escutcheons or plates shall cover sleeve extension.

1.28 TESTS

- .1 Provide the following supplementary requirements to tests specified in mechanical work sections:
 - .1 Give written two-day notice of date when tests will be made.
 - .2 Do not insulate or conceal work until tested and approved. Follow construction schedule and arrange for tests.
 - .3 Conduct tests in presence of the Departmental Representative. Re-test if test fails.
 - .4 Bear all costs including re-testing and making good.
 - .5 Pipe Pressure:
 - .1 Hydraulically test water supply systems at 1-1/2 times system operating pressure or minimum 125 psi, whichever is greater.
 - .2 Test sprinkler piping to NFPA-13.
 - .3 Maintain test pressures without loss for four (4) hours, unless otherwise specified.
 - .4 Test all drainage, waste and vent piping to National Plumbing Code and authorities having jurisdiction.
 - .5 Test all underground drainage pipe to 3m head of water for 2 hours.
 - .6 Conduct all other tests as specified in other Sections of Division 23.
 - .7 Replace defective material or equipment and repair joints using new material.
 - .8 Prior to tests, isolate all equipment or other parts which are not designed to withstand test pressures or test medium.
 - .9 Compile all completed test reports upon completion of all tests in a 3-ring binder and submit to the Departmental Representative.

1.29 PAINTING

- .1 Apply at least one (1) coat of corrosion resistant primer paint to ferrous supports and site fabricated equipment.
- .2 Prime and touch-up all damaged paint on the equipment. Touch-up to match original paint. Do not paint over nameplates.
- .3 Restore to new condition, finishes which have been damaged too extensively to be merely primed and touched-up.

1.30 ACCESS DOORS

- .1 Supply access doors for furred ceilings and duct shafts or spaces for servicing equipment and accessories or for inspection of safety, operating or fire devices for installation under section erecting the walls or ceilings. Also supply and arrange for installation of access pits and covers for servicing and inspection of valves, devices which are to be installed below grade or below floor in floor slabs.
- .2 Access doors shall be flush mounted 600mm x 600mm for body entry and 300mm x 300mm for hand entry, unless otherwise noted. Doors shall open 180°, have rounded safety corners, concealed hinges, screwdriver latches and anchor straps. Doors shall be of approved manufacturer with published literature. Access doors shall be minimum 14 ga. thick.
 - .1 General: Prime coated steel.

.2 Special areas such as tiled or marble surfaces: stainless steel.

.3 In visible areas, access door locations to be approved by the Departmental Representative prior to installation.

1.31 DIELECTRIC COUPLINGS

.1 Provide wherever pipes of dissimilar metals are joined.

.2 Provide insulating unions for pipe sizes 50mm and under, and flanges for pipe sizes over 50mm.

.3 Provide felt or rubber gaskets to prevent dissimilar metals contact.

.4 Cast brass adapters may be used where approved by the Departmental Representative.

1.32 DRAIN VALVES

.1 Locate at all low points and section isolating valves unless otherwise specified.

.2 Minimum 75mm unless otherwise specified: Straight pattern bronze with hose end male thread and complete with cap and chain.

1.33 INSTRUCTION OF OPERATING STAFF

.1 Provide certified personnel to instruct operating staff on maintenance. Provide maintenance specialist personnel to instruct operations staff on maintenance and adjustment of mechanical equipment and any changes or modification in equipment made under terms of guarantee.

.2 Provide instruction during regular work hours prior to acceptance.

.3 Use operation and maintenance data manuals for instruction purposes. On completion of instruction turn the manuals over to the Departmental Representative.

.4 Instructions in maintenance and operation of the following equipment shall be given by factory trained personnel and for a period of two (2) working days for the following systems:

.1 Heating Systems.

.2 Ventilation Systems.

.3 VRF System.

The time specified above does not include the time for start-up of systems and equipment. Operating instructions for systems not listed above shall be for a period of one day. All operating instructions shall take place prior to acceptance and turnover. Where more detailed instructions for some equipment or systems are called for in other sections of the specifications, those sections of specifications shall take precedence over this section.

.5 Training period for the Energy Management and Control Systems shall be as per Division 25.

1.34 CLEANING AND FINAL ADJUSTMENT

- .1 Keep all mechanical systems and equipment clean.
- .2 Clean interior and exterior of all systems including strainers, and vacuuming of interior of ductwork and air handling units.
- .3 Clean and refurbish all equipment and leave in first class operating condition including replacement of all filters in all air and piping systems.
- .4 Balance and adjust all systems and each piece of equipment to operate efficiently.

1.35 PENETRATION OF WALLS AND FLOOR SLABS

- .1 Wherever pipes and ducts penetrate non-fire rated walls and floor slabs, tightly pack the space between construction and ducts/pipes the full depth with acoustic filler material and seal both sides with acoustic sealant. Where pipes pass through fire rated walls and floor slabs, pack space between the pipe and sleeve with approved fire rated and ULC approved sealant.
- .2 Acoustic Filler:
 - .1 Filler material shall be glass fibre or inorganic mineral.
 - .2 Filler material shall not have higher combustion rating than the following:

- Flame Spread Rating	=	25
- Smoke Development Rating	=	0
- Fuel Contribution Rating	=	0
- .3 Acoustic Sealant:
 - .1 Concealed Application:
 - .1 Non-shrinking, non-straining, non-drying and permanently elastic type.
 - .2 Exposed Application:
 - .1 Permanently elastic, paintable acoustic sealant, latex acrylic or acrylic latex type.

1.36 PREPARATION FOR FIRE STOPPING

- .1 Firestopping material and installation within annular space between pipes, ducts, insulation and adjacent fire separation to be ULC listed and acceptable to the Provincial Fire Marshall's Office. Installation to be as per manufacturer's recommendations and ULC's testing procedure.
- .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 to move without damaging firestopping material.
- .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barrier at fire separation.

- .5 Refer also to Section 07 84 00- Fire Stopping and Smoke seals. Division 23 is responsible for providing firestopping for all mechanical duct, pipe and wiring penetrations of fire rated partitions. Work to be done to the standards defined in Section 07 84 00. Intent is to ensure the Mechanical Trades are responsible for their own fire stopping. The wiring fire stopping is only that done by the Div 23 contractor or his sub-contractors (Control wiring, etc.); it is not intended to include for Electrical work.

1.37 SITE SERVICES

- .1 Known Services:
- .1 Conform to drawings, they represent known existing underground facilities.
 - .2 Discuss with the Departmental Representative before starting work and follow his written instructions.
 - .3 Once location is set out, be responsible for all damage there to during excavation work and for the cost of all repairs and replacements made necessary thereby.

1.38 DRAWINGS

- .1 Mechanical drawings are not intended to show structural details or architectural features.
- .2 **The Mechanical drawings are not to be scaled.**
- .3 Except where dimensioned, mechanical drawings indicate general Mechanical layouts only. Because of the small scale of Mechanical drawings, it is not possible to show all offsets, fittings and accessories which may be required. Investigate structural and finish conditions affecting this work and arrange work accordingly, providing such fittings, valves and accessories which are required to meet the conditions.

1.39 EXISTING SITE CONDITIONS

- .1 The Trade-Contractor shall visit the site of the building in order to examine first hand the existing conditions which may affect his contract. No compensation shall be considered for additional expenditures incurred later through failure to do so.

1.40 CUTTING AND PATCHING

- .1 Any cutting, coring and patching shall be done by the Trade-Contractor required for Division 21, 22 or 23 work. Any cutting, coring and patching required for Division 21, 22 or 23 work shall be the responsibility of Division 21, 22 or 23.
- .2 Holes in slabs shall be by coring and the responsibility of Trade concerned. Locations to be approved by the Departmental Representative.
- .3 If the location proposed by the Trade-Contractor is rejected by the Departmental Representative, the Departmental Representative and Trade Contractor will meet on site to determine a mutually agreeable location.

1.41 PROTECTION OF DUCTWORK DURING CONSTRUCTION

- .1 The interior of all ductwork shall be protected from construction dust and dirt by sealing all open ends of the ducts.

1.42 INTERFERENCE DRAWINGS

- .1 The Mechanical Trade Contractor shall prepare interference drawings for all areas. The interference drawings for the Heating/HVAC Project Package shall show all ductwork, all major piping runs including heating and cooling, plumbing, sprinkler, cable trays and electrical conduits. The Heating/HVAC Trade Contractor shall coordinate with Plumbing, Fire Protection and Electrical Trade-Contractors to ensure the ceiling heights as listed in Architectural package are maintained. The Trade-Contractors shall make all the required changes in the layouts to ensure ceiling heights as noted on Architectural drawings and specifications at no additional cost to the Departmental Representative. **The installation shall not commence until the interference drawings have been approved.** The interference drawings shall be reviewed and concurred with by all Trade-Contractors before submission to the Departmental Representative.
- .2 Fire Protection Trade-Contractor shall provide information to Heating/HVAC Trade-Contractor when requested and give diligent assistance to ensure prompt and speedy development of interference drawings.
- .3 Documentation of the interference drawings must present all the various systems at the same scale. Multi-coloured computer drawings and/or a system of transparent overlays may be utilized.

1.43 INSTALLATION OF CONTROL INSTRUMENTS AND DEVICES

- .1 All control valves and dampers supplied by Division 25 shall be installed by the respective Sections of Division 23.
- .2 Division 22 & 23 shall install wells supplied by Division 25 for all control instrumentation and devices installed in piping.
- .3 Division 23 shall provide access doors in ductwork for all control instrumentation and devices installed in ductwork.

1.44 COMMISSIONING

- .1 Building Commissioning is a requirement of this project in order to comply with sections of Division 01 – General Requirements. A Commissioning Agent has been engaged and will provide all systems commissioning in conjunction with all trade contractors. The Commission Agent will provide a Commissioning Plan with commissioning start-up and test procedure sheets to be performed and completed by the various trade contractors.
- .2 All the major mechanical systems shall be commissioned. Refer also to Section 01 91 13 – General Commissioning Requirements. Brief description of the commissioning process is as below:
 - .1 All supply, return and exhaust air systems shall be verified for operation and capacity, and controllability over capacity range.
 - .2 The new heating and cooling VRF heat pump system shall be verified for operation and capacity.

- .4 Operation of all terminal will be verified.
 - .5 Domestic Hot Water Systems.
 - .6 Humidification System.
 - .7 All energy management and control systems shall be verified for operation.
- .3 The commissioning process will be lead by the Departmental Representative. The Mechanical Trade Contractor shall ensure that his Project Manager, TAB and EMCS are present to assist during commissioning. The responsibilities of the Mechanical Trade Contractor's representative and his sub-contractors are defined below:
- .1 Mechanical Trade Contractor shall be responsible for operation of the Mechanical Systems during commissioning.
 - .2 TAB shall assist with measurements of flows, temperatures, air velocities, etc.
 - .3 EMCS technicians shall be responsible for starting/stopping the equipment, to make adjustments to EMCS routines and to provide any other EMCS generated data required for commissioning.

1.45 EXCAVATION & BACKFILLING

- .1 All excavation and backfilling for underground mechanical services shall be carried out by the General Contractor.

1.46 DRAINS FROM HVAC EQUIPMENT & PLENUMS

- .1 Drains from air handling units, air intake plenums, exhaust air plenums shall be trapped and run to the nearest floor drain by the Heating/HVAC Trade Contractor. Drain Sizes shall be a minimum of 38mm. Drains shall be properly trapped and sloped a minimum of 6mm per foot. Trap depth shall equal fan static plus 50mm.

END

PART 1 GENERAL

1.1 GENERAL

- .1 Read and conform to:
 - .1 Comply with Division 1 requirements and documents referred to herein.
- .2 Contractor is responsible for proper performance of Work.
- .3 Provide all labour, materials, Products, equipment and services for commissioning of all building systems to ensure building is operating according to requirements of Contract Documents.

1.2 REFERENCES

- .1 ASHRAE Guideline 0-2005 - The Commissioning Process.
- .2 ASHRAE Guidelines 1-19 - Guidelines for Commissioning of Specific Systems.
- .3 Section 01 91 13 – General Commissioning Requirements.

1.3 COMMISSIONING SUMMARY

- .1 Perform commissioning activities in accordance with requirements of Contract Documents. Activities include, but are not limited to following:
 - .1 Commissioning process shall be performed by Contractor, in accordance with Contract Documents. Contractor shall fully cooperate with Commissioning Authority. Commissioning shall be demonstrated to satisfaction of Commissioning Authority. Commissioning work will be divided into the following phases:
 - .1 Stage 1: Commissioning performed by Contractor on all building items, components, equipment and systems unless otherwise stated, which is a prerequisite requirement for Substantial Performance application. It includes, without limitation, activities such as start-up, verification, adjusting and balancing, demonstration and instructions of authorized Commissioning Authority regarding each building system.
 - .2 Stage 2: Commissioning performed by Contractor after Substantial Performance, which includes without limitation activities such as training and fine tuning of building systems through all seasonal occupancy, or other operational conditions to achieve requirements of Contract Documents during 12 months following Substantial Performance to end of Work.
 - .3 Stage 3: Successful completion of satisfactory system operation during the first month after Total Completion of the Work.

- .4 Stage 4: Successful completion of satisfactory system operation during the third month after Total Completion of the Work.
- .5 Stage 5: Successful seasonal commissioning of the building.
- .2 Commissioning includes systematic testing, documentation of system in all scope of operations and providing performance data. Provide complete description of all systems operation as well as equipment and material information. Perform additional testing as requested by Department Representative or Commissioning Authority to verify results without any extra cost to Departmental Representative.
- .3 Documentation of system includes system monitoring prior to Substantial Performance which includes tabulating at least for 21 Days of operation all significant system parameters. (such as, Room Temperatures, Hot & Chilled Water Temperatures and/or similar items) Process may involve measurement of those parameters during operation and assessment of results by comparing design values against actual performance values.
- .4 Prepare commissioning plan and program in accordance with recommendations of ASHRAE Guidelines and the specifications to suit Project requirements and comply with contract documents. Provide such plan and program and other relevant documentation in hard copy as well as in electronic format in system acceptable to the Departmental Representative.

1.4 EVALUATION OF COMMISSIONING WORK

- .1 An amount of 5% of the mechanical/ electrical construction budget will be held back for the mechanical/ electrical commissioning purposes, and the contractor may draw against that hold back on successful completion of their related commissioning tasks.
- .2 The Project Manager will not grant “Substantial Completion” until the Commissioning Authority submits a commissioning report with a recommendation for interim acceptance.

1.5 DEMONSTRATION AND TRAINING

- .1 Instructions - Mechanical:
 - .1 Thoroughly instruct Departmental Representative Authorized Personnel and in safe operation of systems and equipment after installation of Work. Coordinate with Department Representative and arrange commissioning program and schedule for instruction times. Submit a training schedule to Department Representative, minimum 2 weeks prior to start of training.
 - .2 Arrange and pay for services of qualified service engineers and manufacturers' representatives to instruct Departmental Representative on specialized portions of installation, such as refrigeration machines, boilers, automatic controls and water treatment.
 - .3 Submit a complete record of instructions as part of maintenance instructions and data book given to Departmental Representative. For each instructional period, supply following data:
 - .1 Date.
 - .2 System or equipment involved.
 - .3 Names of persons giving instructions.

- .4 Names of persons being instructed.
- .5 Other persons present.
- .4 Carry out instructional period during a continuous period agreed with Departmental Representative.
- .5 Permit Departmental Representative and authorized representative(s) usage of systems prior to Substantial Performance for purpose of testing and learning operational procedures. This usage shall not affect warranties and no claim for damage shall be made against Department Representative for any injury or breakage to any part or parts of above due to aforementioned tests, where such injuries or breakage are caused by a weakness or inadequacy of parts, or by defective materials or quality of performance of any kind.
- .6 At end of training, obtain and submit to Department Representative, signature of authorized Owner stating they understand system and equipment installation, operation and maintenance requirements.
- .7 Obtain and submit to Departmental Representative, letters from manufacturers of equipment and systems indicating their technical representatives have inspected and tested equipment and systems installed and have approved methods of installation, connections and operation.
- .8 Only exception to foregoing requirements for acceptance of equipment and systems, will be 'fine tuning' which may be performed prior to Completion of Contract.
- .9 In conjunction with foregoing requirements, Contractor shall arrange necessary inspections and obtain written approval and acceptance of equipment and systems requiring approval by authorities having jurisdiction, and subsequent correction of those unacceptable items to satisfaction of such authorities.

END

PART 1 GENERAL

1.1 GENERAL INSTRUCTIONS

- .1 Read and conform to:
 - .1 Comply with Division 1 requirements and documents referred to herein.

1.2 DEFINITIONS

- .1 Validate: for tests and demonstrations: to witness and validate successful performance demonstration or record deficiencies; to validate after correction successful demonstration; these validations of the tests become references for the Departmental Representative's certification.
- .2 Certify: for documents including as-built drawings: Review for accuracy and completeness or record deficiencies.
- .3 Witness: The Commissioning Authority will observe as required and record summary of test results.
- .4 BAS: refers to the Building Automation System (Similar terms are: EMCS)
- .5 TAB: Testing and Balancing for system verification.
- .6 Commissioning Authority: Commissioning authority in charge of the commissioning process and recommends final acceptance.
- .7 Independent Third Party Agent: Independent agent specialized in installation and testing of the system and retained by the Contractor.

1.3 REFERENCES

- .1 CSA B149 - Installation Code for Gas -Burning Equipment.
- .2 NFPA 13 - Installation of Sprinkler Systems.
- .3 NFPA 20 – Centrifugal Fire Pumps.
- .4 CSA/NFPA - Smoke Control.
- .5 LEED - Green Building Rating System Reference Guide.

- .6 ASHRAE Guidelines 0-2005 – The Commissioning Process.
- .7 ASHRAE Guideline 1- 19 – Guidelines for Commissioning of Specific Systems.
- .8 Section 01 92 13 – General Commissioning Requirements.
- .9 Section 23 05 01 – Facility Mechanical Commissioning – General.

1.4 DOCUMENTS

- .1 In case of discrepancies or conflicts between documents, documents will be governed in the order specified in Division 1.

1.5 COMMISSIONING OBJECTIVES

- .1 Objectives of commissioning process are:
 - .1 To support quality management through monitoring and checking of installation;
 - .2 To verify system performance through testing and commissioning of completed installation;
 - .3 To move completed facility from “static completion” state to optimal “dynamic” operating state;
 - .4 To transfer facility from Contractor to DFO in such a manner that provision of a quality facility to DFO been assured.
 - .5 To optimize operating and maintenance through delivery of comprehensive quality training and instruction to DFO’s operating personnel.
 - .6 To assure provision of accurate and useful historical records, such as, as-builts drawings, test certificates, etc. to DFO. Such records provide important data for operating and maintaining systems as well as for future system testing, maintenance or renovations and to trouble shoot and repair the components of systems.
 - .7 To extend commissioning into operational phase in order to verify performance levels under a range of operating conditions; such as change of seasons. This process will help to avoid unforeseen or hidden operating and maintenance expenses that may develop later on.
 - .8 Monitor operation, performance and maintenance programs; optimize system’s performance under normal operating conditions, partial occupancy, and full occupancy, under the direction and review of Commissioning Authority. This phase lasts throughout warranty period. It may, however, involve activities to ensure completion of:
 - .1 System debugging and optimization.
 - .2 Completion of training and instruction for operating and maintenance personnel.
 - .3 Completion of all commissioning activities on defective, seasonally-sensitive systems, for varying modes and periodic simulated emergency conditions.

- .9 Commissioning shall be considered complete when all of the objectives of commissioning, as specified herein, have been achieved.

1.6 COMMISSIONING MEETINGS, SCHEDULING, and REPORTING

- .1 Contractor shall include the commissioning plan in their construction schedule and shall schedule for all tests and equipment start-up in the construction schedule.
- .2 Commissioning meetings shall be scheduled as required. The meetings shall address commissioning related responsibilities as well as all specified testing, documentation, O&M manuals, training, and post construction requirements. The testing schedules and results of all tests shall be reviewed at the meetings.
- .3 Where construction may be completed in phases, allow for the frequency of meetings to correspond to the varying stages of construction of each phase.
- .4 The Contractor shall attend commissioning meetings at regular intervals, as called by the Commissioning Authority.
- .5 The Contractor shall schedule work to include specified Commissioning related tasks. Cooperate with the DFO's Commissioning Authority, and coordinate subtrades as required, to successfully demonstrate and verify commissioning related tests.
- .6 The Contractor shall schedule work to include specified Commissioning related testing prior to DFO Personnel demonstration and training.
- .7 Testing forms and reports associated with the mechanical systems shall be directed to the Departmental Representative and to the Commissioning Authority.
- .8 The forms and reports to be issued shall include:
- .1 Shop drawings, issued and accepted;
 - .2 Equipment verification forms;
 - .3 Testing forms;
 - .4 Reports resulting from tests;
 - .5 Testing schedule;
 - .6 Minutes of commissioning meetings.

1.7 WARRANTY

- .1 Involvement of Commissioning Authority does not void any guarantees or warranties nor does it relieve Contractor of any contractual responsibilities.

1.8 RESPONSIBILITIES OF COMMISSIONING AUTHORITY

- .1 Responsibilities of Commissioning Authority are as follows:
 - .1 Design Phase:
 - .1 Participate in design team meetings. Obtain DFO's requirements and Departmental Representative's philosophy and intent and expected system performance. This will form the basics of the testing and commissioning documents.
 - .2 Provide input and feedback to design team with emphasis on testing, commissioning, operation and maintenance of the proposed system and equipment.
 - .3 Provide commissioning document to form part of the Bid documents.
 - .2 Bid Phase:
 - .1 Review Bid documents, design Drawings and specifications.
 - .2 Documents to ensure the documents have included all the required testing and commissioning requirements.
 - .3 Provide commissioning related comments for incorporation in Contract Documents.
 - .4 Participate in Bid review meetings to ensure Bidders are aware of testing and commissioning requirements.
 - .3 Construction Phase:
 - .1 Review Contractor's approved shop drawing submission for commissioning related issues.
 - .2 Prepare commissioning plan based on the contractor's schedule and installation method statement;
 - .3 Monitor, check and inspect the installation throughout the construction stages.
 - .4 Supervise the commissioning, including scheduling.
 - .5 Issue deficiencies reports noting any issues that may have an impact on the commissioning of the equipment or system.
 - .6 Attend construction site meetings as required to discuss commissioning related items and any impact on Project schedule.
 - .7 Set-up and chair commissioning meetings.
 - .8 Witness and validate tests; note deficiencies and issue progress reports.
 - .9 Work with the project team to expeditiously resolve any problems that may arise due to site conditions.
 - .10 Prepare Systems Operating Manual.
 - .11 Co-ordinate with Departmental Representative, training and instructions provided by Contractors, manufacturers and Suppliers.
 - .4 Post-Construction Phase:
 - .1 Prepare final report on commissioning, identifying any deficiencies that may be outstanding.
 - .2 Recommendation of any additional training and/or instruction of operating and maintenance personnel deemed necessary over and above that already provided.

- .3 Complete system checks with Contractor:
 - .1 Once during the first month of building operation.
 - .2 Once during the third month of building operation.
 - .3 Once between the fourth and tenth months in a season opposite to the first or third month visit.

1.9 RESPONSIBILITIES OF DFO

- .1 Responsibilities of DFO are as follows:
 - .1 To provide operating personnel to attend training and instruction regarding specific components, equipment and systems.
 - .2 To retain the services of independent third parties for system verification and certification as required in the document or by applicable codes.
 - .3 To observe on-site installation, start-up and testing equipment and systems.

1.10 RESPONSIBILITIES OF DEPARTMENTAL REPRESENTATIVE

- .1 Responsibilities of Departmental Representative areas follows:
 - .1 Review contractor's shop drawings submission to ensure that the equipment proposed comply with specifications requirements;
 - .2 Review contractor's installation program to ensure that the installation sequences have been coordinated with the project schedule;
 - .3 Monitor, check and inspect the installation throughout the construction stages to ensure the equipment installation is as approved and the installation method, workmanship, procedures will follow the approved submission and method statement;
 - .4 Inspect the systems installation and issue deficiencies reports. Ensure deficiencies are corrected and certify installation of systems;
 - .5 Review contractor's commissioning plan to ensure the proposed tests, the sequences and method of tests conform to the contract requirements; the testing and commissioning sequences coincide with the project schedule;
 - .6 Review operating and maintenance manuals, balancing and test reports and as-builts for accuracy;
 - .7 Witness tests; note any deficiencies and provide progress report;
 - .8 Certify completion of contractor's commissioning.

1.11 RESPONSIBILITIES OF CONTRACTOR

- .1 Responsibilities of Contractor are as follows:
 - .1 Construction Phase:
 - .1 To manage and ensure entire installation comply with requirements of the Contract Documents;
 - .2 Submit shop drawings complete with Contractor's Stamp of Review;
 - .3 Submit working detail (interference or installation) drawings, as required;

- .4 Complete commissioning data test forms;
- .5 Submit installation method statement. This generally includes:
 - .1 Method of equipment delivery to the installation location on site;
 - .2 Prerequisite preparation for delivery, such as completion of the factory testing and the completion of site work to accept this equipment;
 - .3 Installation method and sequences of installing the equipment and the associated connections to the equipment;
- .6 Submit an installation schedule. This schedule shall include:
 - .1 Time schedule of each activity, with lead and lag time allowed and indicated;
 - .2 Shop drawings and working detail drawings submission;
 - .3 Major equipment delivery and factory testing date;
 - .4 Coordinated installation activities and sequences in compliance with the General Contractor's project schedule and other trade's installation schedule;
 - .5 Schedule of testing and commissioning of the systems and major equipment;
- .7 Submit a commissioning schedule. This schedule shall include:
 - .1 Time schedule for system and equipment commissioning which are in compliance with the timing and sequences of installation schedule stated above. In this schedule allow for additional time for testing and commissioning, such that re-test of the equipment can be performed in a timely manner if required without impacting the overall project schedule or cause delay to Project completion;
 - .2 Dates for completion of required factory tests prior to equipment delivery to the site shall be indicated in the schedule;
 - .3 Prepare and submit testing and commissioning method statements for review and approval;
 - .4 Prepare and submit testing and commissioning record or report forms for review and approval;
- .8 Attend progress and commissioning meetings;
- .9 Promptly rectify or replace reported deficiencies and defects;
- .10 Where required by codes and/or specification, retain manufacturers and/or independent third parties to provide service for testing and certification of the systems and training of DFO's personnel;
- .11 Provide training and instruction to the DFO's operating personnel;
- .12 Perform testing and commissioning of equipment and systems to the satisfaction of the Departmental Representative and Commissioning Authority as stated in approved schedule and method described above. Testing and commissioning will be witness by the Commissioning Authority as required. Contractor or his retain agents shall also record procedure and finding in approved test and record forms. Submit test and record forms with the signature of the tester for review and approval to the Departmental Representative and Commissioning Authority;

- .13 Pay for and be responsible for all inspections required by codes, specification and Authorities having Jurisdiction. Obtain and submit all Certificate of Approval for such inspections and verifications;
 - .14 Submit for review as-builts drawings including those for location of control devices and wiring and operating and maintenance manuals for each equipment as per the specification requirements;
 - .15 Provide Operating and Maintenance Manuals for review by the Departmental Representative and Commissioning Authority with all the testing and commissioning results and reports incorporated;
 - .16 Obtain, issue and assign warranties for equipment and systems to the Departmental Representative.
 - .17 Provision of all necessary test equipment shall be the responsibility of the contractor. Provide recently validated calibration certificate for all equipment to be used for verification prior to testing and commissioning commencement.
- .2 Post-Construction Phase:
- .1 Optimize operation according to occupant's needs, using the System Operation Manual prepared by the Commissioning Authority as reference points;
 - .2 Complete all commissioning procedures and activities and performance verification procedures which were delayed or not concluded during the commissioning phase;
 - .3 Complete system checks:
 - .1 Once during the first month of building operation;
 - .2 Once during the third month of building operation;
 - .3 Once between the fourth and tenth months in a season opposite to the first or third month visit;
 - .4 Complete rectification of all deficiencies revealed by these checks. Equipment manufacturers involved in commissioning shall participate in systems checks.
 - .5 Revise all "as-built" and operating and maintenance documents to reflect all changes, modifications, revisions and adjustment upon completion of commissioning;
 - .6 Schedule a question and answer session for the operating and maintenance personnel 3 months after handover of the facility to the Departmental Representative. The duration of this session or sessions will be dictated by the number of questions or concerns that shall be addressed.

1.12 COMMISSIONING INVOLVEMENT

- .1 Commissioning Authority shall direct, witness and validate as required; and Contractor and/or his Suppliers or retained Independent Third Party Agents shall perform the following:
 - .1 Check and ensure installation of systems and equipment to ensure installations are completed and in a proper and safe state ready for testing and commissioning;

- .2 Run and test the systems and equipment through their design parameters to verify their capabilities in performance, sequencing, safety protection and alarms annunciation;
- .3 Ensure deficiencies and defects found are rectified and replaced and the systems and equipment re-tested as required;
- .4 Arrange and provide demonstration and training of DFO's personnel;
- .5 Issue Operating and Maintenance Manuals for systems and equipment;

1.13 SYSTEMS TO BE COMMISSIONED

- .1 Mechanical systems shall include but not limited to following:
 - .1 Chemical treatment of systems;
 - .2 Fire protection systems: sprinkler, spark detection and extinguishing system, fire department connection and fire extinguisher;
 - .3 Heating Plant and distribution system;
 - .4 Hydronic heating systems;
 - .5 Ventilation system including air handling units;
 - .6 Air distribution and Exhaust systems;
 - .7 VRF Heat Pump Systems;
 - .8 Noise and vibration;
 - .9 Building automation system (controls).

1.14 TESTING EQUIPMENT

- .1 Contractor and manufacturer shall provide all instrumentation and test equipment necessary to conduct the tests specified during the commissioning process. Contractor shall submit a list of equipment to be used and copies of latest equipment calibration certificates to the Commissioning Authority and Departmental Representative for approval.
- .2 Mechanical Testing Equipment:
 - .1 Following equipment shall be provided but not limited to:
 - .1 Pressure measurements: manometers, pressure gauges;
 - .2 Velocity measurement: pitot tube, propeller or revolving vane manometer, thermo anemometers, hot wire anemometers;
 - .3 Volume or mass flow measurement: venturi, nozzle and orifice flow meter, positive displacement meter;
 - .4 Rotational speed: tachometer;
 - .5 Sound measurement: electronic sound level meter for acoustic measurement with octave band analysis;
 - .6 Vibration measurement: accelerometer;
 - .7 Recording: chart recorder;
 - .8 Electrical measurements: voltmeter, ammeter and wattmeter.

1.15 DOCUMENTATION

- .1 Contractor shall record test results and procedures on approved record forms and submit the forms together with copies of test certificates to Departmental Representative and Commissioning Authority for review and approval.
- .2 When results are validated, Commissioning Authority shall incorporate those records in his System Operating Manual. He shall also make entry of those test results into appropriate sections of the System Operating and Maintenance Manual as reference for future system/equipment performance tests.

1.16 COMMISSIONING PROCESS

- .1 Commissioning Authority: to perform and complete all work as specified in the “GENERAL” Section of this specification “Responsibilities of Commissioning Authority”.
- .2 Contractors: To perform and complete all works as specified in the “GENERAL” Section of this specification “Responsibilities of Contractor”. In general, it shall include complete activation of all systems; calibration, test, and verification of performance of all components, equipment and systems; verification of performance of all systems through all specified modes of control and sequence of operation; rectification of deficiencies; recording of test results for submission; demonstration, instruction and training of DFO’s operating and maintenance personnel; follow-up during first year of operation for fine tuning and building service monitoring.
- .3 Equipment verification: Contractor shall test and verify proper operation of all equipment and systems prior to start of commissioning and record all results from the test for each piece of equipment. Forms shall be included in the Operating and Maintenance Manual. Equipment data shall include, but is not limited to:
 - .1 Manufacturer’s name, address and telephone number;
 - .2 Distributors’ name, address and telephone number;
 - .3 Make, model number and serial number;
 - .4 Pumps - RPM, impeller sizes, rated flow;
 - .5 Fans - belt type and size, sheave type and size;
 - .6 Electrical - volts, amps, fuse size, overload size;
 - .7 Equipment enclosure type;
 - .8 Switchboard, panel board - volt, rated current, number of phase and fault rating;
 - .9 Any other special characteristics.

1.17 TESTING FOR MECHANICAL SYSTEMS

- .1 Plumbing and Drainage System Testing:
 - .1 Plumbing and drainage system shall be tested in accordance with the Canadian Plumbing Code.

- .2 Contractor shall notify Building Inspector when systems are available for testing. Contractor shall document all tests performed and shall arrange for Building Inspector to sign for tests completed. Forward forms to Departmental Representative and Commissioning Authority for review.
 - .3 When the plumbing system has been completed take a sample of the drinking water, in the presence of the Departmental Representative. Forward the sample to a testing laboratory which shall be approved by the Departmental Representative. Forward the test results to the Departmental Representative and Commissioning Authority. Include for all cost of water analysis.
 - .4 Also perform hydrostatic pressure test and system disinfection for domestic hot and cold water systems.
- .2 Water Treatment Systems:
- .1 Contractor shall employ a Chemical Treatment Specialist who shall assist the Contractor with selection of the chemical treatment system, inspect the installation and test the system. Specialist shall complete manufacturers' testing forms and submit a report to the Departmental Representative.
 - .2 Specialist shall assist Contractor clean all piping systems. Specialist shall take samples and repeat the cleaning process if specification requirements are not met.
 - .3 Specialist shall assist Contractor and add chemical immediately after the cleaning process for each system for protection. The specialist shall take samples and repeat the process until specification requirements are met.
 - .4 Specialist shall revisit the site after 1 month of operation of each system and re-test systems.
- .3 Fire Protection System:
- .1 Contractor shall hydrostatically test the systems as per the specifications and NFPA requirements to meet all certifications. The test shall be witnessed. Provide a copy of the report in NFPA 13 and NFPA 14 reporting format for all such test to the Commissioning Authority. Contractor to perform flow-pressure test on water service on Garland Street.
 - .2 Contractor to perform flow, alarm, drain flow and supervision as required.
 - .3 Coordinate interfacing with fire alarm control panel installation specified under Division 26. Perform any other test as required by this specification, and its Supplementary Guidelines and Authorities having Jurisdiction.
 - .4 Obtain approval certificates from Authorities having Jurisdiction and submit copies of the certificates to the Commissioning Authority for review.
- .4 Contractor's testing of piping systems (applicable to hydronic circulation, domestic hot and cold water, steam and condensate, sprinkler piping)
- .1 Test all piping systems in accordance with all applicable Plumbing Codes and CSA B149.
 - .2 All other systems not covered by Codes noted above shall be tested and proven tight over a period of 24 hours by a hydrostatic test. Remove fixtures, appliances, devices, vents and gauges and temporarily plug connections as required. Provide temporary by-pass when required.

- .3 Test pressure for water systems (heating/cooling, domestic cold and hot water, sprinkler piping) shall be:
 - .1 1-1/2 times the system working pressure but not less than 1,035 kPa for a minimum of 2 hours;
 - .2 Test pressure shall be limited to the maximum working pressure of expansion joints and vibration isolators.
 - .4 Repair any leaks or defects and repeat the tests to the satisfaction of the Departmental Representative.
 - .5 After completion of the testing, rough balance the water systems and ensure all coils, converters, etc., are operating approximately to the design conditions to ensure freezing conditions will not occur anywhere. Adjust the circuits by means of the balancing valves.
 - .6 Where multiple branch lines are installed, the flow in these shall be balanced to ensure hot or cold water, as applicable, at all fixtures.
 - .7 All tests for the systems shall be witnessed. Complete the testing forms and forward copies of the tests reports to the Departmental Representative and Commissioning Authority.
 - .8 Co-ordinate with TAB Contractor to ensure all necessary valves required for balancing the system are installed.
 - .9 Notify Departmental Representative and Commissioning Authority in writing that this co-ordination has taken place before installation begins. If Contractor fails to co-ordinate with TAB Contractor and if failure to co-ordinate results in being unable to balance the systems, the cost of any changes required shall be paid for by Contractor at no cost to DFO.
 - .10 Ensure all cooling coil drain pans drain freely and that no standing water remains.
 - .11 Ensure access is provided to all valves and equipment that requires servicing.
 - .12 Contractor is responsible for all equipment operating to design conditions and shall trim impellers, etc., to provide the required conditions, but is not responsible for the final balancing of the system, which shall be carried out by TAB Contractor.
 - .13 Contractor shall make available staff at no extra cost to DFO as required by TAB Contractor, to correct any deficiencies in the mechanical systems which prevent TAB Contractor from balancing the system.
 - .14 Contractor shall provide copies of all shop drawings requested by TAB Contractor.
- .5 The Independent Testing and Balancing Contractor's balancing of water and glycol hydronic systems:
- .1 Contractor shall co-ordinate with TAB Contractor and provide assistance during balancing process.
 - .2 Balancing shall not begin until all point to point and EMCS component testing has been satisfactorily completed.
 - .3 TAB Contractor shall balance the entire water system to ensure all equipment and systems are operating to design conditions. Adjust the circuits by means of the balancing valves and record the balance positions.
 - .4 Each pump shall be checked for design, working and shut-off head conditions. Any pump that varies by more than 10% from the design conditions shall have the impeller trimmed or pump changed until design conditions have been met. Contractor shall pay for impeller trimming.

- .5 Flow through all heat exchangers and other such equipment shall be balanced to ensure that the pressure drop through the equipment is within 10% of manufacturer's design conditions.
- .6 Initial balancing of coils shall be used to ensure that the pressure drops are within 10% of manufacturers' design conditions. When both the air and water systems are fully operational, entering air and water and leaving air and water readings shall be taken as close as possible to the peak design conditions to ensure the coil performance meets the design conditions. Coil water working conditions shall only be taken in conjunction with the air flow working conditions for the coil.
- .7 TAB Contractor shall co-ordinate with Contractor to ensure all necessary devices and valves for control and balancing are installed in all necessary locations. Notify Departmental Representative and Commissioning Authority in writing that this co-ordination has taken place. Include in this letter any recommendations made regarding valves, locations, installation, etc. If TAB Contractor fails to co-ordinate with Contractor and if failure to co-ordinate results in being unable to balance the systems, the cost of any changes required shall be paid for by TAB Contractor at no cost to the DFO.
- .8 TAB Contractor shall not disconnect any direct digital control (DDC) device after it has been calibrated. BAS Contractor shall make all necessary adjustments through the control system as requested by TAB Contractor. If TAB Contractor fails to co-ordinate with BAS Contractor and if failure to co-ordinate results in any cost, the cost of any change required shall be paid for by TAB Contractor at no cost to the DFO.
- .9 TAB Contractor shall co-ordinate with the EMCS Contractor and receive instruction regarding set-up, calibration and operation of the DDC as it applies to the TAB Contractor work. The EMCS Contractor shall provide the TAB Contractor with a portable operator's terminal for this work.
- .10 TAB Contractor is responsible for balancing the systems to obtain the design conditions and shall repeat the balancing until the required conditions have been met.
- .11 At time of final inspection, recheck, in presence of Departmental Representative and Commissioning Authority, random selections of data recorded in the certified report. Points or areas of recheck shall be selected by Departmental Representative/Commissioning Authority and shall be a maximum of 30% of the report data.
- .12 A measured deviation of more than 10% between the verification reading and the reported data will be considered as failing the verification procedure.
- .13 A failure of more than 10% of the selected verification readings will be considered unacceptable and will result in rejection of the report.
- .14 In the event the report is rejected, rebalance all systems, submit new certified reports and perform a re-inspection, all at no cost to the DFO.
- .15 Following final acceptance of the certified reports by Departmental Representative, permanently mark the settings of all valves and other adjustable devices so that balance set position can be restored if distributed at any time. For circuit balancing valves, record the valve position by the number of turns registered on the valve and lock the valve into that position. Do not mark such devices until after final acceptance.

- .16 Submit 6 copies of the final testing and balancing reports to Departmental Representative. Reports shall be complete with index pages and index tabs and certified by TAB Contractor. Any diagram or single line representation of a mechanical system specifically prepared for this project shall be prepared using a CAD system and shall be acceptable to Departmental Representative.
 - .17 Submit a copy of the report to Commissioning Authority for review. Include in the water balancing report: Types, serial numbers and dates and calibration of all instruments used in balancing report.
- .6 Contractor's Testing of Air Distribution Systems:
- .1 Contractor shall test for air leakage in accordance with SMACNA Manuals and Standards, all ductwork with the exception of ductwork downstream of variable air volume boxes or other pressure reducing devices. Seal ducts at all equipment connections and pressurize with a smaller blower. Test methods and results shall be in compliance with HVAC air duct leakage test manuals of SMACNA. In addition, seal any leaks. Test system as a whole or in parts, provided all ductwork is accessible for inspection at the time of test. Provide blower, calibrated orifice tube and all test equipment. (The inlet opening of the test blower shall be blocked off before the test blower is started. The inlet opening shall then be opened slowly to prevent over-pressurizing the system). Refer to the specifications for the criteria for leakage evaluation and for the definition of acceptable test results.
 - .2 Refer to specification Section related to Ductwork and Specialties for pressure ratings of ductwork and systems.
 - .3 Entire system shall be tested for noise, tightness of joints and proper functioning of the system. Noise tests shall be made under minimum system pressure drop conditions (highest air velocities and clean filter conditions). This section shall make all necessary alterations and repeat the tests until satisfactory operation is achieved.
 - .4 All tests shall be performed in presence of Departmental Representative. Complete the testing forms and forward to Departmental Representative and Commissioning Authority.
 - .5 Adjust minimum outside air controller and adjust return air and exhaust air damper linkages to approximately design air quantities, for both maximum and minimum conditions where required, to ensure freezing conditions will not occur.
 - .6 Co-ordinate with TAB Contractor to ensure all necessary manual dampers and splitter dampers for balancing the system are installed. Notify Departmental Representative in writing that this co-ordination has taken place before installation begins. If this Contractor fails to co-ordinate with TAB Contractor and if failure to co-ordinate results in being unable to balance the systems, the cost of any changes required shall be paid for by Contractor at no cost to the DFO.
 - .7 The testing equipment shall be itemized in the test reports and shall be approved by the Departmental Representative before any tests are undertaken. Calibration of the test equipment must be confirmed and approved by the Departmental Representative before any tests are undertaken.
 - .8 Ensure access is provided to all fire dampers and equipment that require servicing.

- .9 Contractor is responsible for all equipment operating to design conditions and shall change fan sheaves, etc., to provide the required conditions, but is not responsible for the final balancing of the system.
 - .10 Contractor shall make available staff, as required by TAB Contractor, to correct any deficiencies in mechanical systems which prevent TAB Contractor from balancing system.
 - .11 Contractor shall provide copies of all shop drawings requested by TAB Contractor. Contractor shall provide access ports for balancing as requested by TAB Contractor.
- .7 The Independent Testing and Balancing Contractor's balancing of air systems:
- .1 Contractor shall co-ordinate with TAB Contractor and provide assistance during the balancing process.
 - .2 Balancing shall not begin until all point to point and EMCS component testing has been satisfactorily completed.
 - .3 TAB Contractor shall balance the entire air systems including air volumes and control settings under maximum system pressure drop conditions (filter at replacement condition).
 - .4 TAB Contractor shall take air measurements, make final adjustments and report upon the air volume at each variable volume box, diffuser, register and grille. Measure the static pressure upstream and downstream of the fan, the fan speed and the motor current.
 - .5 Measure the return and supply air flow when mixing dampers are set for full outside air and minimum outside air position.
 - .6 Set the minimum position for the mixing dampers. Co-ordinate with EMCS Contractor.
 - .7 Contractor shall provide new filters, when the final balancing has been completed.
 - .8 Air volumes measured by TAB Contractor shall be within +5% of those shown on Drawings for diffusers, grilles, registers, variable air volume boxes and fans, at both maximum and minimum volumes shown.
 - .9 Duct traverse readings shall be taken through access ports. The access ports shall be Duro Dyne IP-1 or IP-2 air tight type. Duct tape is not acceptable.
 - .10 The insulation or vapour barrier shall be repaired in an approved manner, if damaged.
 - .11 For variable air volume boxes, TAB Contractor shall verify the minimum and maximum air volumes after the VAV boxes are commissioned by the EMCS Contractor.
 - .12 In all cases where measurements by TAB Contractor show failure to comply with the drawings and specifications, Contractor at no cost to DFO shall change fan sheaves, etc., as required, and new balancing measurements shall be taken by TAB Contractor.
 - .13 Ensure all thermostats and controls are set to give the specified conditions and include settings in the report.
 - .14 Adjust each supply outlet to provide proper throw and distribution in accordance with architectural requirements.
 - .15 Fans on all systems shall be set-up to give the minimum discharge pressure required to overcome the resistance of the box, discharge ductwork and diffusers.

- .16 Co-ordinate with Contractor to ensure that all necessary manual and splitter dampers for balancing are installed in all necessary locations. Notify Departmental Representative in writing that this co-ordination has taken place. Include in this letter any recommendations made regarding dampers, locations, installation, etc. If TAB Contractor fails to co-ordinate with Contractor and if failure to co-ordinate results in being unable to balance the systems, the cost of any changes required shall be paid for by TAB Contractor at no cost to DFO
- .17 TAB Contractor shall not disconnect any control device after it has been calibrated. EMCS Contractor shall make all necessary adjustments through Building Automation and Controls Systems as requested by TAB Contractor. If TAB Contractor fails to co-ordinate with EMCS Contractor and if failure to co-ordinate results in any cost, the cost of any change required shall be paid for by TAB Contractor at no cost to DFO
- .18 TAB Contractor shall co-ordinate with EMCS Contractor and receive instruction regarding set-up, calibration and operation of the DDC as it applies to TAB Contractor work. EMCS Contractor shall provide, TAB Contractor, with a portable operator's terminal for this work.
- .19 TAB Contractor is responsible for balancing the systems to obtain the design conditions and shall repeat the balancing until the required conditions have been met.
- .20 At the time of final inspection, recheck in the presence of Departmental Representative and Commissioning Authority random selections of air quantities and fan data recorded in the certified report. Points or areas for recheck would be selected by Departmental Representative/Commissioning Authority and shall be a maximum of 30% of the report data.
- .21 At the time of verification measure space temperature and relative humidity in a representative number of rooms to verify performance. Tabulate these results and include in certified report as an appendix.
- .22 A measured flow deviation of more than 10% between the verification reading and the reported data will be considered as failing the verification procedure.
- .23 A failure of more than 10% of the selected verification readings will be considered unacceptable and will result in rejection of the report.
- .24 In the event the report is rejected, rebalance all systems, submit new certified reports and re-inspect, all at no cost to DFO.
- .25 Following final acceptance of the certified report by Departmental Representative, permanently mark the settings of all dampers, splitters and other adjustable devices so balance set position can be restored if distributed at any time. Do not mark such devices until after final acceptance.
- .26 Submit 6 copies of the final testing and balancing report to Departmental Representative. Reports shall be complete with index pages and index tabs and certified by TAB Contractor. Any diagram or single line representation of a mechanical system specifically prepared for this project shall be prepared using a CAD system and shall be acceptable to Departmental Representative.
- .27 Submit a copy of the report to Commissioning Authority for review.
- .28 Include in balancing report:
 - .1 Types, serial numbers and dates of calibration of all instruments used in balancing report;

- .2 Equipment data, manufacturer and model size, arrangement discharge and class, motor type, horse power, voltage, phase, cycles and full load amps. Location and local identification data;
 - .3 Fan design data, total volume flow rate, static pressure, motor type, RPM, volts, full load amps and outside air flow rate;
 - .4 A complete system schematic with design and actual flow rates at each outlet or inlet. Show room numbers and floors. Duct air quantities: for mains, branches and maximum and minimum for outside air and exhausts, duct size, pressure readings, average velocity, duct recorded flow rates, duct design flow rates. Air inlet and outlets, supply or exhaust outlet identification. Location and number designation;
 - .29 Manufacturers' catalogue identification and type, of air inlets and outlets application factors, designated area, design and recorded velocities, design and recorded air flow rates, deflector vane of diffusion cone settings.
- .8 Testing of HVAC and Specialties Equipment and Systems:
- .1 General:
 - .1 Contractor shall prepare and submit for approval, Commissioning Plan and schedule which includes:
 - .1 Detailed schedule for all individual testing activity. The detail shall include the steps to be taken sequentially and indicate which conditions should be observed and recorded;
 - .2 The status of systems to be able to perform tests;
 - .3 Required testing equipment;
 - .4 Manufacturers' commissioning time for all systems and equipment;
 - .5 Required time for remedial works if necessary;
 - .6 Staged start-up and commissioning of the systems.
 - .2 Start-up and test procedures must be consistent with manufacturer's recommendations contained in the Operating and Maintenance Manual.
 - .3 The start-up report shall record all observations made during the start-up procedures including problems and their resolutions.
 - .4 Contractor shall retain the services of the manufacturer's technicians to test the equipment and associated systems. Technician shall record the results of the tests on the testing forms. The tests shall be witnessed by Departmental Representative. When tests have been completed satisfactorily the technician and witnessing authority shall sign the forms. A copy of the forms shall be forwarded to the Departmental Representative. The original shall be inserted into the Operating Manual.
 - .5 Should equipment or systems fail a test, the test shall be repeated after repairs or adjustments have been made. The additional tests shall be witnessed by the Departmental Representative and the Commissioning Authority.
 - .6 Tests which have not been witnessed shall not be accepted and shall be repeated.
 - .7 Equipment and systems to be tested shall include but not limited to the following wherever applicable:
 - .1 Plumbing and drainage system including pumps, piping, tanks, etc.

- .2 Hydronic systems including boilers and distribution
 - .3 Ventilation system including ductwork, air terminals, fans, solar collectors, etc.
 - .4 Air handling units;
 - .5 Heat recovery systems;
 - .6 Steam humidification system including humidifier, piping, steam accessories, etc.;
 - .7 Fire protection system
 - .8 Building automation and controls systems;
 - .9 Pumped condensate drain system;
 - .10 VRF Heat Pump System
- .9 Air Handling System:
- .1 Air handling units shall be inspected and tested by manufacturer's technician. Technician shall enter the test results on forms provided by manufacturer. The Departmental Representative shall witness the final operational test.
 - .2 Technician shall verify that the air handling units have been installed according to manufacturer's recommendations, shop drawings and the specification.
 - .3 Tests shall include verification of electrical power, electrical interlocks, safeties, control, heating coils, fans and dampers.
 - .4 Technician shall start-up the air handling unit and monitor the operation for a minimum of 4 hours of running time after all tests have been completed. Technician shall revisit the site after 1 month of operation and monitor the operation of the system for a minimum period of 4 hours running time. Technician shall issue a report to Departmental Representative after each visit.
 - .5 Air handling unit manufacturer shall co-ordinate with EMCS Contractor to provide the necessary interface to the Building Automation and Controls Systems. Technician shall witness the Building Automation and Controls Systems testing procedure for the air handling unit and sign the testing forms.
 - .6 Contractor shall rectify any deficiencies identified by TAB Contractor.
- .10 Humidification System:
- .1 Humidifiers shall be inspected and tested by manufacturer's technician. Technician shall enter the test results on the forms provided by manufacturer. Departmental Representative shall witness the final operational test.
 - .2 Technician shall verify humidifiers have been installed according to manufacturer's recommendations, shop drawings and the specification.
 - .3 Tests include verification of safeties and control, drains, steam piping and insulation, steam nozzles and distribution.
 - .4 Technician shall start-up the humidifiers, record and monitor their operation for a minimum of 4 hours running time after the tests have been completed. Technician shall revisit the site after 1 month of operation and monitor the operation of the humidifiers for a minimum period of 4 hours running time. Reports shall be forwarded to Departmental Representative after each visit.
 - .5 Manufacturer shall co-ordinate with EMCS Contractor to provide necessary interface to the Building Automation and Controls Systems. Technician shall

witness the Building Automation and Controls Systems testing procedure and control of the humidifiers.

.11 Hydronic Systems:

- .1 Pumps and other equipments shall be inspected and tested by manufacturer's technician. Technician shall enter the test results on forms provided by manufacturer. Departmental Representative shall witness the final operational test.
- .2 Technician shall verify heat exchangers and pumps have been installed according to manufacturer's recommendations, shop drawings and the specification.
- .3 Tests shall include verification of safeties and controls.

.12 Building Automation and Controls Systems:

- .1 The Building Automation and Controls Systems shall be fully tested and commissioned by manufacturer's technician to operate in the manner defined by the specifications.
- .2 EMCS Contractor shall provide a print-out of general and critical alarm lists and all points connected to the Building Automation and Controls Systems. The all point log shall be sub-divided into points per system. One report shall be taken prior to the acceptance test.
- .3 EMCS Contractor shall provide an operating terminal and sufficient training and instruction to TAB Contractor which will allow them to set-up and balance the water and air systems.
- .4 A point-to-point testing shall be done by EMCS Contractor. This test shall include, but is not limited to:
 - .1 Ensuring that wiring is accurately connected to appropriate terminals;
 - .2 Checking the function of each control and controlled device (such as the beginning, end and extent of actuator travel);
 - .3 Connection integrity between actuator and device;
 - .4 Calibration of sensors;
 - .5 Output from sensors;
 - .6 Operation of relays;
 - .7 Data/information integrity at console;
 - .8 Remote reset integrity from console to field device;
 - .9 Interfacing with other systems such as life safety monitoring system.
 - .10 EMCS contractor in conjunction with the mechanical contractor shall create simulated design load conditions for control verification tests.
- .5 Testing procedure shall include but is not limited to:
 - .1 Check and verify that each input point is reporting to the Building Automation and Controls Systems panels and workstations in the normal state and change or state;
 - .2 Create false alarms at each point and provide a print-out of the test;
 - .3 Command each output point, via the workstation and verify the action at the device;

- .4 Verify that each time of day and optimum start program is operational in software and at the device;
 - .5 Verify that each program is operational in software and at the device(s);
 - .6 Verify that each system graphic is dynamically updating;
 - .7 Test each DDC loop and verify that it is controlling in a stable manner. Create set point changes on output points. False loads shall be introduced to observe the control loops response. Program trend logs at the Building Automation and Controls Systems for a minimum of 30 minutes per control loop with a sampling time of 30 seconds. Provide a print-out of the results. Tune each DDC loop prior to acceptance test. Check each loop again, once during the heating and once during the cooling season and re-tune where necessary;
 - .8 Verify that each report type is functional;
 - .9 Verify that each global program that controls more than 1 system is operating;
 - .10 Verify that all safeties are operating (ie. firestats);
 - .11 Verify valve and damper actuation;
 - .12 Verification of the minimum and maximum settings on VAV boxes (if used);
 - .13 Verify the calibration of each analog input point.
- .6 Any sensor disconnected from the input terminal after completion of the performance test shall be retested.
 - .7 EMCS Contractor shall provide a “signed-off” copy of the results of all tests to the Departmental Representative. Acceptance test will not begin until the tests have been reviewed and accepted. Departmental Representative shall witness these tests.
 - .8 Provide the calibration procedure for each analog sensor. Physically check the calibration of each analog sensor type using a calibrated instrument prior to testing.
 - .9 When all tests have been completed EMCS Contractor shall request the acceptance test procedure shall begin. Departmental Representative shall verify the installation is complete and all tests have been performed and have been successful. EMCS Contractor shall then initiate the acceptance test.
 - .10 The acceptance test period shall be 21 Days. EMCS Contractor shall visit the site each morning. Monday to Friday, to review the Building Automation and Controls Systems operation and the building operators log book. The operators log book shall be provided by the EMCS Contractor and shall contain all problems experienced by the Custodians. The log shall show the point name and number, time and date of failure and time of return service. During the first 14 Days of the acceptance test, any operational or equipment failures shall be corrected and the acceptance test shall continue from the date the failure has been corrected. During the last 7 Days of testing, no major failures of any kind will be accepted, or the last 7 Days shall be repeated.
 - .11 During the acceptance test Contractor shall print out 1 “all-points” log per day. The logs shall be issued to Departmental Representative for review.
 - .12 EMCS Contractor shall set up trend logs and group logs which shall be stored on hard disk for review by Departmental Representative.

- .13 System shall not be accepted or considered substantially complete until all tests are completed and approved.
- .14 EMCS Contractor shall provide a minimum of 2 weeks notice to Departmental Representative prior to testing date.
- .15 EMCS Contractor shall revisit the site during the first year of operation to review the performance of the Building Automation and Controls Systems. The review shall include DDC loop tuning, sensor calibration, programs, communication, DDC panels, workstations and the operational logs. The visits shall be a minimum of 8 hours each visit. The visits shall be:
 - .1 Beginning of cooling season;
 - .2 During the cooling season;
 - .3 Beginning of heating season;
 - .4 During the heating season.

1.18 OPERATING AND MAINTENANCE MANUAL

- .1 Contractor shall prepare and submit the Operating and Maintenance Manual as detailed in the specification to Departmental Representative 6 weeks prior to beginning of training.
- .2 Contractor shall re-submit the manual should the Departmental Representative find deficiencies. Training shall not begin until the manual has been accepted by the Departmental Representative. One copy of the manual shall be forwarded to Commissioning Authority in good quality, vinyl covered binders.
- .3 Each Mechanical manual shall be organized as follows, but not limited to following:
 - .1 A - Project Directory;
 - .2 B - Fire Protection;
 - .3 C - Heating;
 - .4 D – VRF Heat Pump System
 - .5 E - Air Handling Units;
 - .6 F - Ventilation;
 - .7 G - Building Automation and Controls Systems;
- .4 Project directory shall contain the names, addresses, fax numbers and telephone numbers of Contractors, Subcontractors, manufacturers and manufacturer's representatives.
- .5 Sections B to F shall be divided into the following subsections:
 - .1 Shop drawings (reduced to 216 mm to 290 mm);
 - .2 As-built drawings (reduced to 216 mm to 290 mm);
 - .3 As-built riser diagrams (reduced to 216 mm x 290 mm);
 - .4 Operating procedures;
 - .5 Maintenance procedures;
 - .6 Spare parts list;
 - .7 Trouble shooting guide;

- .8 Valve chart (where applicable);
 - .9 Filter size chart (where applicable);
 - .10 Equipment lists;
 - .11 Testing and verification forms;
 - .12 Certification forms.
- .6 Section G shall be sub-divided into the following sub-sections:
- .1 Shop drawings;
 - .2 As-built control sequences;
 - .3 As-built panel layout and points list;
 - .4 All point log per system;
 - .5 Operating procedures for all equipment and systems;
 - .6 Maintenance procedures for all equipment;
 - .7 Spare parts list;
 - .8 Software licensing agreements;
 - .9 Software manuals;
 - .10 Software disks;
 - .11 Point data and program disks;
 - .12 Testing and verification forms.
- .7 Operating procedures shall be the recommended manufacturer's operating procedures for the equipment.
- .8 Maintenance procedures shall include Scope of Work, frequency of activity, parts required and necessary documentation.
- .9 Spare parts list shall be manufacturer's recommended list for maintenance purposes.
- .10 Trouble shooting guide shall be manufacturer's recommendation for equipment.
- .11 Equipment list shall include make, model, serial number, electrical characteristics, RPM, pump impeller sizes, fan belt and sheave sizes.
- .12 Operating and Maintenance Manual shall be submitted to the Departmental Representative in three (3) copies.

1.19 SYSTEMS OPERATING MANUAL

- .1 The Systems Operating Manual will be used by the maintenance personnel to assist them in the daily operation of the systems.
- .2 Systems Operating Manual shall be prepared by Commissioning Authority using data collected by Contractor and test results.
- .3 Each section describing a system will contain as a minimum:
 - .1 A basic description of the system;
 - .2 System location and areas it serves;
 - .3 A basic description of operations;
 - .4 Electrical services and locations;
 - .5 EMCS points alarm limits and setpoints;
 - .6 Time of Day schedules;
 - .7 A schematic of the system.
- .4 Commissioning Authority shall provide a copy of the Systems Operating Manual to Departmental Representative.

1.20 OPERATOR TRAINING AND INSTRUCTIONS

- .1 Contractor and equipment manufacturers shall provide operator training for each mechanical system and equipment.
- .2 The training and instruction shall be provided by qualified technicians and shall be conducted in a classroom setting at the equipment or system.
- .3 Training and instruction will begin when the Operating and Maintenance Manual has been approved and delivered to Departmental Representative.
- .4 Each session shall be structured to cover:
 - .1 The Operating and Maintenance Manual;
 - .2 Operating procedures;
 - .3 Maintenance procedures;
 - .4 Trouble-shooting procedures;
 - .5 Manufacturer's or service representative's name, address and phone number.
- .5 Contractor shall prepare a detailed training and instruction plan. This plan shall include the outline of all sessions and identification of the training presenters.
- .6 Submit the plan including a copy of training manual for Commissioning Authority's review and approval.

- .7 Provide course documentation for up to 6 people.
- .8 The sessions shall be co-ordinated and videotaped by the Commissioning Authority.
- .9 Training and instruction shall be provided for the following systems wherever applicable:

SYSTEM	MINIMUM TRAINING DURATION
Air Handling Units	2 hours per unit
Heating and Ventilation Systems	2 Days
Building Automation and Controls Systems	3 Days
Other Mechanical Systems	See Specs.

- .10 The minimum training and instruction for the Building Automation and Controls Systems shall be 3 Days. The training shall include:
 - .1 A 1 Day class session at manufacturer's local office for 2 of maintenance personnel;
 - .2 A walk-through of the installation for all maintenance personnel to review the installation and equipment;
 - .3 Operation of the central computer;
 - .4 Operation of portable terminals;
 - .5 Control sequences;
 - .6 Report set-up and generation;
 - .7 Managing the system;
 - .8 Maintenance requirements.
- .11 Training and instruction requirement for the mechanical system shall include a walk-through of building by Contractor. During the walk-through the Contractor shall:
 - .1 Identify equipment;
 - .2 Identify starters associated with equipment;
 - .3 Identify valves and balancing dampers;
 - .4 Identify access doors;
 - .5 Review general maintenance of equipment;
 - .6 Review drain points in pipework systems;
 - .7 Identify maintenance items.
- .12 When each session has been completed, the Commissioning Authority shall sign to certify completion.

1.21 SYSTEMS DEMONSTRATION AND TURNOVER

- .1 System demonstration and turnover to the DFO shall occur when:
 - .1 The installation is complete;
 - .2 Acceptance test conducted by the Departmental Representative has been successfully completed;
 - .3 Commissioning Authority system testing has been successfully complete;
 - .4 Training and instruction has been completed;
 - .5 Operating and Maintenance Manual have been accepted;
 - .6 Shop drawings have been updated;
 - .7 As-built drawings have been completed.
- .2 Systems demonstration shall be conducted by Contractor and manufacturers. The demonstration shall cover all operation and maintenance requirements and a physical demonstration of equipment installation and operation.

1.22 TESTING FORMS

- .1 Contractor and manufacturers shall provide information required to complete forms listed in this Section and any other additional data sheets not included in this specification, but required for the mechanical and electrical systems of this Project. All forms to be supplied by Commissioning Authority.
- .2 Commissioning index form shall be maintained by Commissioning Authority to track progress of the commissioning requirements.
- .3 Mechanical testing and verification forms to be completed are as follows wherever applicable, but not limited to:
 - .1 Commissioning index form;
 - .2 Drainage testing form;
 - .3 Equipment test form;
 - .4 Piping pressure test form;
 - .5 System and equipment warranty dates form;
 - .6 System verification form;
 - .7 Test identification form;
 - .8 Testing and start-up schedule form;
 - .9 Air handling unit data sheet;
 - .10 Chemical treatment data sheet;
 - .11 Coil data sheet;
 - .12 Controller device data sheet;
 - .13 Controls data sheet;
 - .14 Damper data sheet;
 - .15 Fan data sheet;
 - .16 Filter data sheet;
 - .17 Heat exchanger data sheet;

- .18 Humidifier data sheet;
- .19 Pressure reducing valve data sheet;
- .20 Pump data sheet;
- .21 Heater data sheet
- .22 VRF Heat pump data sheet.

1.23 EQUIPMENT AND SYSTEM WARRANTIES

- .1 Equipment and system warranties shall be as defined in Division 01.
- 2 Contractor shall fill-out the warranty form listing the equipment and systems and the start and finishing dates for warranty.
- .3 Refer to Division 1, Division 25 and Division 26 of the specification for the requirements during the warranty period.
- .4 Contractor shall re-visit the building during the warranty period with Departmental Representative, Commissioning Authority and DFO. During these visits the performance of the system shall be reviewed. These visits shall occur:
 - .1 Once during the first month of building operation;
 - .2 Once during the third month of building operation;
 - .3 Once between fourth and tenth month in a session opposite to the first and third month visits.
- .5 The Departmental Representative shall organize these visits.
- .6 At these meetings DFO, Departmental Representatives and Commissioning Authority shall review the performance of the systems. If the performance is satisfactory then no further action need to be taken. If unsatisfactory then Contractor will be instructed to correct deficiencies, at his cost, to the satisfaction of Departmental Representative.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .3 Section 23 05 00 - Common Work Results – Mechanical.

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE).
 - .1 ASHRAE 90.1-01, Energy Code for Buildings Except Low-Rise Residential Buildings.
- .2 Electrical Equipment Manufacturers' Advisory Council (EEMAC).

1.3 SECTION INCLUDES

- .1 Electrical work to conform to Division 26 including the following:
 - .1 Supplier and installer responsibility is indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.
 - .2 Control wiring and conduit shall be done by Division 25 to standards set out in Division 26.
 - .3 Division 26 shall leave designated breakers in power panels throughout the building where Division 25 will tie in to Division 25 power requirements.

1.4 COORDINATION

- .1 Refer to Division 01, 21, 22 and 25 for other requirements as included and outlined in other sections of the specifications.

1.5 SHOP DRAWINGS

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

1.6 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 33 00 - Submittal Procedures.

1.7 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Divert unused metal and wiring materials from landfill to metal recycling facility approved by Departmental Representative.
- .3 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .4 Dispose of corrugated cardboard, polystyrene, plastic, packaging material in appropriate on-site bin for recycling in accordance with site waste management program.

PART 2 PRODUCTS

2.1 GENERAL

- .1 Motors to be high efficiency, in accordance with local Hydro company standards and the requirements of ASHRAE 90.1.

2.2 MOTORS

- .1 Provide motors for mechanical equipment as specified.
- .2 If delivery of specified motor will delay delivery or installation of equipment, install motor approved by Departmental Representative for temporary use. Final acceptance of equipment will not occur until specified motor is installed.
- .3 Motors under 373 W (1/2 HP): speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.
- .4 Motors 373 W (1/2 HP) and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40°C, 3 phase, 575 V, unless otherwise specified or indicated.

2.3 TEMPORARY MOTORS

- .1 If delivery of specified motor will delay completion or commissioning work, install motor approved by Departmental 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 specified.

- .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 to be 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 23 05 00 - Common Work Results for HVAC.

2.5 DRIVE GUARDS

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

PART 3 EXECUTION

3.1 INSTALLATION

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

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Section 01 74 11 - Cleaning.
- .3 Section 23 05 00 - Common Work Results – Mechanical.
- .4 Section 23 08 16 - Cleaning and Start-up of HVAC Piping Systems.

1.2 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal recycling facility approved by Departmental Representative.

1.4 COORDINATION

- .1 Refer to Division 01, 21, 22 and 25 for other requirements as included and outlined in other sections of the specifications.

PART 2 PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 EXECUTION

3.1 CONNECTIONS TO EQUIPMENT

- .1 In accordance with manufacturer's instructions unless otherwise indicated.
- .2 Use valves and either unions or flanges for isolation and ease of maintenance and assembly.
- .3 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.

3.2 CLEARANCES

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

3.3 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. Discharge to be visible.
- .4 Drain valves: 19mm gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

3.4 AIR VENTS

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

3.5 DIELECTRIC COUPLINGS

- .1 General: Compatible with system, to suit pressure rating of system.
- .2 Locations: Where dissimilar metals are joined.
- .3 50mm and under: isolating unions or bronze valves.

- .4 Over 50mm: Isolating flanges.

3.6 PIPEWORK INSTALLATION

- .1 Screwed fittings jointed with Teflon tape.
- .2 Protect openings against entry of foreign material.
- .3 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .4 Assemble piping using fittings manufactured to ANSI standards.
- .5 Saddle type branch fittings may be used on mains if branch line is no larger than half the size of main.
 - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .6 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .7 Install concealed pipework to minimize furring space, maximize headroom and conserve space.
- .8 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .9 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .10 Group piping wherever possible and as indicated.
- .11 Ream pipes, remove scale and other foreign material before assembly.
- .12 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .13 Provide for thermal expansion as indicated.
- .14 Valves:
 - .1 Install in accessible locations.
 - .2 Remove interior parts before soldering.
 - .3 Install with stems above horizontal position unless otherwise indicated.
 - .4 Valves accessible for maintenance without removing adjacent piping.
 - .5 Install globe valves in bypass around control valves.
 - .6 Use gate or ball valves at branch take-offs for isolating purposes except where otherwise specified.
 - .7 Install butterfly valves between weld neck flanges to ensure full compression of liner.
 - .8 Install ball valves for glycol service.
 - .9 Use chain operators on valves 63mm and larger where installed more than 2400 mm above floor in Mechanical Rooms.

- .15 Check Valves:
 - .1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and elsewhere as indicated.
 - .2 Install swing check valves in horizontal lines and elsewhere as indicated.

3.7 SLEEVES

- .1 General: Install where pipes pass through masonry, concrete structures, fire rated assemblies, and elsewhere as indicated.
- .2 Material: Schedule 40 black steel pipe.
- .3 Construction: Foundation walls and where sleeves extend above finished floors to have annular fins continuously welded on at mid-point.
- .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: Provide space for firestopping. 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.

3.8 ESCUTCHEONS

- .1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.
- .2 Construction: One piece type with set screws. Chrome or nickel plated brass or type 302 stainless steel.
- .3 Sizes: Outside diameter to cover opening or sleeve. Inside diameter to fit around pipe or outside of insulation if so provided.

3.9 PREPARATION FOR FIRESTOPPING

- .1 In accordance with Section 07 84 00 - Fire Stopping.

- .2 Material and installation within annular space between pipes, ducts, insulation and adjacent fire separation to be ULC listed and acceptable to the Provincial Fire Marshal Office. Installation to be as per Manufacturer's recommendations and ULC's testing procedures.
- .3 Uninsulated unheated pipes not subject to movement: No special preparation.
- .4 Uninsulated heated pipes subject to movement: Wrap with non-combustible smooth material to permit pipe movement without damaging firestopping material or installation.
- .5 Insulated pipes and ducts: Ensure integrity of insulation and vapour barriers.

3.10 FLUSHING OUT OF PIPING SYSTEMS

- .1 In accordance with Section 23 08 16 - Cleaning and Start-up of HVAC Piping Systems.
- .2 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 11 – Cleaning.
- .3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.11 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

- .1 Advise Departmental Representative 48 hours minimum prior to performance of pressure tests.
- .2 Pipework: Test as specified in relevant sections of Division 23.
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant sections of Division 23.
- .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 Departmental Representative.
- .6 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after approval and certification of tests by Departmental Representative.

3.12 EXISTING SYSTEMS

- .1 Connect into existing piping systems at times approved by Departmental Representative.
- .2 Request written approval 10 days minimum, prior to commencement of work.
- .3 Be responsible for damage to existing plant by this work.

.4 Ensure daily clean-up of construction areas.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 00 – Common Work Results – Mechanical.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material, in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal facility as approved by Departmental Representative.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

1.3 REFERENCES

- .1 ASTM A53-10 - Specification for Pipe, Steel, Black and Hot - Dipped, Zinc-Coated Welded and Seamless.

1.4 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Indicate for each item as applicable:
 - .1 Manufacturer, model number, line content, pressure and temperature rating.
 - .2 Movement handled; axial, lateral, angular and the amounts of each.
 - .3 Space between anchors, calculated expansion, traverse of selected expansion joint, number of pipe grinder required and anchor force.
 - .4 Nominal size and dimensions including details of construction and assembly.

1.5 COORDINATION

- .1 Refer to Division 01, 21, 22, 25 and 26 for other requirements as included and outlined in other sections of the specifications.

1.6 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into manual specified in Section 01 77 00 – Closeout Procedures.
- .2 Data to include:
 - .1 Servicing requirements, including stuffing box packing, lubrication and recommended procedures.

PART 2 PRODUCTS

2.2 FLEXIBLE CONNECTIONS

- .1 Inner hose: bronze corrugated.
- .2 Braided wire mesh bronze outer jacket.
- .3 Size and end connection: as indicated.
- .4 Operating conditions:
 - .1 Working pressure: 827 kPa.
 - .2 Working temperature: 93.3°C.
 - .3 To match system requirements.
- .5 Capacity: to absorb 150mm transverse movement with length across flexible portion not less than six diameters.
- .6 Maximum length of hose: 609mm.
- .7 Location:
 - .1 As indicated on Drawings.

2.3 GUIDES

- .1 Pipe alignment guide to consist of a spider rigidly attached to the pipe and housed in a steel sleeve that in turn is rigidly anchored. Pipe guides to permit free axial movement of the pipe while prohibiting lateral movement and restricting any tendency towards angular movement.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Install in accordance with the manufacturer's instructions.
- .2 Provide expansion loops as indicated and as required for proper operation of the piping system.

- .3 Provide anchors and pipe guides for proper operation of expansion loops. Anchors to withstand 150% of axial thrust. Number of pipe guides to be as per manufacturer's recommendations.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 01 74 19 - Construction/Demolition Waste Management and Disposal.

1.2 REFERENCES

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
 - .1 ANSI/ASME B31.1-1998, Power Piping.
 - .2 ANSI/ASME B31.3-2000, Process Piping Addenda A.
 - .3 ANSI/ASME B31.3-2001, Process Piping Addenda B.
 - .4 ANSI/ASME Boiler and Pressure Vessel Code-1998:
 - .1 Section I: Power Boilers.
 - .2 Section V: Nondestructive Examination.
 - .3 Section IX: Welding and Brazing Qualifications.
- .2 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA C206-97, Field Welding of Steel Water Pipe.
- .3 American Welding Society (AWS)
 - .1 AWS C1.1-2000, Recommended Practices for Resistance Welding.
 - .2 AWS Z49.1-1999, Safety Welding, Cutting and Allied Process.
 - .3 AWS W1-2000, Welding Inspection Handbook..
- .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-48.2-92, Spot Radiography of Welded Butt Joints in Ferrous Materials.
- .5 Canadian Standards Association (CSA International)
 - .1 CSA W47.2-M1987(R1998), Certification of Companies for Fusion Welding of Aluminum.
 - .2 CSA W48 series-01, Filler Metals and Allied Materials for Metal Arc Welding.
 - .3 CSA B51-97, Boiler, Pressure Vessel and Pressure Piping Code.
 - .4 CSA-W117.2-01, Safety in Welding, Cutting and Allied Processes.
 - .5 CSA W178.1-02, Certification of Welding Inspection Organizations.
 - .6 CSA W178.2-01, Certification of Welding Inspectors.

1.3 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 Furnish welder's qualifications to Departmental 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.

1.4 QUALITY ASSURANCE

- .1 Registration of welding procedures in accordance with CSA B51.
- .2 Copy of welding procedures available for inspection.
- .3 Safety in welding, cutting and allied processes in accordance with CSA-W117.2.

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal, and with the Waste Reduction Workplan.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.

PART 2 PRODUCTS

2.1 ELECTRODES

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

PART 3 EXECUTION

3.1 WORKMANSHIP

- .1 Welding: in accordance with ANSI/ASME B31.1 B31.3, 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.

3.2 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 50 mm and smaller: install welding type sockets.
 - .2 Branch connections: install welding tees or forged branch outlet fittings.

3.3 INSPECTION AND TESTS - GENERAL REQUIREMENTS

- .1 Review weld quality requirements and defect limits of applicable codes and standards with Departmental Representative before work is started.
- .2 Formulate "Inspection and Test Plan" in co-operation with Departmental 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.

3.4 SPECIALIST EXAMINATIONS AND TESTS

- .1 General
 - .1 Perform examinations and tests by specialist qualified in accordance with CSA W178.1 and CSA W178.2 and approved by Departmental Representative.
 - .2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.
 - .3 Inspect and test 100% of welds in accordance with "Inspection and Test Plan" by non-destructive visual examination and magnetic particle (hereinafter referred to as "particle") tests.
- .2 Hydrostatically test welds to requirements of 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 Departmental Representative of total of up to 10 % of welds, selected at random by Departmental Representative by radiographic tests.

3.5 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 100 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 1500 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 particle tests.

3.6 REPAIR OF WELDS WHICH FAILED TESTS

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

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 00 – Common Work Results - Mechanical.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material, in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal facility as approved by Departmental Representative.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittals.
- .2 Indicate on manufacturers catalogue literature the following:
 - .1 Thermometers.
 - .2 Pressure gauges.
 - .3 Mini ball valves.
 - .4 Syphons.
 - .5 Wells.

1.4 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into manual specified in Section 01 77 00 – Closeout Procedures.

1.5 COORDINATION

- .1 Refer to Division 01, 21, 22, 25 and 26 for other requirements as included and outlined in other sections of the specifications.

PART 2 PRODUCTS

2.1 GENERAL

- .1 Thermometers and pressure gauges to operate at mid-point of scale or range.

2.2 DIRECT READING THERMOMETERS

- .1 Industrial, variable angle type, liquid filled, 225mm (9") scale length: to CAN/CGSB 14-GP-2A.
- .2 Thermometers shall read temperatures in °F and °C both.

2.3 REMOTE READING THERMOMETERS

- .1 100mm (4") mercury activated dial type: to CAN/CGSB-14.5, stainless steel bourdon tube, accuracy within one scale division, brass movement, stainless steel capillary, stainless steel spiral armour, stainless steel bulb and polished brass case for wall mounting.

2.4 THERMOMETER WELLS

- .1 For copper pipe use copper or bronze.
- .2 For steel pipe use stainless steel.

2.5 PRESSURE GAUGES

- .1 100mm (4"), dial type: CGSB 91-GP-3, having 1/2 of 1% accuracy unless otherwise specified.
- .2 Provide mini ball valves and:
 - .1 Snubber for pulsating operation.
 - .2 Diaphragm for corrosive service.

PART 3 EXECUTION

3.1 GENERAL

- .1 Install so they can be easily read from floor or platform. If this cannot be accomplished, install remote reading thermometers and gauges.
- .2 Install engraved lamicoid nameplates as specified in Section 23 05 53 – Identification for HVAC Piping and Equipment, identifying medium.

3.2 THERMOMETERS

- .1 Install in wells on all piping. Provide heat conductive material for inside of well.
- .2 Install in locations as indicated and on inlet and outlet of:
 - .1 DHW tanks.
 - .2 Inlet and outlet on all three way control valves.
 - .3 Inlet & outlet of heating and cooling coils.
 - .4 Heat exchangers.
 - .5 Inlet and outlet of heat pumps and boilers.
 - .6 In other locations as indicated.
- .3 Use extensions where thermometers are installed through insulation.

3.3 PRESSURE GAUGES

- .1 Install in following locations:
 - .1 Suction and discharge of pumps.
 - .2 Upstream and downstream of PRV's.
 - .3 Upstream and downstream of mixing valves and control valves.
 - .4 Inlet and outlet of all coils.
 - .5 Inlet and outlet of heat exchangers.
 - .6 Inlet and outlet of heat pumps and boilers.
 - .7 In other locations as indicated.
- .2 Use extensions where pressure gauges are installed through insulation.

END

PART 1 GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Bronze - valves.
- .2 Sustainable requirements for construction and verification.
- .3 Related Sections:
 - .1 Section 01 33 00 - Submittal Procedures.
 - .2 Section 01 35 29 - Health and Safety Requirements.
 - .3 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .4 Section 01 78 00 - Closeout Submittals.
 - .5 Section 23 05 15 – Common Installation Requirements for HVAC Pipework.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME).
 - .1 ANSI/ASME B1.20.1 (R2001), Pipe Threads, General Purpose (Inch).
 - .2 ANSI/ASME B16.18-2001, Cast Copper Alloy Solder Joint Pressure Fittings.
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A276-04, Specification for Stainless Steel Bars and Shapes.
 - .2 ASTM B62-02, Specification for Composition Bronze or Ounce Metal Castings.
 - .3 ASTM B283-99a, Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
 - .4 ASTM B505/B505M-02, Specification for Copper-Base Alloy Continuous Castings.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
 - .1 MSS-SP-25-1998, Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 MSS-SP-80-2003, Bronze Gate Globe, Angle and Check Valves.
 - .3 MSS-SP-110-1996, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 62 00.01 - Hazardous Materials.
 - .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Submit data for valves specified in this section.

- .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 - Health and Safety Requirements.

1.5 DELIVERY STORAGE AND DISPOSAL

- .1 Waste Management and Disposal:
 - .2 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .3 Collect and separate for disposal packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

PART 2 PRODUCTS

2.1 MATERIALS

- .1 Valves:
 - .1 Except for specialty valves, to be single manufacturer.
 - .2 All 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: Solder ends to ANSI/ASME B16.18.
- .3 Lockshield Keys:
 - .1 Where lockshield valves are specified, provide 10 keys of each size: malleable iron cadmium plated.
- .4 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: non-asbestos.

- .6 Handwheel: non-ferrous.
- .7 Handwheel Nut: bronze to ASTM B62.
- .2 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 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 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 NPS 2 and under, rising stem, solid wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Operator: Handwheel.
- .6 NPS 2 and under, rising stem, solid wedge disc, Class 150:
 - .1 Body: with long disc guides, screwed union bonnet.
 - .2 Operator: Handwheel.
- .5 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.
 - .2 NPS 2 and under, composition disc, Class 125:
 - .1 Body and bonnet: screwed bonnet.
 - .2 Disc and seat: renewable rotating disc composition to suit service conditions , regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
 - .3 Operator: Handwheel.
 - .3 NPS 2 and under, composition disc, Class 150:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat: renewable rotating disc in easily removable disc holder, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
 - .3 Operator: Handwheel.
 - .4 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 AISI S420 stainless steel to ASTM A276, loosely secured to stem.

- .3 Operator: Handwheel.
- .5 Angle valve, 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.
- .6 Check Valves:
 - .1 Requirements common to check valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Connections: screwed with hexagonal shoulders.
 - .2 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 NPS 2 and under, swing type, bronze disc:
 - .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 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 composition to suit service conditions, bronze two-piece hinge disc construction.
 - .5 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 rotating disc in disc holder having guides top and bottom, of bronze to ASTM B62.
 - .6 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 Silent Check Valves:
 - .1 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 Stainless steel spring, heavy duty.
 - .6 Seat: regrindable.

- .8 Ball Valves:
 - .1 NPS 2 and under:
 - .1 Body and cap: cast high tensile bronze to ASTM B62.
 - .2 Pressure rating: Class125 2760-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 solid ball and teflon seats.
 - .7 Stem seal: TFE with external packing nut.
 - .8 Operator: removable lever handle.

PART 3 EXECUTION

3.1 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.

END

PART 1 GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Valves, gate, globe, and check.
- .2 Sustainable requirements for construction and verification.
- .3 Related Sections:
 - .1 Section 01 33 00 - Submittal Procedures.
 - .2 Section 01 35 29 - Health and Safety Requirements.
 - .3 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .4 Section 01 78 00 - Closeout Submittals.
 - .5 Section 23 05 15 – Common Installation Requirements for HVAC Pipework.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME).
 - .1 ANSI/ASME B16.1-1998, Cast Iron Pipe Flanges and Flanged Fittings.
- .2 American Society for Testing and Materials International (ASTM).
 - .1 ASTM A49-01, Specification for Heat-Treated Carbon Steel Joint Bars.
 - .2 ASTM A126-95 (2001), Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - .3 ASTM B61-93, Specification for Steam or Valve Bronze Castings.
 - .4 ASTM B62-93, Specification for Composition Bronze or Ounce Metal Castings.
 - .5 ASTM B85-03, Specification for Aluminum-Alloy Die Castings.
 - .6 ASTM B209-04, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
 - .1 MSS SP-70-1998, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .2 MSS SP-71-1997, Grey Iron Swing Check Valves, Flanged and Threaded Ends.
 - .3 MSS SP-82-1992, Valve Pressure Testing Methods.
 - .4 MSS SP-85-2002, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 62 00.01 - Hazardous Materials.
 - .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.

- .2 Submit data for valves specified in this section.
- .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 - Health and Safety Requirements.

1.5 DELIVERY STORAGE AND DISPOSAL

- .1 Waste Management and Disposal:
 - .2 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .3 Collect and separate for disposal packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

PART 2 PRODUCTS

2.1 MATERIAL

- .1 Valves:
 - .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 with 2 mm raised face with serrated finish 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 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 CRN registration numbers.

2.2 GATE VALVES

- .1 NPS 2 1/2 - 8, non rising stem, inside screw, bronze trim, solid wedge disc:
 - .1 Body and multiple-bolted bonnet: with full length disc guides designed to ensure correct re-assembly. Class 125.
 - .2 Disc: solid offset taper wedge, bronze to ASTM B62.
 - .3 Seat rings: renewable bronze to ASTM B62, screwed into body.
 - .4 Stem: bronze to ASTM B62.
 - .5 Disc: solid offset taper wedge, cast iron to ASTM A126 Class B, secured to wrought steel stem.
 - .6 Seat: Integral with body.
 - .7 Stem: wrought steel.
 - .8 Operator: Handwheel.
- .2 NPS 2 1/2-8, outside screw and yoke (OS&Y), bronze trim, solid wedge disc:
 - .1 Body and multiple-bolted bonnet: with full length disc guides designed to ensure correct re-assembly, yoke, yoke hub, yoke sleeve and nut. Class 125.
 - .2 Disc: solid offset taper wedge, bronze to ASTM B62 up to NPS 3, cast iron with bronze disc rings on other sizes, secured to stem through integral forged T-head disc-stem connection.
 - .3 Seat rings: renewable bronze screwed into body.
 - .4 Stem: nickel-plated steel.
 - .5 Disc: solid offset taper all-cast iron, secured to stem through integral forged T-head disc-stem connection.
 - .6 Seat rings: integral with body.
 - .7 Stem: nickel-plated steel.
 - .8 Pressure-lubricated operating mechanism.
 - .9 Operator: Handwheel.

2.3 UNDERWRITERS APPROVED GATE VALVE

- .1 NPS 2 1/2 - 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 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 NPS 4 and over.
- .9 Disc: solid taper wedge. Up to NPS 3: bronze. NPS 4 and over: cast iron with bronze disc rings.
- .10 Disc seat ring: self-aligning, Milwood undercut on NPS 3 - 12.
- .11 Pressure rating:
 - .1 NPS 2-1/2 - 12: 1.7 Mpa CWP.
 - .2 NPS 14-1.2: 1.2 MPa CWP.
- .12 Operator: handwheel.

2.4 GLOBE VALVES

- .1 NPS 2 1/2 - 10, OSY:
 - .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 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 2400 mm above floor in mechanical equipment rooms.

2.6 CHECK VALVES

- .1 Swing check valves, Class 125:
 - .1 Body and bolted cover: with tapped and plugged opening on each side for hinge pin. Flanged ends: plain faced with smooth finish.
 - .1 Up to NPS 16: cast iron to ASTM A126 Class B.
 - .2 NPS 18 and over: cast iron to ASTM A126 Class C.
 - .2 Ratings:
 - .1 NPS 2 1/2 - 12: 860 kPa steam; 1.4 MPa CWP.
 - .3 Disc: rotating for extended life.
 - .1 Up to NPS 6: bronze to ASTM B 62.
 - .2 NPS 8 and over: bronze-faced cast iron.
 - .4 Seat rings: renewable bronze to ASTM B62 screwed into body.
 - .5 Hinge pin, bushings: renewable bronze to ASTM B62.
 - .6 Disc: A126 Class B, secured to stem, rotating for extended life.
 - .7 Seat: cast iron, integral with body.
 - .8 Hinge pin: exelloy; bushings: malleable iron.

- .9 Identification tag: fastened to cover.
- .10 Hinge: galvanized malleable iron.

- .2 Swing check valves, NPS 2 1/2 - 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: 250 psi steam; 500 psi CWP.
 - .4 Disc: rotating for extended life.
 - .1 Up to NPS 3: bronze to ASTM B61.
 - .2 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.

2.7 SILENT CHECK VALVES

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

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.

END

PART 1 GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Valves Cast Steel, gate, globe, and check.
- .2 Sustainable requirements for construction and verification.
- .3 Related Sections:
 - .1 Section 01 33 00 - Submittal Procedures.
 - .2 Section 01 35 29 - Health and Safety Requirements.
 - .3 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .4 Section 01 78 00 - Closeout Submittals.
 - .5 Section 23 05 15 – Common Installation Requirements for HVAC Pipework.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME).
 - .1 ANSI/ASME B16.5-2003, Pipe Flanges and Flanged Fittings.
 - .2 ANSI/ASME B16.10-1992, Face-to-Face and End-to-End Dimensions Valves.
 - .3 ANSI/ASME B16.25-1997, Buttwelding Ends.
 - .4 ANSI/ASME B16.34-1996, Valves - Flanged, Threaded and Welding End.
- .2 American Petroleum Institute (API).
 - .1 API 598-1996, Valve Inspection and Testing.
- .3 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A49-01, Specification for Heat-Treated Carbon Steel Joint Bars.
 - .2 ASTM A193/A193M-04, Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
 - .3 ASTM A194/A194M-03b, Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.
 - .4 ASTM A216/A216M-1993(03), Specification for Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service.
 - .5 ASTM B85-03, Specification for Aluminum-Alloy Die Castings.
- .4 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
 - .1 MSS SP-25-1998, Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 MSS SP-61-2003, Pressure Testing of Steel Valves.

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 62 00.01 - Hazardous Materials.

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit data for valves specified this section.
- .3 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .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- Health and Safety Requirements.

1.5 DELIVERY STORAGE AND DISPOSAL

- .1 Waste Management and Disposal:
 - .2 Separate and recycle waste materials in accordance with Section 01 74 21- Construction/Demolition Waste Management and Disposal.
 - .3 Collect and separate for disposal paper packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

PART 2 PRODUCTS

2.1 MATERIAL

- .1 Valves:
 - .1 Except for specialty valves, to be of single manufacturer.
 - .2 Valves to be individually tested.
- .2 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 CRN registration number required for all products.

2.2 GATE VALVES

- .1 NPS 2 1/2 - 12, rising stem, OS&Y, solid wedge disc, flanged ends, Class 150:
 - .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 degrees 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 NPS 2 1/2 - 6: Solid corrosion and heat resistant 13% chromium steel with minimum hardness of 350 HB.
 - .2 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 degrees V threads, top screwed for handwheel nut, T-head disc-stem connection.
 - .12 Operator: see elsewhere this section.

2.3 GLOBE VALVES

- .1 NPS 2 1/2 - 12, rising stem, OS&Y, flanged ends, Class 150:
 - .1 Body and multiple-bolted integral yoke and bonnet: cast steel to ASTM A216/A216M WCB.
 - .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 bushing: Ni-Resist, minimum melting point above 954 degrees C.
 - .8 Hydraulic grease fitting: for lubrication of yoke sleeve bearing surfaces.

- .9 Disc: Plug type with 15 degrees 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 degrees V threads, top screwed for handwheel nut.
- .12 Operator: see elsewhere this section.

2.4 VALVE OPERATORS

- .1 Handwheel: on all valves except as specified.
- .2 Handwheel with chain operators: on valves installed more than 2400 mm above floor in Boiler Room and Mechanical Equipment Room.

2.5 CHECK VALVES

- .1 NPS 2 1/2 and over, flanged ends, Class 150: 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.
 - .8 Hinge pin.
 - .9 Hinge pin plugs.

2.6 SILENT CHECK VALVES

- .1 Construction:
 - .1 Body: Cast steel to ASTM with integral seat.
 - .2 Pressure rating: Class 125.
 - .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.

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 Building Commissioning is a requirement of this project in order to comply with sections of Division 01 – General Requirements. A Commissioning Agent has been engaged and will provide all systems commissioning in conjunction with all trade contractors. The Commission Agent will provide a Commissioning Plan with commissioning start-up and test procedure sheets to be performed and completed by the various trade contractors.
- .2 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.

END

PART 1 GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Butterfly Valves.
- .2 Related Sections:
 - .1 Section 01 33 00 - Submittal Procedures.
 - .2 Section 01 35 29 - Health and Safety Requirements.
 - .3 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .4 Section 01 78 00 - Closeout Submittals.
 - .5 Section 23 05 15 – Common Installation Requirements for HVAC Pipework.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME).
 - .1 ANSI/ASME B1.20.1-1983 (R2001), Pipe Threads, General Purpose (Inch).
 - .2 ANSI/ASME B16.1-1998, Cast Iron Pipe Flanges and Flanged Fittings.
 - .3 ANSI/ASME B16.5-03, Pipe Flanges and Flanged Fittings.
 - .4 ANSI/ASME B16.11-01, Forged Fittings, Socket-Welding and Threaded.
 - .5 ANSI/ASME B16.25-1997, Buttwelding Ends.
 - .6 ANSI/ASME B16.34-1996, Valves - Flanged, Threaded and Welding Ends.
- .2 American National Standards Institute (ANSI)/American Petroleum Institute (API).
 - .1 ANSI/API 609-1997, Lug- and Water-Type Butterfly Valves.
- .3 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A126-95 (01), Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - .2 ASTM B62-02, Specification for Composition Bronze or Ounce Metal Castings.
 - .3 ASTM B209M-04, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .4 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
 - .1 MSS SP-67-02, Butterfly Valves.

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 62 00.01 - Hazardous Materials.
 - .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Submit data for valves specified this section.

- .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 - Health and Safety Requirements.

1.5 DELIVERY STORAGE AND DISPOSAL

- .1 Waste Management and Disposal:
 - .2 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .3 Collect and separate for disposal packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

PART 2 Products

2.1 MATERIAL

- .1 Sustainable Requirements:
 - .1 Materials and resources in accordance with Section 01 47 15 Sustainable Requirements.

2.2 BUTTERFLY VALVES - RESILIENT SEAT – 1380 kPa

- .1 Except to specialty valves, to be of single manufacturer.
- .2 To be suitable for dead-end service.
- .3 CRN registration number required for products.
- .4 Sizes: Lug type: NPS 2 to 30.
- .5 Pressure rating for tight shut-off at temperatures up to maximum for seat material.
 - .1 NPS 2 - 12: 200.
- .6 Minimum seat temperature ratings to 135 degrees C.
- .7 Application: on-off operation.
- .8 Full lug body.
- .9 Operators:

- .1 NPS 2 - 6: Handles capable of locking in any of ten (10) positions - 0 degrees to 90 degrees. Handle and release trigger - ductile iron. Return spring and hinge pin: carbon steel. Latch plate and mounting hardware: cadmium plated carbon steel. Standard coating: black laquer.
- .2 NPS 8 - 30: Manual enclosed gear operator.
- .10 Designed to comply with MSS SP-67 and API 609.
- .11 Compatible with ANSI Class 125/Class 150 flanges.
- .12 Construction:
 - .1 Body ductile iron.
 - .2 Disc: aluminum bronze or 316 SS.
 - .3 Seat: Viton or EPT.
 - .4 Shaft: 316 stainless steel.
 - .5 Taper pin: 316 SS Monel.
 - .6 Key: stainless.
 - .7 O-Ring: Buna-N.
 - .8 Bushings: Teflon.

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.

END

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 – Common Work Results – Mechanical.
- .2 Section 23 05 15 – Common Installation Requirements for HVAC Equipment.

1.2 REFERENCE STANDARDS

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B31.1-07, Power Piping.
- .2 ASTM International (ASTM)
 - .1 ASTM A125-1996(2007), Standard Specification for Steel Springs, Helical, Heat-Treated.
 - .2 ASTM A307-07b, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .3 ASTM A563-07a, Standard Specification for Carbon and Alloy Steel Nuts.
- .3 Factory Mutual (FM)
- .4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP58-2002, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - .2 MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.
 - .3 MSS SP89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .5 National Research Council Canada (NRC)
 - .1 National Plumbing Code of Canada 2015 (NPC).
- .6 Underwriter's Laboratories of Canada (ULC)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00- Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and data sheets for hangers and supports and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Nova Scotia.
 - .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 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

1.4 CLOSEOUT SUBMITTALS

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

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials crates, pallets, padding, 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.

2.2 GENERAL

- .1 Fabricate hangers, supports and sway braces in accordance with MSS SP58. ANSI B31.1.
- .2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

2.3 PIPE HANGERS

- .1 Finishes:

- .1 Pipe hangers and supports: galvanized after manufacture.
- .2 Use electro-plating galvanizing process.
- .3 Ensure steel hangers in contact with copper piping are epoxy coated.
- .2 Upper attachment structural: suspension from lower flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut carbon steel retaining clip.
 - .1 Rod: 13 mm FM approved, 9 mm UL listed.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed MSS-SP69, FM approved to MSS-SP58.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, FM approved to MSS SP69, UL listed.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut FM approved UL listed.
- .4 Upper attachment to concrete:
 - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
 - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed FM approved to MSS SP69.
- .5 Hanger rods: threaded rod material to MSS SP58:
 - .1 Ensure that hanger rods are subject to tensile loading only.
 - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
 - .3 Do not use 22 mm or 28 mm rod.
- .6 Pipe attachments: material to MSS SP58:
 - .1 Attachments for steel piping: carbon steel black galvanized.
 - .2 Attachments for copper piping: copper plated black steel.
 - .3 Use insulation shields for hot pipework.
 - .4 Oversize pipe hangers and supports.
- .7 Adjustable clevis: material to MSS SP69 UL listed, FM approved, 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.
- .8 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.
- .9 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.
 - .1 Finishes for steel pipework: galvanized.
 - .2 Finishes for copper, glass, brass or aluminum pipework: epoxy coated with formed portion plastic coated.
- .10 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

2.4 RISER CLAMPS

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

2.5 INSULATION PROTECTION SHIELDS

- .1 Insulated cold piping:
 - .1 64 kg/m³ density insulation plus insulation protection shield to: MSS SP69, galvanized sheet carbon steel. Length designed for maximum 3 m span.
- .2 Insulated hot piping:
 - .1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP69.

2.6 CONSTANT SUPPORT SPRING HANGERS

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

2.7 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 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. Submit calculations with shop drawings.

2.9 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

2.10 HOUSE-KEEPING PADS

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

2.11 OTHER EQUIPMENT SUPPORTS

- .1 Fabricate equipment supports from structural grade steel.
- .2 Submit structural calculations with shop drawings.

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install in accordance with:
 - .1 Manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
 - .1 Install on piping systems at pumps, boilers, chillers, cooling towers, and as indicated.
- .3 Clamps on riser piping:
 - .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
 - .2 Bolt-tightening torques to industry standards.
 - .3 Steel pipes: install below coupling or shear lugs welded to pipe.
 - .4 Cast iron pipes: install below joint.
- .4 Clevis plates:
 - .1 Attach to concrete with 4 minimum concrete inserts, one at each corner.
- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
- .6 Use approved constant support type hangers where:
 - .1 Vertical movement of pipework is 13 mm or more,
 - .2 Transfer of load to adjacent hangers or connected equipment is not permitted.
- .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 Provincial Code National Plumbing Code of Canada (NPC) authority having jurisdiction .
- .2 Fire protection: to applicable fire code.
- .3 Gas and fuel oil piping: up to NPS 1/2: every 1.8 m.
- .4 Copper piping: up to NPS 1/2: every 1.5 m.
- .5 Flexible joint roll groove pipe: in accordance with table below for steel, but not less than one hanger at joints. Table listings for straight runs without concentrated loads and where full linear movement is not required.
- .6 Within 300 mm of each elbow.

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

- .7 Pipework greater than NPS 12: to MSS SP69.

3.4 HANGER INSTALLATION

- .1 Install hanger so that rod is vertical under operating conditions.
- .2 Adjust hangers to equalize load.
- .3 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.

3.5 HORIZONTAL MOVEMENT

- .1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4 degrees from vertical.
- .2 Where horizontal pipe movement is less than 13 mm, offset pipe hanger and support so that rod hanger is vertical in the hot position.

3.6 FINAL ADJUSTMENT

- .1 Adjust hangers and supports:
 - .1 Ensure that rod is vertical under operating conditions.
 - .2 Equalize loads.

- .2 Adjustable clevis:
 - .1 Tighten hanger load nut securely to ensure proper hanger performance.
 - .2 Tighten upper nut after adjustment.
- .3 C-clamps:
 - .1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.
- .4 Beam clamps:
 - .1 Hammer jaw firmly against underside of beam.

3.7 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.
- .2 Verification requirements in accordance with Contractor's Verification, include:
 - .1 Materials and resources.
 - .2 Storage and collection of recyclables.
 - .3 Construction waste management.
 - .4 Resource reuse.
 - .5 Recycled content.
 - .6 Local/regional materials.
 - .7 Certified wood.
 - .8 Low-emitting materials.

3.8 CLEANING

- .1 Clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling reuse in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 00 – Common Work Results – Mechanical.
- .3 Section 23 05 93 – Testing, Adjusting and Balancing of HVAC.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material, in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal facility as approved by Departmental Representative.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

1.3 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Provide separate shop drawings for each isolated system complete with performance and product data.

1.4 GENERAL

- .1 Provide vibration isolators under all moving and rotating equipment. Maximum transmissibility: 2% max.
- .2 Provide elastomeric pads between non-vibrating equipment connected to vibrating equipment via piping and the mechanical room floor.
- .3 Provide vibration isolation mounts, resilient pipe guides and resilient penetration sleeves/ seals for all piping within mechanical rooms or within 15.25 m (50') total pipe length (whichever is longer) connected to major equipment. Isolated from the building structure by means of spring isolators or inertia bases.

- .4 Provide following services for correction of excessive vibration.
 - .1 Adjust and set springs that are not operating properly.
 - .2 Replace springs required to reduce the vibration levels to within design limits.
- .5 Vibration isolators shall be of the type and having static deflection as noted on the drawings. The springs selected shall have the required static deflection when 2/3 solid.
- .6 All vibration isolators supporting one particular piece of equipment shall be selected for equal deflections. All nuts and bolts and washers shall be zinc electroplated. Vibration isolation equipment for outdoor applications shall be neoprene coated or cadmium plated.
- .7 All vibration isolators and equipment bases shall be by one manufacturer.

1.5 COORDINATION

- .1 Refer to Division 01, 21, 22, 25 and 26 for other requirements as included and outlined in other sections of the specifications.

1.6 QUALITY ASSURANCE

- .1 Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pads.
- .2 Provide vibration isolators of the appropriate sizes and proper loading to meet the specified deflection requirements.
- .3 Supply and install any incidental materials needed to meet the requirements stated herein, even if not expressly specified or shown on the drawings, without claim for additional payment.
- .4 Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.
- .5 Should any rotating equipment cause excessive noise or vibration, the contractor shall be responsible for rebalancing, realignment, or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.
- .6 Upon completion of the work, the Departmental Representative, shall inspect the installation and shall inform the installing contractor of any further work that may be completed. Make all adjustments as directed by the Departmental Representative that result from the final inspection. This work shall be done before vibration isolation systems are accepted.

1.7 SPEED & BALANCE REQUIREMENTS FOR ROTATING EQUIPMENT

- .1 Fans and other rotating mechanical equipment must not operate at speeds in excess of 80% of their true critical speed.

- .2 Vertical vibration of rotating equipment shall not be greater than the levels indicated. The vibration shall be measured on the equipment or steel frame equipment base when the equipment is mounted on its vibration isolation mounts. If the equipment has an inertia base, the allowable vibration level is reduced by the ratio of the equipment weight alone to the equipment weight plus the inertia base weight.

Equipment Speed	Vibration Displacement (MILS peak-to-peak)
under 600 rpm	4
600 to 1000 rpm	3
1000 to 2000 rpm	2
over 2000 rpm	1

PART 2 PRODUCTS

2.1 SPRING ISOLATORS

- .1 Type SL Spring Isolators
- .1 Freestanding and laterally stable without any housing. All mounts shall have levelling bolts. Spring diameter shall not be less than 0.8 compressed height of the spring at rated load. Each isolator shall be mounted on a double layer of 8mm (5/16") thick ribbed or waffle neoprene separated by a 1.6129mm (16 ga.) stainless steel plate. A square bearing plate shall be provided to load the pad uniformly in the range of 275 kPa to 345 kPa (40 to 50 psi).
- .2 Type SLR Spring Isolators
- .1 Open, stable pair of steel springs and include vertical travel limit stops to control extension when weight is removed. The housing of the spring unit shall serve as a blocking during erection of equipment. Unit isolator base plate shall be complete with two layers of 8mm (5/16") thick ribbed or waffle pattern neoprene pads separated by a 1.61 mm (16 ga.) stainless steel plate. Base plate shall be sized to load the pad uniformly in the range of 275.8 kPa to 345 kPa (40 to 50 psi).
- .3 Type NSN Pads
- .1 Double layer of 12 mm (1/2") thick 50 durometer neoprene separated by 7 mm (1/4") thick steel plate.

2.2 SPRING HANGERS

- .1 Type SH Spring Hangers
- .1 Vibration hangers shall contain a steel spring set in a neoprene cup manufactured with a grommet to prevent short circuiting of the hanger rod. Spring diameters and hanger box lower hole sizes shall be large enough to permit the rod to swing through a 30° arc before contacting the hole and short circuiting the spring.

- .2 Type SHR Spring Hangers
 - .1 Type SHR spring hangers shall contain a laterally stable steel spring and 8mm (5/16") deflection neoprene element in series. A neoprene neck shall be provided where the rod passes through the steel box supporting the isolator mount to prevent metal to metal contact. Spring diameter and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc before contacting the hole and short circuiting the spring.

2.3 EQUIPMENT BASES

- .1 Type S Steel Base
 - .1 Where called for on the drawings, equipment shall be mounted on Type "S" primed steel base. Frames shall consist of structural steel sections, sized, spaced and connected to form a rigid base which will not twist, rack, deform or deflect in any manner that will negatively effect the operation of the supported equipment or performance of the vibration isolation mounts. Frames shall include side mounting brackets for attachment to Unit SL or SLR spring isolator. The clearance between the underside of the steel base and top of the building shall be at least 50mm (2").

2.4 FLEXIBLE PIPE CONNECTIONS

- .1 Flexible pipe connections shall be fabricated multiple plies of nylon cord, fabric and neoprene, vulcanized so as to become inseparable and homogenous. Straight connections shall be formed in a double sphere shape. Elbow connections shall have a single sphere shape at the curve of the unit. Flexible connections shall be able to accept compressive, elongative, transverse, and angular movements.
- .2 The flexible connections shall be selected and specially fitted, if necessary, to suit the system temperature, pressure and fluid type. No rods or cables shall be used to control extension of the connector.
- .3 Connectors for pipe sizes 50 mm (NPS 2) or smaller shall have threaded female union couplings on each end. Larger sizes shall be fitted with metallic flange couplings.

PART 3 EXECUTION

3.1 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 25mm (1") minimum static deflection as follows:
 - .1 Up to 100 mm (NPS 4): first 3 points of support.
 - .2 125mm to 200mm (NPS 5 to NPS 8): first 4 points of support.
 - .3 250mm (NPS 10) and Over: first 6 points of support.
 - .4 First point of support shall have a static deflection of twice deflection of isolated equipment, but not more than 100mm (4").
- .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 a rigid system at the operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.
- .6 Drilled or power driven anchors or fasteners not permitted for use with seismic control measures.

3.2 SITE VISIT

- .1 Manufacturer to visit site and provide Departmental Representative with written certification that installation is in accordance with manufacturer's instructions, make adjustments and corrections in accordance with all written reports including final.
- .2 Provide Departmental Representative with notice 24 h in advance of visit.

END

PART 1 GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and requirements for the identification of piping systems, duct work, valves and controllers, including the installation and location of identification systems.
 - .2 Sustainable requirements for construction and verification.
- .2 Related Sections
 - .1 Division 01 - General Requirements.
 - .2 Section 01 74 21 – Construction/Demolition Waste Management and Disposal.

1.2 REFERENCES

- .1 Canadian Gas Association (CGA):
 - .1 CSA/CGA B149.1-05, Natural Gas and Propane Installation Code.
- .2 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.
 - .2 CAN/CGSB-24.3-92, Identification of Piping Systems.
- .3 National Fire Protection Association (NFPA):
 - .1 NFPA 13-2002, Standard for the Installation of Sprinkler Systems.

1.3 SUBMITTALS

- .1 Product data submittals in accordance with sections of Section 01 33 00 – Submittals.
- .2 Product data to include paint colour chips, other products specified in this section.
- .3 Samples:
 - .1 Submit samples in accordance with sections of Section 01 33 00 – Submittals.

1.4 QUALITY ASSURANCE

- .1 Do construction occupational health and safety in accordance sections of Section 01 33 00 – Submittals.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with sections of Division 01 - General Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

- .2 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal.
 - .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
 - .4 Separate for reuse and recycling and place in designated containers Steel Metal Plastic waste in accordance with Waste Management Plan.
 - .5 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Departmental Representative.
 - .6 Fold up metal banding, flatten and place in designated area for recycling.
 - .7 Do not dispose of unused paint coating material into sewer system, into streams, lakes, onto ground or in locations where it will pose health or environmental hazard.

PART 2 PRODUCTS

2.1 SUSTAINABLE REQUIREMENTS

- .1 Materials and products in accordance with sections of Division 01 - General Requirements.

2.2 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.

2.3 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 3.2 mm (1/8") 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 # INCHES	SIZES (INCHES)	NO. OF LINES	HEIGHT OF LETTERS (INCHES)
1	3/8 x 2	1	1/8
2	1/2 x 3	1	3/16
3	1/2 x 3	2	1/8
4	3/4 x 4	1	5/16
5	3/4 x 4	2	3/16
6	3/4 x 8	1	5/16
7	1 x 5	1	1/2
8	1 x 5	2	5/16
9	1-1/2 x 8	1	3/4

.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.
- .3 On t-bar ceiling splines and at units for fire dampers, VAV boxes, coils, etc. that are mounted in the ceiling space.

2.4 EQUIPMENT CONCEALED BY CEILING

- .1 At valves, plumbing air vents and drains, dampers and other similar pieces of equipment located above T-bar ceilings or access doors, provide circular 19 mm (3/4") diameter self adhesive identification discs on the underside of the ceiling, located as near as possible to where the item is located.
- .2 Discs shall be coloured as scheduled in this specification.
- .3 Where the item has a primary and secondary colour, provide a 19 mm (3/4") diameter primary colour disc with a 9.5 mm (3/8") diameter secondary colour disc centred on the primary disc.
- .4 For backflow preventers, fire dampers, air terminal units, exhaust fans, reheat coils, balancing dampers and other similar pieces of equipment located above T-bar ceilings or access doors, provide laminated plastic plates as noted for System nameplates above. A second identical plate shall be installed on the underside of the ceiling grid or access door opening frame, as close as possible to the location of the equipment.
- .5 Damper handles shall be spray painted a bright colour to enable Air Balance Contractor to readily locate.

2.5 PIPING SYSTEMS GOVERNED BY CODES

- .1 Identification:
 - .1 Natural gas: to CSA/CGA B149.1.
 - .2 Sprinklers: to NFPA 13.
 - .3 Standpipe and hose systems: to NFPA 14.

2.6 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 capital letters 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 (3"): 100mm (4") long x 50mm (2") high.
 - .2 Outside diameter of pipe or insulation 75 mm (3") and greater: 150mm (6") long x 50mm (2") 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 19mm (¾") and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.
 - .2 Other pipes: pressure sensitive plastic-coated cloth vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150°C (300°F) and intermittent temperature of 200°C (390°F).
- .7 Colours and Legends:
 - .1 Where not listed, obtain direction from Departmental Representative.
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:

Pipe Marker	Tag	Primary Colour	Second Colour
Heating Water Supply	H.W.S.	Yellow	Black
Heating Water Return	H.W.R.	Yellow	Black
Heating Exchanger Water Supply	H. X.W.S	Yellow	Black
Heating Exchanger Water Return	H.X.W.R	Yellow	Black

Pipe Marker	Tag	Primary Colour	Second Colour
Make-Up Water	M.U.W.	Green	None
Domestic Cold Water	D.C.W.	Green	None
Domestic Hot Water	D.H.W.	Green	None
Domestic Hot Water Recirculation	D.H.W.R.	Green	None
Rain Water Leader	R.W.L	Green	None
Sanitary	SAN.		
Plumbing Vent	VENT	Green	None
Sprinkler	F.P.	Red	White
Humidifier Steam	H.H.M	Yellow	Black
Fire Protection Water	F.P.W.	Red	White
Glycol Heating Supply	G.L.S.	Yellow	Black
Glycol Heating Return	G.L.R.	Yellow	Black
Refrigerant Liquid Line	REF. LIQUID	Yellow	Black
Refrigerant Suction Line	REF. SUCTION	Yellow	Black
Refrigerant High Pressure Line	REF. HP	Yellow	Black
Refrigerant Low Pressure Line	REF. LP	Yellow	Black

.9 Valves

- .1 50mm (2") laminated plastic plates (tags) with corner hole shall be provided for all valves and installed with nonferrous chains, "S" hooks or heavy duty plastic tie wraps. Tags shall have horizontal 12mm (1/2") letters accurately aligned and machine engraved into the core. Required for all valves and operating controllers.
- .2 Provide one valve chart for each Operations and Maintenance Manual and one chart framed and wall mounted.
- .3 Valves in systems to be numbered consecutively.

.10 Buried Pipe Identification

- .1 Use detectable Identoline underground warning tape colour coded to pipe service for full length of pipe.
- .2 Bury to manufacturers recommendations.
- .3 Identify all systems, equipment, components, controls and sensors. Inscription to identify function.

.11 Duct Identification

- .1 50mm (2") high black stencilled letters to be used, i.e., "Fresh Air", "Supply", "Return", "Sanitary Exhaust", with directional flow arrow and Fan System No.
- .2 Maximum distance between markings not to exceed 15m (50'-0").
- .3 Locate identification on long straight runs in Mechanical Rooms so that at least one is clearly visible from any one viewpoint in usual operating areas or walking aisles, adjacent to all changes in direction, at least once in each room, on both sides of visible obstructions, on both sides of walls, floors and partitions, at each piece of equipment and beside each access door.
- .4 Stencil over final finish only.

.5 Identify system to include air handling unit number.

.12 Controls Equipment Identification

.1 Electrically fed equipment supplied by Division 25 (excluding that noted in .2, below) shall be identified as per Division 26 identification requirements.

.2 Intermediate and end control devices including sensors, controllers, monitoring devices, etc., shall be identified with laminated plastic plates as noted for System nameplates above. The plates shall be fastened securely with pop rivets or screws. Where rivets or screws are not feasible, provide heavy duty plastic tie wraps. As a minimum control device identification shall correspond to descriptors provided in the approved shop drawings with respect to panel designation or DDC point name.

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

2.7 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 in sections of Division 01 - General Requirements 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, cool and/or insulated surfaces.

- .3 Protection:
 - .1 Do not paint, insulate or cover.
- .4 Nameplates to be fastened securely with pop rivets or screws in conspicuous place.

3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

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

3.6 VALVES, CONTROLLERS

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

3.7 FIELD QUALITY CONTROL

- .1 Verification requirements in accordance with sections of Division 01 - General Requirements, include:

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

3.8 CLEANING

- .1 Proceed in accordance with sections of Division 01 - General Requirements.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.9 COMMISSIONING

- .1 Building Commissioning is a requirement of this project in order to comply with sections of Division 01 - General Requirements. A Commissioning Agent has been engaged and will provide all systems commissioning in conjunction with all trade contractors. The Commission Agent will provide a Commissioning Plan with commissioning start-up and test procedure sheets to be performed and completed by the various trade contractors.

END

PART 1 GENERAL

1.1 GENERAL

- .1 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do all other work as specified in this section.
- .2 TAB shall be carried out by an independent Agency registered member of AABC.

1.2 QUALIFICATIONS OF TAB PERSONNEL

- .1 Names of all personnel it is proposed to perform TAB to be submitted to and approved by Departmental Representative within 14 days of award of contract.
- .2 Provide documentation confirming qualifications, successful experience.

1.3 PURPOSE OF TAB

- .1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads.
- .2 Adjust and regulate equipment and systems so as to meet specified performance requirements and to achieve specified interaction with all other related systems under all normal and emergency loads and operating conditions.
- .3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.4 EXCEPTIONS

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

1.5 CO-ORDINATION

- .1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule so as 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.
- .3 Refer to Division 01, 21, 22, 25 and 26 for other requirements as included and outlined in other sections of the specifications.

1.6 PRE-TAB PREVIEW

- .1 Review contract documents before project construction is started and confirm in writing to Departmental Representative adequacy of provisions for TAB and all other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to Departmental Representative in writing all proposed procedures which vary from standard.
- .3 During construction, co-ordinate location and installation of all TAB devices, equipment, accessories, measurement ports and fittings.

1.7 START - UP

- .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
- .2 Follow special start-up procedures specified elsewhere in Division 25.

1.8 OPERATION OF SYSTEMS DURING TAB

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

1.9 START OF TAB

- .1 Notify Departmental Representative 7 days prior to start of TAB.
- .2 Start TAB only when each phase of project is essentially completed, including:
 - .1 Installation of ceilings, doors, windows, other construction affecting TAB.
 - .2 Application of weatherstripping, sealing, caulking.
 - .3 All pressure, leakage, other tests specified elsewhere Division 25.
 - .4 All provisions for TAB installed and operational.
 - .5 Start-up, verification for proper, normal and safe operation of all 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 All outlets installed, volume control dampers open.

- .3 Liquid systems:
 - .1 Flushed, filled, vented.
 - .2 Correct pump rotation.
 - .3 Strainers in place, baskets clean.
 - .4 Isolating and balancing valves installed, open.
 - .5 Calibrated balancing valves installed, at factory settings.
 - .6 Chemical treatment systems complete, operational.

1.10 APPLICATION TOLERANCES

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

1.11 ACCURACY TOLERANCES

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

1.12 INSTRUMENTS

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

1.13 SUBMITTALS

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

1.14 PRELIMINARY TAB REPORT

- .1 Submit for checking and approval of Departmental Representative, prior to submission of formal TAB report, three (3) copies sample of rough TAB sheets. Make changes and resubmit if necessary include:
 - .1 Details of instruments used.
 - .2 Details of TAB procedures employed.
 - .3 Calculations procedures.
 - .4 Summaries.

1.15 TAB REPORT

- .1 Format to be in accordance with AABC.
- .2 TAB report to show all results in SI units and to include:
 - .1 Project record drawings.
 - .2 System schematics.
- .3 Submit 6 copies of TAB Report to Departmental Representative for verification and approval, in D-ring binders, complete with index tabs.

1.16 VERIFICATION

- .1 All reported results subject to verification by Departmental Representative.
- .2 Provide manpower and instrumentation to verify up to 30% of all reported results.
- .3 Number and location of verified results to be at discretion of Departmental Representative.
- .4 Bear costs to repeat TAB as required to satisfaction of Departmental Representative.

1.17 SETTINGS

- .1 After TAB is completed to satisfaction of Departmental Representative, replace drive guards, close all access doors, lock all devices in set positions, ensure sensors are at required settings.
- .2 Permanently mark all settings to allow restoration at any time during life of facility. Markings not to be eradicated or covered in any way.

1.18 COMPLETION OF TAB

- .1 TAB to be considered complete only when final TAB Report received and approved by Departmental Representative.

1.19 AIR SYSTEMS SMACNA, ASHRAE

- .1 Standard: TAB to be to most stringent standards of AABC, SMACNA, and ASHRAE.
- .2 General: measurements as required by referenced standards, including, but not limited to, the following:
 - .1 Measurements:
 - .1 Air velocity.
 - .2 Static pressure.
 - .3 Velocity pressure.
 - .4 Temperature:
 - .1 Wet bulb.

- .2 Dry bulb.
- .5 Cross sectional area.
- .6 RPM.
- .7 Electrical power:
 - .1 Voltage.
 - .2 Current draw.
- .2 Location of equipment measurements:
 - .1 Inlet and outlet of each:
 - .1 Fan.
 - .2 Coil.
 - .3 Filter.
 - .4 Damper.
 - .5 Other auxiliary equipment.
 - .3 Location of system measurements at:
 - .1 Main ducts.
 - .2 Main branch ducts.
 - .3 Sub-branch ducts.
 - .4 Each supply, exhaust and return air inlet and outlet.
 - .5 Terminal Unit.
 - .6 Other auxiliary equipment.
 - .7 All areas served by system.
- .4 All locations for systems measurements shall be identified and be readily accessible for future testing agencies.

1.20 HYDRONIC SYSTEMS

- .1 General: measurements as required by referenced standards, including, but not limited to, following:
 - .1 Measurements:
 - .1 Flow.
 - .2 Pressure.
 - .3 Temperature.
 - .4 Specific gravity.
 - .5 RPM.
 - .6 Electrical power:
 - 1. Voltage.
 - 2. Current draw.
 - .2 Location of equipment measurements:
 - .1 Inlet and outlet for each:
 - 1. Heat exchangers (primary and secondary sides).
 - 2. Heating Coils.
 - 3. Indirect Water Heaters
 - 4. Pumps.
 - 5. PRV.
 - 6. Make-up (water).
 - 7. Flow rates for each circuit setter.
 - .3 Location of system measurements at:
 - .1 Supply and return each primary and secondary loop of following hydronic systems:

1. Heating Systems.
2. Glycol Systems.
3. Pool Water System.
4. Consider glycol systems as hydronic for purposes of this section.

1.21 DOMESTIC HW SYSTEM

- .1 Meet all requirements as specified for hydronic systems.
- .2 Locations of equipment measurements: To include, but not limited to, following as appropriate: Inlet and outlet of each heat exchanger, tank, pump, circulator, at each controller and controlled device.
- .3 Locations of systems measurements to include, but not be limited to, following as appropriate: main, main branch, branch, sub-branch.

1.22 OTHER SYSTEMS

- .1 Plumbing System:
 - .1 TAB procedures:
 - .1 Flush valves: adjust to suit project conditions.
 - .2 Pumped sanitary and storm water systems; test for proper operation at all possible flow rates.
 - .3 Refer to Division 22 as applicable.
 - .2 Chemical treatment systems:
 - .1 TAB procedures: refer to Specification Section 23 25 00 - HVAC Water Treatment Systems.
 - .3 Potable water treatment systems:
 - .1 TAB procedures: Refer to Specification Section 23 25 00 - HVAC Water Treatment Systems.
 - .4 EMCS System:
 - .1 TAB procedures: Refer to Specification Section Division 25.

1.23 OTHER TAB REQUIREMENTS

- .1 General requirements applicable to all work specified this paragraph:
 - .1 Qualifications of TAB personnel: as for air systems specified in this section.
 - .2 Quality assurance: as for air systems specified this section
- .2 Building pressure conditions:
 - .1 Adjust HVAC systems, equipment, controls to ensure specified pressure conditions during all times.
- .3 Zone pressure differences:
 - .1 Adjust HVAC systems, equipment, controls to establish specified air pressure differentials, with all systems in all possible conditions of normal operating modes.

- .4 Provide balancing of all system and establish system supply and return static pressure readings and fan speed drive positions for all modes of system operation. Refer also to Section 25 90 01 - EMCS Site Requirements, Applications and Systems Sequence of Operations; for the various modes of operation on all systems.

1.24 POST OCCUPANCY TAB

- .1 Emergency evacuation: Participate in full scale emergency evacuation exercises.
- .2 Participate in systems checks twice during the one year standard Warranty Period - #1 check approximately three (3) months after acceptance and #2 check within one month of termination of Warranty Period.

1.25 SCHEDULING OF AIR BALANCING

- .1 The final air balancing report must be submitted a minimum of three (3) weeks before the substantial completion date.

1.26 IDENTIFICATION OF DUCT TRAVERSE LOCATIONS

- .1 Locations where duct traverses are taken shall be marked and identified on the ductwork and the ceilings to enable the location of existing holes in the ductwork for future airflow measurements.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 - General Requirements.
- .2 Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .3 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE):
 - .1 ANSI/ASHRAE/IESNA 90.1-01, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 American Society for Testing and Materials International, (ASTM):
 - .1 ASTM B209M-02, Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric).
 - .2 ASTM C335-95, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411-97, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C547-00, Specification for Mineral Fiber Pipe Insulation.
 - .6 ASTM C553-00, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .7 ASTM C612-00a, Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .8 ASTM C795-92, Specification for Thermal Insulation for Use with Austenitic Stainless Steel.
 - .9 ASTM C921-92(1998)e1, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
- .3 Canadian General Standards Board (CGSB):
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .4 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (R1999).
- .5 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC-S102-M88(R2000), Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701-01, Thermal Insulation Polystyrene, Boards and Pipe Covering.

1.3 DEFINITIONS

- .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
 - .2 "EXPOSED" - will mean "not concealed" as defined herein.

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

.2 TIAC Codes:

.1 CRD: Code Round Ductwork.

.2 CRF: Code Rectangular Finish.

1.4 SHOP DRAWINGS

.1 Submit shop drawings in accordance with sections of Section 01 33 00 – Submittals.

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

1.5 SAMPLES

.1 Submit samples in accordance with sections of Section 01 33 00 – Submittals.

.2 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on ½" plywood board. Affix typewritten label beneath sample indicating service.

1.6 MANUFACTURER'S INSTRUCTIONS

.1 Submit manufacturer's installation instructions in accordance with sections of Section 01 33 00 – Submittals.

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

1.7 DELIVERY, STORAGE AND HANDLING

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

.2 Protect from weather and construction traffic.

.3 Protect against damage from any source.

.4 Store at temperatures and conditions recommended by manufacturer.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.

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

.3 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Separate for reuse and recycling and place in designated containers Steel Metal Plastic waste in accordance with Waste Management Plan.

- .5 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Departmental Representative.
- .6 Fold up metal banding, flatten and place in designated area for recycling.
- .7 Do not dispose of unused adhesive materials into sewer systems, into lakes, streams, onto ground or in other locations where it will pose health or environmental hazard.

PART 2 PRODUCTS

2.1 GENERAL

- .1 All components of insulation system to have maximum flame spread rating of 25 and maximum smoke developed rating of 50 in accordance with CAN4-S102.
- .2 Materials to be tested in accordance with ASTM C411.

2.2 D-1 DUCT INSULATION WITH VAPOUR BARRIER

- .1 Application: Ductwork up to 760mm (30") for:
 - .1 All fresh air intake plenums and ducts.
 - .2 All VRF fan coil ductwork (supply and return).
 - .3 Exhaust air ductwork from fan or damper to exhaust louvers.
 - .4 All exhaust air ductwork within 10 feet of outdoor outlet shall be insulated.
 - .5 All solar wall take-offs from the wall to the AHU.
- .2 Material:
 - .1 CGSB 51-GP-11M+Amdt-Apr-78 mineral glass fibre blanket. CGSB-51-GP-52 for vapour barrier.
- .3 Thickness: Supply air ductwork: 25 mm (1").
Fresh air intake plenums and exhaust air ductwork: 50 mm (2").

2.3 D-2 FIBREGLAS RIGID WITH VAPOUR BARRIER

- .1 Application: Ductwork to include all exposed ductwork in addition to all ductwork over 790 mm (31") for the following:
 - .1 All fresh air intake plenums and ducts.
 - .2 All VRF fan coil ductwork (supply and return).
 - .3 Exhaust air ductwork from fan or damper to exhaust louvers.
 - .4 All exhaust air ductwork within 10 feet of outdoor outlet shall be insulated.
 - .5 All solar wall take-offs from the wall to the AHU.
- .2 Material:
 - .1 CGSB 51-GP-10M, rigid mineral fibre board; CGSB 51-GP-52M vapour barrier, jacket and facing material.
- .3 Thickness: Supply air ductwork: 25 mm (1").

Fresh air intake plenums and exhaust air ductwork: 50 mm (2").

2.4 FASTENINGS

- .1 Tape: self adhesive, 4" wide, aluminum, ULC labelled for less than 25 flame spread and less than 50 smoke developed.
- .2 Contact adhesive: quick-setting, non-flammable fire resistive to adhere fibrous glass to ducts. Flame spread 15, smoke development 0.
- .3 Lap seal adhesive: quick-setting for joints and lap sealing of vapour barriers.
- .4 For Canvas:
 - .1 Washable adhesive for cementing canvas lagging cloth to duct insulation.
- .5 Pins:
 - .1 Weld pins 1/6" diameter, with 1-1/2" diameter head for installation through the insulation. Length to suit thickness of insulation.
 - .2 Weld pins 1/12" diameter, for installation prior to applying insulation. Length to suit thickness of insulation. Nylon retain clips 1-1/4" square.

2.5 JACKETS

- .1 Canvas:
 - .1 Apply in exposed areas: ULC listed plain weave, cotton fabric at 11 oz/ft².

2.6 ACOUSTIC LAGGING FOR DUCTS

- .1 Product shall consist of a clear, tough polyester cover, a bonded flexible 1-6 lb. per sq. ft. banner for transmission loss and a 6 mm. urethane foam decoupler.

PART 3 EXECUTION

3.1 APPLICATION

- .1 Apply insulation after required tests have been completed and approved by Departmental Representative. Insulation and surfaces shall be clean and dry when installed and during application of any finish. Apply insulation materials, accessories and finishes to manufacturer's recommendations and as specified.
- .2 Vapour barriers and insulation to be unbroken over full length of duct or surface, without penetration for hangers, standing duct seams and without interruption at sleeves and supports.
- .3 Use stand-offs for all duct mounted control accessories.
- .4 Apply 20 ga. thick galvanized sheet metal corners to all ductwork in mechanical rooms.

3.2 INSTALLATION

- .1 General:
 - .1 Install in accordance with ANSI/NFPA 90A and ANSI/NFPA 90B.
 - .2 Adhere and seal vapour barrier using vapour seal adhesives.
 - .3 Stagger longitudinal and horizontal joints, on multi-layered insulation.
- .2 Mechanical fastenings:
 - .1 On rectangular ducts, use 50% coverage of insulating cement and weld pins at not more than 200mm (8") centres, but not less than 2 rows per side and bottom.
- .3 Acoustic Lagging for Ducts:
 - .1 Install in strict accordance with manufacturer's instructions using manufacturer specified adhesives.

3.3 SIZING

- .1 Provide fire retardant coating on canvas jackets.
- .2 Fire retardant coating shall be U.L. approved.
- .3 Coat canvas covering exposed in finished spaces with diluted coat of lagging adhesive. Provide two coats of lagging adhesive. Dilution of lagging adhesive as per manufacturer's recommendations for painting.

3.4 INSULATION TABLE

- .1 As per Table below:

DUCT INSULATION TABLE		
Service	Insulation	Thickness
Supply Air From AHU's	D1/D2	25 mm
Supply Air From Fan Coils	D1/D2	25 mm
Return Air to AHU's	D1/D2	12 mm Acoustic
Return Air to Fan Coils	D1/D2	12 mm Acoustic
Exhaust from Damper/Fan to Outside	D1/D2	50 mm
ERV Supply Air	D1/D2	25 mm
ERV Return Air	D1/D2	25 mm
ERV Fresh Air Intake	D1/D2	25 mm
ERV Exhaust Air	D1/D2	50 mm
Washroom Exhaust	D1/D2	25 mm
Air Intake Plenums	D1/D2	50 mm
Exhaust Air Plenums	D1/D2	50 mm
Fresh Air Intake to AHUs	D1/D2	50 mm
Solar Wall Air Take-off to AHUs	D1/D2	50 mm

3.5 COMMISSIONING

- .1 Fundamental Building Commissioning is a requirement of this project in order to comply with sections of Division 01 - General Requirements. A Commissioning Agent has been engaged and will provide all systems commissioning in conjunction with all trade contractors. The Commission Agent will provide a Commissioning Plan with

commissioning start-up and test procedure sheets to be performed and completed by the various trade contractors.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 - General Requirements.
- .2 Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .3 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE):
 - .1 ANSI/ASHRAE/IESNA 90.1-01-SI, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 American Society for Testing and Materials (ASTM International):
 - .1 ASTM B209M-01, Specification for Aluminum and Aluminum Alloy Sheet and Plate.
 - .2 ASTM C335-95, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411-97, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M-00, Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C533-95 (2001), Specification for Calcium Silicate Block and Pipe Thermal Insulation.
 - .6 ASTM C547-00, Specification for Mineral Fiber Pipe Insulation.
 - .7 ASTM C553-00, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .8 ASTM C612-00a, Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .9 ASTM C795-92 (1998) e1, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .10 ASTM C921-89 (R1996), Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB):
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .2 CGSB 51-GP-53M-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts.
- .4 Thermal Insulation Association of Canada (TIAC):
 - .1 National Insulation Standards 1992 (R1999).
- .5 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC-S102-M88 (R2000), Surface Burning Characteristics of Building Materials and Assemblies.

1.3 PRODUCT DATA

- .1 Submit Product Data in accordance with sections of Section 01 33 00 – Submittal Procedures.

1.4 SAMPLES

- .1 Submit samples in accordance with sections of Section 01 33 00 – Submittal Procedures.
- .2 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on ½" plywood board. Affix typewritten label beneath sample indicating service.

1.5 MANUFACTURER'S INSTRUCTIONS

- .1 Submit manufacturer's installation instructions in accordance sections of Section 01 33 00 – Submittal Procedures.
- .2 Installation instructions to include procedures to be used and installation standards to be achieved.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Protect from weather and construction traffic.
- .3 Protect against damage from any source.
- .4 Store at temperatures and conditions recommended by manufacturer.

1.7 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal recycling facility approved by Departmental Representative.
- .5 Divert unused adhesive materials from landfill to official hazardous material collections site approved by Departmental Representative.
- .6 Do not dispose of unused adhesive materials into sewer systems, into lakes, streams, onto ground or in other locations where it will pose health or environmental hazard.

1.8 DEFINITIONS

- .1 For Purposes of this Section:
 - .1 "CONCEALED" – insulated mechanical services and equipment in hung ceilings and non-accessible chases and furred spaces.
 - .2 "EXPOSED" – will mean "not concealed" as defined herein.

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 HOT EQUIPMENT

- .1 Application: Hydraulic Separators, Air separators, expansion tanks, *heat exchangers* on hot water heating systems and all other hot equipment supplied by Mechanical.
- .2 Material:
 - .1 CGSB-51-GP-10M rigid material fiber board.
- .3 Thickness: 50mm (2").
- .4 Application: Cut or miter insulation to fit the shape and contour of the equipment. Impale insulation over glued pins on 200mm (8") centers and secure in place with speed washers. Apply expanded metal lath over the insulation secured to welded pins. Lace edges of wire together with 16 ga. copper annealed wire. Apply 13mm (½") thick insulating cement in two coats. Finish the insulation with canvas adhered with lagging adhesive and brushed into one coat of lagging adhesive.

2.3 DEMOUNTABLE INSULATION

- .1 Application: Hot water heating pumps, water meter bodies, backflow preventers, balancing valves.
- .2 Material:
 - .1 CGSB-51-GP-2M, block rigid hydrous calcium silicate thermal insulation.
- .3 Thickness: 25mm (1").
- .4 Insulation shall be made to required shape, demountable w/ hinged or doweled construction with 24 gauge thick aluminum alloy outer lined.
- .5 Insulation pads with 50mm (2") thick insulation will be acceptable.

2.4 FASTENINGS

- .1 For Vapour Barriers:

- .1 Quick-setting adhesive for joints and lap sealing of vapour barriers. Flame spread 10 smoke development 0.
 - .2 For Canvas:
 - .1 Washable adhesive for cementing canvas lagging cloth to equipment insulation.
- 2.5 JACKETS**
- .1 Canvas:
 - .1 Apply on all equipment inside the building: compact, firm ULC listed heavy plain weave, cotton fabric at 6 oz/yd².
- 2.6 COLD EQUIPMENT**
- .1 Insulate all cold equipment including air separators, expansion tanks and heat exchangers. Insulation to be 50mm (2") thick complete with vapour barrier.
- 2.7 CEMENT**
- .1 Thermal insulating and finish:
 - .1 To: ASTM C449/C449M.
 - .2 Hydraulic setting or air drying on mineral wool, to ASTM C449.
- PART 3 EXECUTION**
- 3.1 APPLICATION**
- .1 Apply insulation after all tests have been completed and approved by the Departmental Representative.
 - .2 Surface to be clean and dry during installation of insulation and finishes.
 - .3 If not specified herein, application to be to manufacturer's recommendations.
 - .4 Maintain uninterrupted integrity of vapour barrier.
 - .5 Apply high density insulation under supports and hangers.
- 3.2 INSTALLATION**
- .1 Insulation supports where welding or bolting is permitted:
 - .1 Angle anchors: weld or bolt to equipment at lowest point of insulation. Thereafter, locate every 4m (13 ft). vertically.
 - .2 Welded steel clips: at 200mm (8") maximum on centers, but not less than two (1) rows per side.
 - .2 Insulation:
 - .1 Multi-layered: staggered butt joints and expansion joints in insulation, secured with wire or bands at 400 mm (16") center intervals.

- .3 Expansion joints in insulation: Leave 25mm (1") space in each layer at 5.5 m (18 ft). intervals. Pack space tightly with mineral fibre.
- .4 Insulation at bolts, studs, nuts, instrumentation: bevel to permit removal without damage to insulation or finish.
- .5 Fastenings: secure insulation with stainless steel wire at 1 m (3 ft). on center before application of finishing cement.
- .6 Vapour barriers: adhere and seal with vapour seal adhesive.
- .7 Finishes:
 - .1 Cement: apply over insulation in 1/8"-1/4" thick layers, reinforced by 25mm (1") mesh galvanized steel wire netting.
 - .2 Canvas: sewn and pasted on to all insulation and over cement finishes. Seams inconspicuously placed.
- .8 Do not insulate over nameplates, data plates, etc. Provide smooth bevelled edges at the name and data plates.
- .9 Install in accordance with TIAC National Standards:
 - .1 Hot equipment: To TIAC Code 1503-H.
 - .2 Cold equipment: To TIAC Code 1503-C.
- .10 Elastomeric Insulation: to remain dry. Overlaps to manufacturer's instructions. Joints tight and sealed properly.
- .11 Apply materials in accordance with insulation and equipment manufacturer's instructions and this specification.
- .12 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Hangers, supports outside vapour retarder jacket.
- .13 Supports, Hangers:
 - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.3 COMMISSIONING

- .1 Building Commissioning is a requirement of this project in order to comply with sections of Division 01 - General Requirements. A Commissioning Agent has been engaged and will provide all systems commissioning in conjunction with all trade contractors. The Commission Agent will provide a Commissioning Plan with commissioning start-up and test procedure sheets to be performed and completed by the various trade contractors.

END

PART 1 GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Thermal insulation for piping and piping accessories in commercial type applications.
 - .2 Thermal insulation for vertical stacked fan coil unit risers shall be ½” closed cell insulation.
- .2 Related Sections:
 - .1 Division 01 - General Requirements.
 - .2 Section 01 74 21 – Construction/Demolition Waste Management and Disposal.

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE):
 - .1 ASHRAE Standard 90.1-01, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).
- .2 American Society for Testing and Materials International (ASTM):
 - .1 ASTM B209M-04, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate Metric.
 - .2 ASTM C335-04, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411-04, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C533-2004, Calcium Silicate Block and Pipe Thermal Insulation.
 - .6 ASTM C547-2003, Mineral Fiber Pipe Insulation.
 - .7 ASTM C795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .8 ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB):
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .2 CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS):
 - .1 Material Safety Data Sheets (MSDS).
- .5 Manufacturer's Trade Associations:
 - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).

- .6 Underwriters' Laboratories of Canada (ULC):
 - .1 CAN/ULC-S102-03, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701-01, Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - .3 CAN/ULC-S702-1997, Thermal Insulation, Mineral Fibre, for Buildings.
 - .4 CAN/ULC-S702.2-03, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

1.3 DEFINITIONS

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

1.4 SUBMITTALS

- .1 Submittals: in accordance with sections of Section 01 33 00 – Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with sections of Division 01 - General Requirements. Include product characteristics, performance criteria, and limitations.
 - .1 Submit 12 copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS).
- .3 Shop Drawings:
 - .1 Submit shop drawings in accordance with sections of Section 01 33 00 – Submittal Procedures.
- .4 Samples:
 - .1 Submit samples in accordance with sections of Section 01 33 00 – Submittal Procedures.
 - .2 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on ½" plywood board. Affix label beneath sample indicating service.
- .5 Quality Assurance Submittals: submit following in accordance with sections of Division 01 - General Requirements.
 - .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 Contractor will make available five (5) copies of systems supplier's installation instructions.

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions and sections of Division 01 - General Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
 - .3 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Storage and Protection:
 - .1 Protect from weather, construction traffic.
 - .2 Protect against damage.
 - .3 Store at temperatures and conditions required by manufacturer.
- .3 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal.
 - .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
 - .4 Separate for reuse and recycling and place in designated containers Steel Metal Plastic waste in accordance with Waste Management Plan.
 - .5 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Departmental Representative.
 - .6 Fold up metal banding, flatten and place in designated area for recycling.

1.7 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Separate for reuse and recycling and place in designated containers Steel Metal Plastic waste in accordance with Waste Management Plan.

- .5 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Departmental Representative.
- .6 Fold up metal banding, flatten and place in designated area for recycling.
- .7 Do not dispose of unused adhesive materials into sewer systems, into lakes, streams, onto ground or in other locations where it will pose health or environmental hazard.

PART 2 PRODUCTS

2.1 GENERAL

- .1 All components of insulation system to have maximum flame spread rating of 25 and maximum smoke developed rating of 50 in accordance with CAN4-S102.
- .2 Materials to be tested in accordance with ASTM C411.

2.2 P-1 FORMED MINERAL FIBRE TO 200°C

- .1 Application: for piping valves and fittings on:
 - .1 Humidifier steam piping.
 - .2 All HWS & HWR piping.
 - .3 Domestic hot water, temperature 60°C.
 - .4 Domestic hot water recirculation, temperature 60°C.
 - .5 All other hot piping to include HWS(DHW), HWR(DHW), GLS, GLR
- .2 Materials:
 - .1 CGSB 51-GP-9M, rigid mineral fibre sleeving for piping.
 - .2 Thickness: To MNECB, refer to table.

2.3 P-2 FORMED MINERAL FIBRE WITH VAPOUR BARRIER TO 85°C

- .1 Application: for piping, valves and fittings on:
 - .1 Domestic cold water, temperature 4°C.
 - .2 All rainwater piping.
 - .3 Chilled water piping.
 - .4 Sprinkler piping identified as requiring insulation and heat tracing as identified on the drawings.
 - .5 Sanitary drainage piping identified as requiring insulation and heat tracing as identified on the drawings.
 - .6 All other cold water piping systems such as trap priming above floors, drains from plenums
 - .7 All fan coil unit condensate drainage piping.
- .2 Material:
 - .1 CGSB 51-GP-9M, rigid mineral fibre sleeving for piping and CGSB 51-GP-52M, vapour barrier jacket and facing material.
 - .2 Thickness: To MNECB, refer to drawings.

- .3 Thickness: To MNECB, refer to plans.
- .4 Thickness for all rainwater piping, heat traced sprinkler piping, heat traced sanitary piping and all fan coil unit condensate piping to be 1".

2.4 P-3 FLEXIBLE MINERAL FIBRE WITH VAPOUR BARRIER TO 85°C

- .1 Application on:
 - .1 Underside of roof drain body.
- .2 Material:
 - .1 CGSB 51-GP-11M, mineral fibre blanket for piping and CGSB 51-GP-52M vapour barrier jacket and facing material.
- .3 Thickness: all sizes, 25 mm (1").

2.5 FASTENINGS

- .1 For insulation systems P-1, P-2, P-3:
 - .1 Tape: self adhesive aluminum ULC labelled for less than 25 flame spread and less than 50 smoke developed.
 - .2 Lap seal adhesive: quick-setting for joints and lap sealing of vapour barriers.
 - .3 Lagging adhesive: fire retardant coating.
- .2 For vapour barriers:
 - .1 Quick-setting adhesive for joints and lap sealing of vapour barriers. Flame spread 10, smoke development 0.
- .3 All adhesives shall be U.L. listed and suitable for application as per insulation manufacturers' recommendations.

2.6 INSULATION CEMENT

- .1 To CAN/CGSB-51.12.

2.7 JACKETS

- .1 Canvas:
 - .1 Apply in exposed areas: ULC listed plain weave, cotton fabric at 11 oz/ft².
 - .2 On concealed valves and fittings: ULC listed plain weave cotton fabric at 11 oz/ft².
- .2 PVC:
 - .1 Apply in exposed areas accordance with CGSB 51-GP-53M.
 - .1 15 mil thick minimum.
 - .2 Fitting covers, one piece, premoulded to match.
 - .3 Fastenings standard to manufacturer.
 - .4 PVC jacket will meet 25 flame spread and 50 smoke developed rating.

- .5 Refer to 23 05 18 for jacket colouring.
- .3 Aluminium with S.S. cinch straps:
 - .1 Apply on all outdoor piping.
 - .2 Insulation on piping located outdoors shall be made weatherproof prior to installation of aluminum jacket. Weatherproof treatment to include 0.12" thick weather resistant mastic reinforced with tight overwrapping of open mesh glass fabric and finished with a coat of mastic.
 - .3 Thickness to be 6 mil.

2.8 REMOVABLE PREFABRICATED INSULATION AND ENCLOSURES

- .1 Application: expansion joints, valves, orifice plates.
- .2 Design: to permit movement of expansion joint to permit periodic removal and replacement without damage to adjacent insulation.
- .3 Insulation:
 - .1 Flexible to fit components.
 - .2 Thickness to match application.
 - .3 Chilled water systems: provide vapour barrier.
 - .4 Enclosure: aluminum 1/16" thick to match adjacent pipe jacketing.

2.9 REFRIGERANT PIPING

- .1 Flexible Foamed Pipe Insulation
- .2 Application: All refrigerant piping and fittings.
- .3 Thickness: 25 mm (1") for refrigerant piping.

PART 3 EXECUTION

3.1 APPLICATION

- .1 Apply insulation after required tests have been completed and approved by Departmental Representative. Insulation and surfaces shall be clean and dry when installed and during application of any finish. Apply insulation materials, accessories and finishes in accordance with manufacturer's recommendations and as specified herein.
- .2 On piping with insulation and vapour barrier, install high density insulation under hanger shield. Maintain integrity of vapour barrier over full length of pipe without interruption at sleeves, fittings and supports.
- .3 Apply insulation materials, accessories and finishes in accordance with manufacturers' recommendations.

3.2 INSTALLATION

- .1 Preformed: Sectional up to 300mm (12"), sectional or curved segmented above 300mm (12").

- .2 Expansion Joints in Insulation: Terminate single layer and each layer of multiple layers in straight cut at intervals recommended by manufacturer. Leave void 25mm (1") between terminations. Pack void tightly with mineral fibre.
- .3 Seal and finish exposed ends and other terminations with insulating cement.
- .4 Expansion Joints in Piping: Provide for adequate movement without damage to insulation or finishes.
- .5 Orifice Plate Mounting Flanges, Flanges & Unions at Equipment, Expansion Joints, Valves, Other Components Requiring Regular Maintenance: Install insulation and finish to permit easy disassembly and replacement without damage to adjacent insulation and finishes.
- .6 Insulation is not required for:
 - .1 Chrome-plated piping, valves and fittings.
 - .2 Heating pipe connection between floor and the underside of heating unit for upfed units when the unit is 4" above the floor.

3.3 THICKNESS

- .1 NECB 2015 Table of Minimum Pipe Insulation Thickness as per schedule on heating drawings.

3.4 FASTENINGS

- .1 Secure pipe insulation by tape at each end and centre of each section, but not greater than 18" on centres.

3.5 SIZING

- .1 Provide fire retardant coating on canvas jackets.
- .2 Fire retardant coating shall be U.L. approved.
- .3 Coat canvas covering exposed in finished spaces with diluted coat of lagging adhesive. Provide a total of two coats of lagging adhesive. Provide a total of two coats of lagging adhesive. Dilution of lagging adhesive as per manufacturer's recommendations for priming.

3.6 HANGERS

- .1 Hot Piping:
 - .1 For pipes up to 2", provide proper covering shields sized to suit the insulated pipe, between the pipe insulation and the pipe hanger or support.
 - .2 Where roller hangers and supports are used for hot piping 2" diameter and larger, steel protection saddles shall be supplied and installed as part of the piping work. Pack the saddle voids with fiberglass insulation.
- .2 Cold Piping:
 - .1 Use calcium silicate insulation at all hanger locations on cold piping systems, except domestic water piping. Calcium silicate insulation length to be 18".

Thickness of insulation to be the same as specified on adjacent insulation. The use of the "Buckaroo System" in lieu of the calcium silicate insulation at the hangers on cold piping will be acceptable.

3.7 DEMOUNTABLE INSULATION

- .1 Insulation on valves, flanges and orifice plates for steam flow measurements and other fittings requiring access for servicing shall be demountable.

3.8 PIPE ELBOWS

- .1 Use of flexible insulation for pipe elbows will be acceptable.

3.9 REFRIGERANT PIPING

- .1 Insulation shall fit in snug contact with pipe and be installed in accordance with Manufacturer's recommendations.
- .2 Stagger joints on layered insulation.
- .3 Slip insulation on tubing before tubing sections and fittings are assembled keeping slitting of insulation to a minimum.
- .4 Seal joints in insulation.
- .5 Insulate flexible pipe connectors.
- .6 Provide 6" long, 20 ga. galvanized steel sleeve around pipe insulation at each support.
- .7 Extend insulation through pipe support clamps.
- .8 Insulation shall have "slit" joint seams placed on bottom of pipe. Use manufacturer's recommended adhesive to seal joints.
- .9 Insulate fittings with sheet insulation and as recommended by manufacturer.

3.10 FINISHES

- .1 Finishes:
 - .1 Exposed indoors: canvas or PVC Jacket.
 - .2 Exposed in mechanical rooms: Canvas 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: aluminum bands, at 6" on centre. Seals: closed.
 - .7 Installation: to appropriate TIAC code CRF/1 through CPF/5.

3.11 CLEANING

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

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

3.12 COMMISSIONING

- .1 Building Commissioning is a requirement of this project in order to comply with sections of Division 01 - General Requirements. A Commissioning Agent has been engaged and will provide all systems commissioning in conjunction with all trade contractors. The Commission Agent will provide a Commissioning Plan with commissioning start-up and test procedure sheets to be performed and completed by the various trade contractors.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 01 91 13 – General Commissioning Requirements.
- .2 Section 23 05 00 – Common Work Results – Mechanical.
- .3 Section 23 05 01 – Facility Mechanical Commissioning – General.
- .4 Section 23 05 02 – Facility Commissioning – Mechanical.
- .5 Section 23 21 13.01 – Valves – Bronze.
- .6 Section 23 21 13.02 – Valves – Cast Iron.

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E202-04, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.3 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS

- .1 In accordance with Section 23 08 16 - Cleaning and Start-up of Mechanical Piping Systems.

1.4 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 heat pump plant operation.
 - .3 Pressure bypass open/closed.
 - .4 Control pressure failure.
 - .5 Maximum heating demand.
 - .6 Maximum cooling demand.
 - .7 Boiler and/or heat pump plant failure.
 - .8 Pump failure – seawater loop failure.
 - .9 Outdoor reset. Re-check heat exchanger output supply temperature at 100% and 50% reset, maximum water temperature.

1.5 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.
- .7 Cooling water system capacity test:
 - .1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:
 - .1 Adding heat from building heating system or;
 - .2 Raising space temperature by turning off cooling and air systems for sufficient period of time before starting testing and pre-heating building to summer design space temperature (occupied) or above. Set OAD and RAD for minimum outside air if OAT is near outside design temperature or to maximum recirculation if RAT is greater that OAT. RAT to be at least 23 degrees C minimum.
 - .2 Test procedures:
 - .1 Open fully cooling coil control valves.
 - .2 Set thermostats on associated AHU's for maximum cooling.
 - .3 Set AHU's for design maximum air flow rates.
 - .4 Set load or demand limiters on chillers to 100%.

- .5 After system has stabilized, record chilled water, and condenser water flow rates and supply and return temperatures simultaneously.

1.6 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.

1.7 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.

1.8 WET AND DRY PIPE SPRINKLER SYSTEM, STANDPIPE AND HOSE SYSTEMS

- .1 Cleaning, testing, start-up, performance verification of equipment, systems, components, and devices is specified elsewhere in Division 23.
- .2 Verification of controls, detection devices, alarm devices is specified Division 26.
- .3 Verify operation of interlocks between HVAC systems and fire alarm systems.

1.9 SANITARY AND STORM DRAINAGE SYSTEMS

- .1 Buried systems: perform tests prior to back-filling. 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.
- .5 Cleanouts: refer to Section 22 42 01 – Plumbing Specialties and Accessories.

1.10 REPORTS

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

1.11 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

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Section 23 25 00 - HVAC Water Treatment Systems.
- .3 Section 23 05 93 - Testing Adjusting and Balancing for HVAC.

1.2 REFERENCES

- .1 American Society for Testing and Materials
 - .1 ASTM E202, Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Dispose of unused cleaning solutions at official hazardous material collections site approved by the Departmental Representative.
- .3 Do not dispose of unused cleaning solutions into sewer system, into streams, lakes, onto ground or in other locations where it will pose health or environmental hazard.
- .4 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .5 Dispose of corrugated cardboard polystyrene plastic packaging material in appropriate on-site bin for recycling in accordance with site waste management program.

1.4 COORDINATION

- .1 Refer to Division 01, 21, 22, 25 and 26 for other requirements as included and outlined in other sections of the specifications.

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 CLEANING HYDRONIC AND STEAM SYSTEMS

- .1 Timing
 - .1 Systems to be 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 to be 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 to be used to ensure water will not damage systems or equipment.
- .5 Conditions at time of cleaning of systems
 - .1 Systems to be free from construction debris, dirt and other foreign material.
 - .2 Control valves to be operational, fully open to ensure that terminal units can be cleaned properly.
 - .3 Strainers to be 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°C for at least 36 h. 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 so as 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 maximum design 82°C minimum. Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38°C. Drain as quickly as possible. Refill with clean water. Circulate for 6 h 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 procedures specified herein.
 - .2 Test to prove concentration will prevent freezing to minus 40°C Test inhibitor strength and include in procedural report. Refer to ASTM E202.

3.2 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 Commission water treatment systems as specified in Section 23 25 00 - HVAC Water Treatment.
 - .7 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.
 - .8 Repeat with water at design temperature.
 - .9 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.
 - .10 Bring system up to design temperature and pressure over a 48 hour period.
 - .11 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .12 Adjust pipe supports, hangers and springs as necessary.
 - .13 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
 - .14 If bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.
 - .15 Re-tighten bolts, etc. using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.

- .16 Check operation of drain valves.
- .17 Adjust valve stem packings as systems settle down.
- .18 Fully open all balancing valves (except those that are factory-set).
- .19 Check operation of over-temperature protection devices on circulating pumps.
- .20 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

END

PART 1 GENERAL

1.1 APPLICATIONS

- .1 This section intended for all hot water heating, glycol piping system provided in Division 23.

1.2 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 00 – Common Work Results – Mechanical.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material, in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal facility as approved by Departmental Representative.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

1.4 REFERENCES

- .1 ANSI B16.1- 2010 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800.
- .2 ANSI B16.5- 2009 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and other Special Alloys.
- .3 ASTM A53- 87b - Specification for Pipe, Steel, Black and Hot- Dipped, Zinc Coated, Welded and Seamless.
- .4 MSS-SP-70- 2006 - Cast Iron Gate Valves, Flanged and Threaded Ends.
- .5 MSS-SP-71- 2005 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
- .6 MSS-SP-80- 2003 - Bronze Gate, Globe, Angle and Check Valves.

- .7 MSS-SP-85- 2002 - Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.5 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.
.2 Indicate on manufacturer’s catalogue literature: Valves.

1.6 COORDINATION

- .1 Refer to division 01, 21, 22, 25 and 26 for other requirements as included and outlined in other sections of the specifications.

1.7 MAINTENANCE

- .1 Provide maintenance data for incorporation into manual data specified in Section 01 77 00 – Closeout Procedures.

PART 2 PRODUCTS

2.1 PIPE

- .1 Steel pipe: Schedule 40 to ASTM A53, Grade B.
.2 Schedule 10 with roll groove joints for size 65mm (2-1/2") and larger.

2.2 PIPE JOINTS

- .1 50mm (2") and under: screwed fittings with Teflon tape.
.2 65mm (2-1/2") and over: welding fittings and flanges to CSA W47.1.
.3 Flanges: plain or raised face.
.4 Orifice flanges: slip-on raised face, 2069 kPa (300 psi).
.5 Flange gaskets: to ANSI B16.21 or ANSI B16.20.
.6 Pipe thread taper.
.7 Bolts and nuts: to ANSI B18.2.1.
.8 Mechanical roll grooved coupling with gaskets rated for 93.3°C (200°F) continuous rise. Products shall have current CRN numbers from the Province of Nova Scotia.

- .9 All grooved couplings to be designed to provide rigid joints unless noted otherwise.
- .10 All grooved products to be provided by one manufacturer.
- .11 Flexible couplings shall be used on expansion joints and/or where noted.

2.3 FITTINGS

- .1 Cast iron pipe flanges: Class 125 to ANSI B16.1.
- .2 Screwed fittings: malleable iron, Class 150.
- .3 Pipe flanges and flanged fittings:
 - .1 Steel: to ANSI B16.5.
- .4 Steel butt-welding fittings.
- .5 Unions: malleable iron, to ASTM A47M.
- .6 Mechanical roll grooved piping.

2.4 GATE VALVES

- .1 500mm (2") and under, screwed:
 - .1 Rising stem: to MSS SP-80, Class 125, 860 kPa (125 psi), bronze body, solid wedge disc.
 - .2 Rising stem: to MSS SP-80, Class 200, 1379kPa (200 psi) bronze body, nickel alloy seats, union bonnet.
- .2 65mm (2-1/2") and over in mechanical rooms, flanged:
 - .1 Rising stem: to MSS SP-70, Class 125, 860kPa (125 psi), FF flanges, cast-iron body, OS & Y bronze trim.
- .3 65mm (2-1/2") and over other than mechanical rooms, flanged:
 - .1 Non-rising stem: to MSS SP-70, Class 125, 860 kPa (125 psig.), FF flanges, cast-iron body, bronze trim, bolted bonnet.

2.5 BALL VALVES

- .1 65mm (2") and under:
 - .1 Bronze body, screwed ends, TFE seal, hard chrome ball, 3999 kPa (580 psig.) WOG.

2.6 GLOBE VALVES

- .1 50mm (2") and under, screwed:
 - .1 To MSS SP-80, Class 125, 860 kPa (125 psig.), bronze body, screwed over bonnet, renewable composition disc suitable for service.

.2 Lockshield handles: as indicated.

.2 65mm (2-1/2") and over, flanged:

.1 To MSS SP-85, Class 125, 860 kPa (125 psig.), F.F. flanges, cast iron body, bronze trim, OS&Y, bolted bonnet, bronze disc and seat ring.

2.7 SWING CHECK VALVES

.1 50mm (2") and under, screwed:

.1 To MSS SP-80, Class 125, 860 kPa (125 psig.), bronze body, bronze swing disc, screw in cap, regrindable seat.

.2 65mm (2-1/2") and up, flanged:

.1 To MSS SP-71, Class 125, 860 kPa (125 psig.), cast iron body, FF flange, regrind renewable seat, bronze disc, bolted cap.

2.8 SILENT CHECK VALVES

.1 50mm (2") and under:

.1 To ASTM B62, Class 125, 860 kPa (125 psig.) cast steel, wafer style, brass seatings, brass inner valve, stainless steel spring (heavy duty spring in vertical down flow application).

.2 65mm (2-1/2") and over:

.1 To MSS SP-71, Class 125, 860 kPa (125 psig.), cast steel, wafer style, bronze trim, stainless spring (heavy duty spring in vertical down flow application).

2.9 LUBRICATED PLUG COCKS

.1 50mm (2") and under, screwed:

.1 To ASTM B61, Class 150, 1034 kPa (150 psig.) bronze body.

2.10 BALANCING VALVES

.1 Water flow indicating device for lines up to 75mm (3") shall be Y-pattern globe style calibrated bronze balance valve with provisions for connecting a portable differential pressure meter.

.2 For pipes 100mm and larger, use a flow sensor along with a globe valve for adjustment.

.3 Provide demountable polyurethane insulation with two (2) stainless steel bands.

2.11 RADIATOR VALVES

.1 Provide shut-off radiator valve at supply to perimeter radiation panels.

- .2 Provide lock shield flow control valve at return on perimeter radiation units complete with flow measurement fittings.

2.12 BUTTERFLY VALVES

- .1 Ductile iron body to ASTM A-536, Grade 65-45-12, Ductile Iron disk, rubber encapsulated suitable to 110°C. Seat tested to MSS SP67.
- .2 65mm to 150mm (2-1/2" to 6") to have lever lock handle with memory stop.
- .3 200mm to 300mm (8" to 12") to be supplied with gear operator.
- .4 For use in lieu of gate valves in heating water systems up to 110°C.

PART 3 EXECUTION

3.1 PIPING

- .1 Connect to equipment in accordance with manufacturer's installation instruction unless otherwise indicated.
- .2 Install concealed pipes close to building structure to keep furring space to minimum. Install to conserve headroom and space. Run exposed piping parallel to walls. Group piping wherever practical.
- .3 Slope piping in direction of drainage and for positive venting.
- .4 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.
- .5 Ream pipes, clean scale and dirt, inside and outside, before and after assembly.
- .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 the size of main. Hole saw or drill and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .8 Piping:
 - .1 Connect equipment as per manufacturer's installation literature and as instructed.
 - .2 Provide flexible connections at moving equipment.
 - .3 Route piping in orderly manner and maintain proper grades. Install concealed pipes close to building structure to keep furring space to minimum. Install to conserve headroom and space. Run exposed piping parallel to walls.
 - .4 Slope water piping up in direction of flow 1:700 and drain at low points and vent at high points.
 - .5 On all closed systems, equip low points with 19 mm (3/4") drain valves and hose nipples. Provide, at high points on lines and on equipment connections, collecting chambers and high capacity float operated automatic air vents.

- .6 Make reductions in water pipe sizes with eccentric reducing fittings.
- .7 Provide clearance for installation of insulation and for access to strainers, valves, air vents, drains, cleanouts, unions, expansion joints, flex connectors and trap assemblies.
- .8 Ream pipes and tubes. Clean scale and dirt, inside and outside, before and after assembly.
- .9 The use of “main sized saddle type branch connections” or “directly connecting branch lines to mains” in steel piping will be permitted if: for all water systems and low pressure steam systems, main is at least two pipe sizes larger than the branch up to 150mm mains; and if main is at least two pipe sizes larger than branch for 200mm and larger mains. Where reducing tees of proper size are not available, use available tees with an eccentric reducer. Tees with increasers shall not be acceptable.
- .10 Make all connections to equipment with unions, or flanges.
- .11 Provide non-conducting type connections wherever joining dissimilar metals. Brass adaptors flanges and valves are acceptable.

3.2 VALVES

- .1 Install valves with stems upright or horizontal unless approved otherwise by Departmental Representative.
- .2 Install gate valves at all branch take-offs and to isolate each piece of equipment, and as indicated.
- .3 Install globe valves for balancing and in by-pass around programmed water mixing valve. Flow measurement fittings to be provided in all balancing applications.
- .4 Provide swing check valves on discharge of pumps and as indicated.

3.3 TESTING

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

3.4 BALANCING VALVES

- .1 Install balancing valves at the following locations:
 - .1 At each coil bank in air handling units.
 - .2 At each heat exchanger.
 - .3 All other locations as shown on the drawings.
 - .4 Any other location where required for proper balancing of the system.

END

PART 1 GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation for steel piping, valves and fittings for hydronic systems in building services piping.
 - .2 Sustainable requirements for construction and verification.
- .2 Related Sections:
 - .1 Section 01 33 00 - Submittal Procedures.
 - .2 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .3 Section 01 35 29 - Health and Safety Requirements.
 - .4 Section 01 78 00 - Closeout Submittals.
 - .5 Section 23 05 00 - Common Work Results - Mechanical.
 - .6 Section 23 05 17 - Pipe Welding.
 - .7 Section 23 08 16 - Cleaning and Start-up of Mechanical Piping Systems.
 - .8 Section 23 05 15 – Common Installation Requirements for HVAC Pipework.
 - .9 Section 23 05 23.01 - Valves - Bronze.
 - .10 Section 23 05 23.02 - Valves - Cast Iron.
 - .11 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .12 Section 23 08 01 - Performance Verification of Mechanical Piping.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME):
 - .1 ASME B16.1-98, Cast Iron Pipe Flanges and Flanged Fittings.
 - .2 ASME B16.3-98, Malleable Iron Threaded Fittings.
 - .3 ASME B16.5-03, Pipe Flanges and Flanged Fittings.
 - .4 ASME B16.9-01, Factory-Made Wrought Butt Welding Fittings.
 - .5 ASME B18.2.1-03, Square and Hex Bolts and Screws (Inch Series).
 - .6 ASME B18.2.2-87(R1999), Square and Hex Nuts (Inch Series).
 - .7 ASME B16.9 – Factory Made Wrought Butt Welded Fittings.
 - .8 ASME B31.9 – Building Services Piping.
- .2 American Society for Testing and Materials International, (ASTM):
 - .1 ASTM A47/A47M-99, Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M-02, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
 - .3 ASTM A536-84(1999)e1, Standard Specification for Ductile Iron Castings.
 - .4 ASTM B61-02, Standard Specification for Steam or Valve Bronze Castings.
 - .5 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.

- .6 ASTM E202-00, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.
- .7 ASTM A-53 – Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- .8 ASTM A-183 – Carbon Steel Track Bolts and Nuts
- .9 ASTM A-234 – Standard Specification For Piping Fittings or Wrought Carbon Steel and Alloy Steel.
- .10 ASTM A-449 – Quenched and Tempered Steel Bolts and Studs.
- .11 ASTM A-536 – Ductile Iron Castings.
- .12 ASTM F-1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.

- .3 American Water Works Association (AWWA):
 - .1 AWWA C111-00, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .4 Canadian Standards Association (CSA International):
 - .1 CSA B242-M1980(R1998), Groove and Shoulder Type Mechanical Pipe Couplings.
 - .2 CAN/CSA W48-01, Filler Metals and Allied Materials for Metal Arc Welding (Developed in cooperation with the Canadian Welding Bureau).
- .5 Manufacturer's Standardization of the Valve and Fittings Industry (MSS):
 - .1 MSS-SP-67-025, Butterfly Valves.
 - .2 MSS-SP-70-98, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS-SP-71-97, Cast Iron Swing Check Valves Flanged and Threaded Ends.
 - .4 MSS-SP-80-03, Bronze Gate, Globe, Angle and Check Valves.
 - .5 MSS-SP-85-02, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 SUBMITTALS

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 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 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal.
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Fold up metal and plastic banding, flatten and place in designated area for recycling.

1.6 MAINTENANCE

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

PART 2 PRODUCTS

2.1 PIPE

- .1 Steel pipe: to ASTM A53/A53M, Grade B, Schedule 40.

2.2 PIPE JOINTS

- .1 NPS2 and under: screwed fittings with PTFE tape or lead-free pipe dope.
- .2 NPS2-1/2 and over: welding fittings and flanges to CAN/CSA W48.
- .3 Roll grooved: rigid coupling to CSA B242.
- .4 Flanges: plain or raised face, slip-on to AWWA C111.
- .5 Orifice flanges: slip-on raised face, 2100 kPa.
- .6 Flange gaskets: to AWWA C111.
- .7 Pipe thread: taper.
- .8 Bolts and nuts: to ASME B18.2.1 and ASME B18.2.2.
- .9 Roll grooved coupling gaskets: type EPDM.

2.3 FITTINGS

- .1 Screwed fittings: malleable iron, to ASME B16.3, Class 150.
- .2 Pipe flanges and flanged fittings:
 - .1 Cast iron: to ASME B16.1, Class 125.

- .2 Steel: to ASME B16.5.
- .3 Butt-welding fittings: steel, to ASME B16.9.
- .4 Unions: malleable iron, to ASTM A47/A47M and ASME B16.3.
- .5 Fittings for roll grooved piping: malleable iron to ASTM A47/A47M ductile iron to ASTM A536.

2.4

VALVES

- .1 Connections:
 - .1 NPS2 and smaller: screwed ends.
 - .2 NPS 2-1/2 and larger: grooved ends.
- .2 Gate valves: to MSS-SP-70 to MSS-SP-80 Application: Isolating equipment, control valves, pipelines:
 - .1 NPS2 and under:
 - .1 Mechanical Rooms: Class 125, rising stem, split wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 Elsewhere: Class 125, non- rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS2 1/2 and over:
 - .1 Mechanical Rooms: rising stem, wedge disc, bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.
 - .2 Elsewhere: Non- rising stem, solid wedge disc, bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.
- .3 Butterfly valves: to MSS-SP-67 Application: Isolating cells or section of multiple component equipment (e.g. multi-section coils, multi-cell cooling towers).
 - .1 NPS 2-1/2 and over: Lug type or Grooved ends: as specified Section 23 05 17 - Pipe Welding.
- .4 Globe valves: to MSS-SP-80 85 Application: Throttling, flow control, emergency bypass:
 - .1 NPS2 and under:
 - .1 Mechanical Rooms: with PTFE disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 Elsewhere: Globe, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS2 1/2 and over:
 - .1 With composition disc, bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.
- .5 Balancing, for TAB:
 - .1 Sizes: Calibrated balancing valves, as specified this section.
 - .2 NPS2 and under:
 - .1 Mechanical Rooms: Globe, with plug disc as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 Elsewhere: Globe, with plug disc as specified Section 23 05 23.01 - Valves - Bronze.
- .6 Drain valves: Gate, Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.

- .7 Bypass valves on glove valves NPS8 and larger: NPS3/4, Globe, with PTFE disc as specified Section 23 05 23.01 - Valves - Bronze.
- .8 Swing check valves: to MSS-SP-71:
 - .1 NPS2 and under:
 - .1 Class 125, swing, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS21/2 and over:
 - .1 Flanged Grooved ends: as specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.
- .9 Silent check valves:
 - .1 NPS2 and under:
 - .1 As specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS21/2 and over:
 - .1 Flanged or Grooved ends: as specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.
- .10 Ball valves:
 - .1 NPS2 and under: as specified Section 23 05 23.01 - Valves - Bronze.

2.5 QUALITY ASSURANCE

- .1 To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved products utilized shall be supplied by one manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved components.

2.6 GROOVED/CUT MECHANICAL COUPLING SYSTEM

- .1 Pipe/Grooved (Standard): Carbon Steel, A-53B/A-106B - Roll or cut grooved-ends as appropriate to pipe material, wall thickness, pressures, size and method of joining. Pipe ends to be grooved in accordance with current listed standards conforming to ANSI/AWWA C-606.
- .2 Mechanical Couplings for Joining Carbon Steel Pipe
 - .1 Standard Mechanical Couplings, 2 inch (DN50) through 12 inch (DN300): Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure-responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. (Gaskets used for potable water applications shall be UL classified in accordance with ANSI/NSF-61 for potable water service). Mechanical Coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A-183, minimum tensile strength 110,000 psi (758450 kPa) as provided standard.
 - .1 Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9, and NFPA 13.
 - .1 2” (DN50) through 12” (DN300): Installation ready rigid coupling for direct stab installation without field disassembly. Gasket shall be Grade “EHP” EPDM compound with red color code designed for operating temperatures from -30 deg F (-34 deg C) to +250 deg F (+120 deg C).
 - .2 10” (DN250) through 12” (DN300): Standard rigid coupling. Gasket shall be Grade “E” EPDM compound with green color

code designed for operating temperatures from -30 deg F (-34 deg C) to +230 deg F (+110 deg C).

- .2 Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three couplings, for each connector, shall be placed in close proximity to the vibration source.
 - .1 2” (DN50) through 8” (DN200): Installation ready flexible coupling for direct stab installation without field disassembly. Gasket shall be Grade “EHP” EPDM compound with red color code designed for operating temperatures from -30 deg F (-34 deg C) to +250 deg F (+120 deg C).
 - .2 10” (DN250) through 12” (DN300): standard flexible couplings. Gasket shall be Grade “E” EPDM compound with green color code designed for operating temperatures from -30 deg F (-34 deg C) to +230 deg F (+110 deg C).
- .3 Flange Adapters: For use with grooved end pipe and fittings, flat faced, for mating to ANSI Class 125 / 150 flanges.
- .4 Grooved couplings shall meet the requirements of ASTM F-1476.
- .5 Gasket: Synthetic rubber conforming to steel pipe outside diameter and coupling housing, manufactured of elastomers as designated in ASTM D-2000.
- .6 Gasket: Wide width, pressure-responsive, synthetic rubber design, conforming to steel pipe outside diameter and coupling housing, manufactured of elastomers as designated in ASTM D-2000.
 - .1 Grade “E” EPDM with green color code designed for operating temperatures from -30 deg F (-34 deg C) to +230 deg F (+110 deg C).
 - .2 Grade “T” Nitrile with orange color code designed for operating temperatures from -20 deg F (-29 deg C) to +180 deg F (+82 deg C).
Grade “L” Silicone with red color code designed for operating temperatures of -30 deg F (-34 deg C) to +350 deg F (+177 deg C); recommended for dry heat service (air without hydrocarbons).
- .7 Coupling Types:
 - .1 Rigid Coupling: Coupling key shall be designed to fill the wedge shaped AGS groove to provide a rigid joint that corresponds with support spacings as defined by ASME B31.1 and B31.9. Systems incorporating rigid couplings require the calculated thermal growth/contraction of the piping system to be fully compensated for in the design of the piping system through use of adequate flexible components.
 - .2 Flexible Coupling: Coupling key shall be designed to fit into the wedge shaped AGS groove and allow for linear and angular movement, vibration attenuation, and stress relief..

- .1 Standard fittings shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12, forged steel conforming to ASTM A-234, Grade WPB 0.375" wall (9.53 mm wall), or fabricated from Std. Wt. Carbon Steel pipe conforming to ASTM A-53, Type F, E or S, Grade B. Fittings provided with an alkyd enamel finish or hot dip galvanized to ASTM A-153. Zinc electroplated fittings and couplings conform to ASTM B633.
- .2 AGS Fittings shall be supplied with factory AGS grooved ends, for use with couplings and flange adapters. Fittings shall be manufactured of ductile iron conforming to ASTM A-536, forged carbon steel conforming to ASTM A-234, or factory fabricated from carbon steel pipe conforming to ASTM A-53. Fittings shall be manufactured to the dimensional standards ASME B16.9. Orange enamel coated or galvanized.
- .3 Hole-Cut Branch Outlets:
 - .1 Bolted Branch Outlet: Branch reductions on 2"(DN50) through 8"(DN200) header piping. Bolted branch outlets shall be manufactured from ductile iron conforming to ASTM A-536, Grade 65-45-12, with synthetic rubber gasket, and heat treated carbon steel zinc plated bolts and nuts conforming to physical properties of ASTM A-183.
 - .2 Strapless Outlet: 1/2"(DN15) or 3/4"(DN20) NPT outlet on 4" (DN100) and larger header sizes rated for 300 PSI (2065 kPa).
 - .3 Thermometer Outlet: To accommodate industrial glass bulb thermometers with standard 1-1/4"-18 NEF 2B extra fine thread and 6" (152mm) nominal bulb length on 4" (DN100) and larger header sizes rated for 300 PSI (2065 kPa).
- .4 Grooved End Valves
 - .1 Butterfly Valves:
 - .1 2" (DN50) through 12"(DN300) Sizes: 300 psi CWP (2065 kPa) suitable for bidirectional and dead-end service at full rated pressure. Body shall be grooved end black enamel coated ductile iron conforming to ASTM A536. Disc shall be electroless nickel plated ductile iron with blowout proof 416 stainless steel stem. Disc shall be offset from the stem centerline to allow full 360 degree circumferential seating. Seat shall be pressure responsive EPDM. Valve bearings shall be TFE lined fiberglass, and stem seals shall be of the same grade elastomer as the valve seat. Valve shall be complete with ISO flange for actuation mounting. Valve operators shall be lever handle or gear operator, available with memory stop feature, locking device, chainwheel, or supplied bare. (Valve with EPDM seat is UL classified in accordance with ANSI/NSF-61.)
 - .2 14" (DN350) through 24" (DN600) Sizes: 300 psi (2065 kPa), AGS grooved ends, polyphenylene sulfide (PPS) coated ductile iron body (ASTM A-536, Grade 65-45-12), PPS coated ductile iron disc (ASTM A-536), and two piece 17-4 PH S/S stem design. Seat and seal material to suit intended service. Reinforced PTFE bearings and gear operator. Bubble tight, dead-end, or bi-directional service. With memory stop for throttling, metering or balancing service.
 - .3 Refer to latest published literature, Butterfly Valve Material Selection section, for liner/seat and disc material recommendations for chemical service.

- .2 Check Valves:
 - .1 2” (DN50) through 3”(DN80) Sizes Spring Assisted: Black enamel coated ductile iron body, ASTM A-536, Grade 65-45-12, stainless steel non-slam tilting disc, stainless steel spring and brass shaft, nickel-plated seat surface, 365 psi (2517 kPa).
 - .2 4” (DN100) through 12”(DN300) Sizes Spring Assisted: Black enamel coated ductile iron body, ASTM A-536, Grade 65-45-12, elastomer encapsulated ductile iron disc suitable for intended service, stainless steel spring and shaft, welded-in nickel seat, 300 psi (2065 kPa).
 - .3 2”(DN50) through 4”(DN100) Sizes Horizontal Swing: Horizontal installation, ductile iron body, ASTM A-536, Grade 65-45-12, and Type 316 stainless steel clapper. Synthetic rubber bumper & bonnet seals suitable for intended service, stainless steel wetted parts, 300 psi (2065 kPa).
 - .4 4” DN100) through 12”(DN300) Sizes Venturi Check: Black enamel coated ductile iron body, ASTM A-536, Grade 65-45-12 with venturi-like taps, elastomer encapsulated ductile iron disc suitable for intended service, stainless steel spring and shaft, welded-in nickel seat, 300 psi (2065 kPa).
 - .5 14” (DN350) through 24” (DN600) Check Valves: 230 psi (1585 kPa), AGS grooved ends, spring-assisted dual disc check valve. ASTM A-536, Grade 65-45-12 coated ductile iron body, EPDM seat bonded to the valve body, 304 stainless steel disc, and stainless steel spring and shaft.
- .3 Tri-Service Valve Assembly: Combination shut-off, throttling and non-slam check valve.
 - .1 2-1/2”(DN65) through 12”(DN300) Sizes: butterfly valve with memory stop feature assembled (2-1/2” & 3”) (DN65 & DN75) or Venturi Check (4” – 12”) (DN100-DN300). Check valve with venturi like taps for flow measurement. Working pressures to 300 psi (2065 kPa).
 - .2 14” (DN350) through 24” (DN600) Sizes: butterfly valve with gear operator and memory stop feature Check Valve. Working pressures to 232 psi (1600 kPa).
- .4 Ball Valves: 1-1/2”(DN40) through 6”(DN150) sizes, ASTM A-536, Grade 65-45-12, ductile iron body, chrome plated carbon steel ball and stem, TFE seats, with Fluoroelastomer seals. 800 psi (5515 kPa).
- .5 Plug Valves: 3”(DN75) through 12”(DN300) sizes, with memory stop for throttling, metering or balancing service. Unidirectional bubble-tight shut-off, bi-directional sealing optional. ductile iron body, bonnet, and plug, ASTM A-536, Grade 65-45-12. Plug encapsulated with synthetic rubber suitable for intended service. Welded-in nickel seat, stainless steel self-lubricating bearings. 175 PSI (1200 kPa). AWWA rigid groove dimensions may be adapted to IPS sized system through the use of transition couplings.
- .6 Circuit Balancing Valves:
 - .1 2” (DN50) and Smaller Sizes: 300 psi (2065 kPa), y-pattern, globe type with soldered or threaded ends, non-ferrous brass copper alloy body, EPDM o-ring seals. 4-turn digital readout handwheel for balancing, hidden memory feature with locking tamper-proof setting, and connections for portable differential meter.
 - .1 Install union port fitting and strainer/ball valve combination to complete terminal hookup at coil outlet.

- .2 Install differential pressure controller to stabilize differential pressure and ensure stable and accurate modulating control. brass copper alloy body, bonnet, cone and spindles, threaded ends only.
 - .2 2-1/2" (DN65) and Larger Sizes: 300 psi (2065 kPa), y-pattern, globe type with flanged or grooved ends, ASTM A536 ductile iron body, all other metal parts of brass copper alloy, EPDM O-ring seals. 8, 12 or 16-turn digital readout handwheel for balancing, hidden memory feature with locking tamper-proof setting, and connections for portable differential meter.
 - .3 Differential Pressure Controller: For use in conjunction with TA Balancing valves to stabilize differential pressure and ensure stable and accurate modulating control. Ductile iron, brass copper alloy bonnet, cone, and spindles, flanged ends only.
- .5 Grooved End Specialties
- .1 Expansion Joints
 - .1 2"(DN50) through 6"(DN150) Sizes: Packless, gasketed, type with grooved end telescoping body, suitable for axial end movement to 3". 350 psi (2410 kPa).
 - .2 3/4"(DN20) and Larger Sizes: Expansion joint consisting of a series of grooved end nipples joined with flexible-type couplings. Joint movement and expansion capabilities determined by number of couplings / nipples used in the joint.
 - .2 Dielectric Waterways:
 - .1 1/2" (DN15) through 4" (DN100) sizes, IPS to copper-tubing size dielectric transition fitting. Fittings shall be a copper-silicon casting conforming to UNS C87850, and UL classified in accordance with ANSI / NSF-61 for potable water service. Fittings shall have threaded ends, grooved ends, or a combination.
 - .2 1" (DN25) through 8" (DN200) sizes, grooved, plain end, or threaded end, ASTM A-53 carbon steel or ASTM A-536 ductile iron body, zinc electroplated, with LTHS high temperature stabilized polyolefin polymer liner.
 - .3 Strainers – Grooved-End
 - .1 T-Type Strainer. 2" (DN50) through 12"(DN300) sizes, 300 PSI (2065 kPa) T-Type Strainer shall consist of ductile iron (ASTM A-536, Grade 65-45-12) body, Type 304 stainless steel frame and mesh removable basket with No. 12 mesh, 2"-3" (DN50-DN75) strainer sizes, or No. 6 mesh, 4"-12" (DN100-DN300) strainer sizes, 57% free open area.
 - .2 T-Type Strainer: 14" (DN350) through 24" (DN600) sizes, 300 PSI (2065 kPa), AGS grooved end "Tee" strainer. Factory fabricated carbon steel body conforming to ASTM A-53, Grade B, carbon steel T-bolt hinged closure/cap, and type 304 stainless steel frame and mesh basket, (6x6 mesh for 14" (DN350) and 16" (DN400) sizes, and 4x4 mesh for 18" (DN450) through 24" (DN600) sizes).
 - .3 Y-Type Strainer. 2"(DN50) through 18"(DN450) sizes, 300 PSI (2065 kPa) Y-Type Strainer shall consist of ductile iron body, ASTM A-536, Grade 65-45-12, Type 304 stainless steel perforated metal removable

baskets with 1/16" (1,6mm) diameter perforations 2"-3" (DN50-DN75) strainer sizes, 1/8" (3,2mm) diameter perforations 4"-12" (DN100-DN300) strainer sizes, and 0.156" (4mm) diameter perforations 14" -18" (DN350-DN450) strainer sizes.

- .4 Suction Diffuser - Flanged outlet with grooved inlet connections, rated to 300 psi (2065 kPa). Ductile iron (ASTM A-536) body, 304 stainless steel frame and perforated sheet diffuser with 5/32" (4,0mm) diameter holes. Removable 20 mesh 304 stainless steel start-up pre-filter, outlets for pressure/temperature drain connections, and base support boss.
- .6 Tooling:
 - .1 Tools shall be manufactured and supplied by Product Manufacturer. Use roll sets or cut groovers compatible with the pipe material and wall thickness per installation instructions.

PART 3 EXECUTION

3.1 PIPING INSTALLATION

- .1 Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing.
- .2 The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified.
- .3 Install the piping system in accordance with the latest suppliers' installation instructions.
- .4 AGS products shall not be installed with standard grooved end pipe or components. (Installing AGS products in combination with standard grooved end products could result in joint separation and/or leakage.)
- .5 Use grooving tools with AGS roll sets to groove the pipe. Follow manufactures' guidelines for tool selection and operation.
- .6 Couplings installation shall be complete when visual metal-to-metal contact is reached.
7. Install pipework in accordance with Section 23 05 15 – Common Installation Requirements for HVAC Pipework.

3.2 CIRCUIT BALANCING VALVES

- .1 Install flow measuring stations and flow balancing valves as indicated.
- .2 Remove handwheel after installation and when TAB is complete.
- .3 Tape joints in prefabricated insulation on valves installed in chilled water mains.

3.3 CLEANING, FLUSHING AND START-UP

- .1 In accordance with Section 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems.

3.4 TESTING

- .1 Test system in accordance with Section 23 05 00 – Common Work Results - Mechanical.
- .2 For glycol systems, retest with ethylene propylene glycol to ASTM E202, inhibited, for use in building system after cleaning. Repair leaking joints, fittings or valves.

3.5 BALANCING

- .1 Balance water systems to within plus or minus 5 % of design output.
- .2 Refer to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC for applicable procedures.

3.6 GLYCOL CHARGING

- .1 Provide mixing tank and positive displacement pump for glycol charging.
- .2 Retest for concentration to ASTM E202 after cleaning.

3.7 PERFORMANCE VERIFICATION

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

3.8 TRAINING

- .1 A factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and product installation.

3.9 APPLICATION

- .1 A manufacturers' representative shall periodically visit the job site and review installation. Contractor shall remove and replace any improperly installed products.
- .2 Grooved mechanical pipe couplings, fittings, valves and other grooved components may be used as an option to welding, threading or flanged methods.
- .3 All grooved components shall conform to local code approval and/or as listed by ANSI-B-31.1, B-31.3, B-31.9, ASME, UL/ULC, FM, IAPMO or BOCA.
- .4 Grooved end product manufacturer to be ISO-9001 certified.

END

PART 1 GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 The supply and installation of Hydronic Specialties Equipment.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .3 Section 02 61 33 - Hazardous Materials.
- .4 Section 01 35 29 - Health and Safety Requirements.
- .5 Section 01 78 00 - Closeout Submittals.
- .6 Section 23 08 01 - Performance Verification of Mechanical Piping Systems.

1.3 REFERENCES

- .1 American Society of Mechanical Engineers (ASME).
 - .1 ASME-04, Boiler and Pressure Vessel Code.
- .2 American Society for Testing and Materials, (ASTM).
 - .1 ASTM A47/A47M-99, Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A278M-01, Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (345 degrees C).
 - .3 ASTM A516/A516M-96(e1), Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.
 - .4 ASTM A536-84(1999)e1, Specification for Ductile Iron Castings.
 - .5 ASTM B62-93, Specification for Composition Bronze or Ounce Metal Castings.
- .3 Canadian Standards Association (CSA International).
 - .1 CSA B51-03, Boiler, Pressure Vessel, and Pressure Piping Code.

1.4 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 61 33 - Hazardous Materials.
 - .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Indicate on product data expansion tanks air vents separators valves strainers.
- .3 Closeout Submittals:
 - .1 Submit maintenance data in accordance with Section 01 78 00 - Closeout Submittals.

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY STORAGE AND DISPOSAL

- .1 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .2 Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

PART 2 PRODUCTS

2.1 DIAPHRAGM TYPE EXPANSION TANK

- .1 Vertical steel pressurized diaphragm type expansion tank.
- .2 Capacity: See schedule on plans.
- .3 Diaphragm sealed in elastomer EPDM suitable for 115 degrees C operating temperature.
- .4 Working pressure: 860 kPa with ASME stamp and certification 520 kPa.
- .5 Air precharged to 84 kPa (initial fill pressure of system).
- .6 Saddles for horizontal installation Base mount for vertical installation.
- .7 Supports: provide supports with hold down bolts and installation templates.

2.2 AUTOMATIC AIR VENT

- .1 Standard float vent: brass body and NPS connection and rated at 690 kPa working pressure.
- .2 Industrial float vent: cast iron body and NPS 1/2 connection and rated at 860 kPa working pressure. Use in boiler & chiller room.
- .3 Float: solid material suitable for 115 degrees C working temperature.

2.3 AIR SEPARATOR - EXPANSION TANK FITTING

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

2.4 AIR SEPARATOR - IN-LINE

- .1 Working pressure: 860 kPa.
- .2 Size: as indicated.

2.5 COMBINATION SEPARATORS/STRAINERS

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

2.6 COMBINATION LOW PRESSURE RELIEF AND REDUCING VALVE

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

2.7 PIPE LINE STRAINER

- .1 NPS 1/2 to 2: bronze body to ASTM B62, solder end screwed connections, Y pattern.
- .2 NPS 2 1/2 to 12: cast steel body to ASTM A278M, Class 30, cast iron body to ASTM, Class 30 flanged connections.
- .3 NPS 2 to 12: T type with ductile iron body to ASTM A536 malleable iron body to ASTM A47M, grooved ends.
- .4 Blowdown connection: NPS 1.
- .5 Screen: stainless steel brass with 1.19 mm perforations.
- .6 Working pressure: 860 kPa.

2.8 SUCTION DIFFUSER

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

2.10 GLYCOL FILL TANK AND PUMP

- .1 Pre-assembled packaged tank and pump system c/w low level pump cut-out and low level alarm/remote monitoring dry contacts.
- .2 Diaphragm pump with EPDM diaphragm, thermal cut out, integral pressure switch, internal check valve, cord and plug. Suitable for 115/1/60 power.
- .3 Tank shall be 151 litre storage tank with covers.
- .4 Pressure regulating valve adjustable from 5-55 psi, c/w pressure gauge, built-in check valve and integral replaceable strainer.
- .5 Built in supply shutoff valve with union connection and 12mm x 900mm long flexible connection hose.

PART 3 EXECUTION

3.1 GENERAL

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

3.2 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 except at radiation and as indicated.

3.3 AIR VENTS

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

3.4 EXPANSION TANKS

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

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

3.5 PRESSURE SAFETY RELIEF VALVES

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

3.6 SUCTION DIFFUSERS

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

3.7 PERFORMANCE VERIFICATION

- .1 In accordance with Section 23 08 01 - Performance Verification of Mechanical Piping Systems, supplemented as specified herein.

3.8 COMMISSIONING

- .1 Building Commissioning is a requirement of this project in order to comply with sections of Division 01 – General Requirements. A Commissioning Agent has been engaged and will provide all systems commissioning in conjunction with all trade contractors. The Commission Agent will provide a Commissioning Plan with commissioning start-up and test procedure sheets to be performed and completed by the various trade contractors.

END

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .3 Section 01 35 29 - Health and Safety Requirements.
- .4 Section 01 78 00 - Closeout Submittals.
- .5 Section 01 91 13 – General Commissioning Requirements.

1.3 REFERENCES

- .1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE).
 - .1 Standard 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 Electrical Equipment Manufacturers Advisory Council (EEMAC).
- .3 Canadian Standards Association (CSA International).
 - .1 CAN/CSA-B214-01, Installation Code for Hydronic Heating Systems.
- .4 National Electrical Manufacturers Association (NEMA).
 - .1 NEMA MG 1-2003, Motors and Generators.

1.4 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers.
- .4 Submit product data of pump curves for review showing point of operation.
- .5 Indicate piping, valves and fittings shipped loose by packaged equipment supplier, showing their final location in field assembly.
- .6 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 HEALTH AND SAFETY

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

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Separate for reuse and recycling and place in designated containers Steel Metal Plastic waste in accordance with Waste Management Plan.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

1.7 EXTRA MATERIALS

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

PART 2 PRODUCTS

2.1 EQUIPMENT

- .1 Do component selection and sizing to: CAN/CSA-B214.

2.2 IN-LINE CIRCULATORS

- .1 Volute: cast iron radially split, with screwed or flanged design suction and discharge connections.
- .2 Impeller: alloy steel cast bronze cast iron stainless steel.
- .3 Shaft: alloy steel stainless steel with bronze sleeve bearing, integral thrust collar.
- .4 Seal assembly: mechanical for service to 135 degrees C.
- .5 Coupling: flexible rigid self-aligning.
- .6 Motor: to NEMA MG 1 resilient mounted, drip proof, sleeve bearing, 1750 r/min.
- .7 Capacity: as indicated on drawings.
- .8 Design pressure: 860 kPa.

2.3 VERTICAL IN-LINE CIRCULATORS

- .1 Volute: cast iron radially split, with tapped openings for venting, draining and gauge connections, flanged suction and discharge connections.
- .2 Impeller: bronze.

- .3 Shaft: alloy steel with bronze sleeve bearing, integral thrust collar.
- .4 Seal assembly: mechanical for service to 135 degrees C serviceable without breaking pipe connections.
- .5 Coupling: flexible rigid self-aligning.
- .6 Motor: to NEMA MG 1 resilient mounted, drip proof, sleeve bearing, 1750 r/min.
- .7 Capacity: as indicated on drawings.
- .8 Design pressure: 1200 kPa.
- .9 Pumps fitted with flush line to mechanical seal with cyclone separator and floating ball sight flow indicator.
- .10 Where Variable Speed Drives are required as per schedules, provide pump mounted frame.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Do Work in accordance with CAN/CSA-B214.
- .2 In line circulators: install as indicated by flow arrows. Support at inlet and outlet flanges or unions. Install with bearing lubrication points accessible.
- .3 Base mounted type: supply templates for anchor bolt placement. Furnish anchor bolts with sleeves. Place level, shim unit and grout. Align coupling in accordance with manufacturer's recommended tolerance. Check oil level and lubricate. After run-in, tighten glands.
- .4 Ensure that pump body does not support piping or equipment. Provide stanchions or hangers for this purpose. Refer to manufacturer's installation instructions for details.
- .5 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.

3.2 START-UP

- .1 General
 - .1 In accordance with Section 01 91 13 – General Commissioning Requirements; supplemented as specified herein.
 - .2 In accordance with manufacturer's recommendations.

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

3.3 PERFORMANCE VERIFICATION (PV)

- .1 General:
 - .1 In accordance with Section 01 91 13 – General Commissioning Requirements supplemented as specified herein.
- .2 Exclusions:
 - .1 This paragraph does not apply to small in-line circulators.
- .3 Assumptions: these PV procedures assume that:
 - .1 Manufacturer's performance curves are accurate.
 - .2 Valves on pump suction and discharge provide tight shut-off.
- .4 Net Positive Suction Head (NPSH):
 - .1 Application: measure NPSH for pumps which operate on open systems and with water at elevated temperatures.
 - .2 Measure using procedures prescribed in the Standard.
 - .3 Where procedures do not exist, discontinue PV, report to 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 Requirements supplemented as specified herein. Reports to include:
 - .1 Record of point(s) 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 Report forms as specified Section 01 91 13 – General Commissioning Requirements: Report Forms and Schematics.
 - .3 Pump performance curves (family of curves).

END

PART 1 GENERAL

1.1 SUMMARY

- .1 Includes But Not Limited to: Furnishing and installing piping for refrigeration systems.

1.2 REFERENCES

- .1 ANSI/ASHRAE-17-1982, Capacity Rating of Thermostatic Refrigerant Expansion Valves, Method of Testing.
- .2 ANSI/ARI-710-80, Driers, Liquid Line.
- .3 ANSI/ASME-B16.29-1986, Wrought Copper and Wrought Copper Alloy Solder Joint Damage Fittings – DWV.
- .4 ASTM-B88M-88, Specification for Seamless Copper Water Tube.
- .5 ASTM-B280-88, Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- .6 ANSI/AWS-A5.8-81, Specification for Brazing Filler Material.
- .7 CAN/CGSB-19.13-87, Sealing Compound, One Component, Elastomeric, Chemical Curing.
- .8 CSA B52-M1983, Mechanical Refrigeration Code.

1.3 QUALITY ASSURANCE

- .1 Installer Qualifications
 - .1 Refrigerant piping shall be installed by licensed refrigeration contractor.

1.4 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 00 – Common Work Results - Mechanical.
- .3 Section 23 07 18 – Thermal Insulation for Equipment.

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material, in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal facility as approved by Departmental Representative.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

1.6 COORDINATION

- .6 Refer to Division 01, 21, 22, 25 and 26 for other requirements as included and outlined in other sections of the specifications.

1.7 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 – Submittals Procedures.
- .2 Provide diagrams of field installation wiring and piping for field assembly with refrigerant flows, pipe sizes, pressure drops in equipment and suction lines.

PART 2 PRODUCTS

2.1 MATERIAL

- .1 Refrigerant Piping:
 - .1 Type L, hard drawn, degreased, scaled-at-the-mill copper tubing, cleaned and sealed at the mill. Do not use pre-charged refrigerant lines.
- .2 Refrigerant Fittings:
 - .1 Wrought copper with long radius elbows. Mueller Streamline.
- .3 Suction Line Traps:
 - .1 Manufactured standard one-piece traps.
- .4 Solder:
 - .1 For Brazing – Sil-Fos or Easy Flow.
 - .2 For Connections – 95/5 or Sta-Bright.
- .5 Flux:
 - .1 Hardy and Harmon

2.2 EXPANSION VALVES

- .1 For pressure type distributors, externally equalized with stainless steel diaphragm, and same refrigerant in thermostatic elements as in system.

- .2 Size valves to provide full rated capacity of cooling coil served.

2.3 FILTER-DRIER

- .1 One lines 20mm (3/4") OD and larger, filter-drier shall be replaceable core type with non-ferrous casing and Schraeder type valve.
- .2 On lines smaller than 20mm (3/4") OD, filter-drier shall be a sealed type using sweat copper fittings.
- .3 Size shall be full line size.

2.4 SIGHT GLASS

- .1 Combination moisture and liquid indicator with protection cap.
- .2 Sight glass shall be full line size.

2.5 MANUAL REFRIGERANT SHUT-OFF VALVE

- .1 Ball valves designed for refrigeration service and full line size.
- .2 Valve shall have cap seals.
- .3 Valves with hand wheels are not acceptable.
- .4 Provide service valve on each liquid and suction line at compressor.
- .5 If service valves come as integral part of condensing unit, additional service valves shall not be required.

2.6 FLEXIBLE CONNECTIONS

- .1 Provide in each liquid line and suction line at both condensing unit and evaporator.
- .2 Anchor pipe near each flexible connector.
- .3 Connectors shall be for refrigerant service with bronze seamless corrugated hose and bronze braiding.

PART 3 EXECUTION

3.1 PERFORMANCE

- .1 For general piping installation, see Section 23 05 00 – Common Work Results – Mechanical.

- .2 Slope suction lines down toward compressor 1:120 (1" per 10'-0"). Locate traps at vertical rises against flow in suction lines.
- .3 Refrigeration system connections shall be seat copper type properly cleaned and brazed. Use flux only where necessary.
- .4 Solder valve, sight glass, and flexible connections.
- .5 Circulate dry nitrogen through tube being soldered to eliminate formation of copper oxide during brazing operation.
- .6 Make evacuation and leak tests in presence of Departmental Representative after completing refrigeration piping systems. A positive pressure test will not suffice for the procedure outlined below.
 - .1 Draw a vacuum on each entire system with vacuum pump to 200 microns using a vacuum gauge calibrated in microns. Do not use cooling compressor to evacuate system nor operate it while system is under high vacuum. Isolate compressor from system piping using shut-off valves prior to pulling vacuum.
 - .2 Break vacuum with nitrogen to be used and re-establish vacuum test. Vacuum shall hold for 24 hours at 200 microns without compressor running.
 - .3 Conduct tests at 21°C (70°F) ambient temperature or above.
 - .4 Do not run systems until above tests have been made and systems started up as specified. Inform Departmental Representative of status of systems at time of final inspection and schedule start-up and testing if prevented by outdoor conditions before this time.
 - .5 After testing, fully charge system with refrigerant and conduct a test with a Halide Leak Detector and submit results to Department Representative.

3.2 REFRIGERANT CHARGE

- .1 This contractor shall be responsible for providing refrigerant to fully charge the system.
- .2 The final refrigerant charge for each system shall be recorded in the O&M Manuals.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 00 – Common Work Results – Mechanical.

1.2 REFERENCES

- .1 Do HVAC water treatment in accordance with ASME Boiler Code Section VII, and requirements and standards of regulating authorities, except where specified otherwise.

1.3 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in the Province of Nova Scotia, Canada.
- .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.
- .4 Closeout Submittals:
 - .1 Submit operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
 - .2 Include following:
 - .1 Log sheets as recommended by manufacturer Departmental Representative.

1.4 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
- .2 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 47 19 - Construction/Demolition Waste Management and Disposal.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
 - .4 Divert unused metal materials from landfill to metal facility as approved by Department Representative.
 - .5 Fold up metal and plastic banding, flatten and place in designated area for recycling.

1.6 COORDINATION

- .1 Refer to Division 01, 21, 22, 25 and 26 for other requirements as included and outlined in other sections of the specifications.

1.7 MAINTENANCE DATA

- .1 Provide maintenance data for water equipment for incorporation into manual specified in Section 01 77 00 – Closeout Procedures.

PART 2 PRODUCTS

2.1 MANUFACTURER

- .1 Equipment, chemicals, service provided by one supplier.

2.2 POT FEEDER

- .1 Welded steel, pressure rating 860 kPa. Temperature rating: 90 degrees C.

2.3 CHEMICAL FEED PIPING

- .1 Schedule 80, Resistant to chemicals employed. Pressure rating: 860 kPa.

2.4 CHEMICAL FEED PUMPS

- .1 Top-mounted electronic metering diaphragm type: flow range 0-100%, adjustable, plus or minus 1.0% accuracy (repetitive), on-off operation, with pressure relief valve, check valve, foot valve, injection fitting.

- .2 Piston type: flow range 0-100%, adjustable, plus or minus 1.0% accuracy (repetitive), on-off operation, with stainless steel piston, pressure relief valve, double ball and check valves.

2.5 SHIPPING/FEEDING CHEMICAL CONTAINERS

- .1 High density moulded polyethylene, with liquid level graduations, cover.

2.6 WATER TREATMENT FOR HYDRONIC SYSTEMS

- .1 Hot water heating system: pot feeder, 25L, operating pressure 860 kPa.
- .2 Chilled water system: pot feeder, 25L, operating pressure 860 kPa.
- .3 Glycol system: pot feeder, 25 L, operating pressure 860 kPa.
- .4 Micron filter for each pot feeder:
 - .1 Capacity 2% of pump recirculating rate at operating pressure.
 - .2 Six (6) sets of filter cartridges for each type, size of micron filter.

2.7 CHEMICALS

- .1 Provide 1 year supply.

2.8 TEST EQUIPMENT

- .1 Provide one set of test equipment for each system to verify performance.
- .2 Complete with carrying case, reagents for chemicals, specialized or supplementary equipment.
- .3 Poly Pure Test Kit.
- .4 Alkalinity and Chloride Titration Test Kit.
- .5 Molybdate Test Kit.
- .6 PH Test Kit.
- .7 Model 3B Cabinet Wall Mounted.
Acceptable Product: T3065.

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 HVAC water treatment systems in accordance with ASME Boiler Code Section VII, and requirements and standards of authorities having jurisdiction, except where specified otherwise.
- .2 Ensure adequate clearances to permit performance of servicing and maintenance of equipment.

3.3 CHEMICAL FEED PIPING

- .1 Install crosses at changes in direction. Install plugs in unused connections.

3.4 CLEANING OF MECHANICAL SYSTEM

- .1 Provide copy of recommended cleaning procedures and chemicals for approval by Departmental Representative.
- .2 Flush mechanical systems and equipment with approved cleaning chemicals designed to remove deposition from construction such as pipe dope, oils, loose mill scale and other extraneous materials. Use chemicals to inhibit corrosion of various system materials that are safe to handle and use.
- .3 Examine and clean filters and screens, periodically during circulation of cleaning solution, and monitor changes in pressure drop across equipment.
- .4 Drain and flush systems until alkalinity of rinse water is equal to make-up water. Refill with clean water treated to prevent scale and corrosion during system operation.
- .5 Disposal of cleaning solutions approved by authority having jurisdiction.

3.5 WATER TREATMENT SERVICES

- .1 Provide water treatment monitoring and consulting services for period of one year after system start-up. Service to include:
 - .1 Initial water analysis and treatment recommendations.
 - .2 System start-up assistance.
 - .3 Operating staff training.
 - .4 Visit plant every day during period of operation and as required until system stabilizes, and advise on treatment system performance.
 - .5 Provide necessary recording charts and log sheets for one year operation.
 - .6 Provide necessary laboratory and technical assistance.
 - .7 Provide clear, concise, written instructions and advice to operating staff.

3.6 FIELD QUALITY CONTROL

- .1 Start-up:
 - .1 Start up water treatment systems in accordance with manufacturer's instructions.

.2 Commissioning:

- .1 Building Commissioning is a requirement of this project in order to comply with sections of Division 01 – General Requirements. A Commissioning Agent has been engaged and will provide all systems commissioning in conjunction with all trade contractors. The Commission Agent will provide a Commissioning Plan with commissioning start-up and test procedure sheets to be performed and completed by the various trade contractors.
- .2 Commissioning Agency: to be water treatment supplier.
- .3 Timing:
 - .1 After start-up deficiencies rectified.
 - .2 After start-up and before TAB of connected systems.
- .4 Pre-commissioning Inspections: verify:
 - .1 Presence of test equipment, reagents, chemicals, details of specific tests performed, and operating instructions.
 - .2 Suitability of log book.
 - .3 Currency and accuracy of raw initial water analysis.
 - .4 Required quality of treated water.
- .5 Commissioning procedures - applicable to Water Treatment Systems:
 - .1 Establish, adjust as necessary and record automatic controls and chemical feed rates.
 - .2 Monitor performance continuously during commissioning of connected systems and until acceptance of project.
 - .3 Establish test intervals, regeneration intervals.
 - .4 Record on approved report forms commissioning procedures, test procedures, dates, times, quantities of chemicals added, raw water analysis, treated water analysis, test results, instrument readings, adjustments made, results obtained.
 - .5 Establish, monitor and adjust automatic controls and chemical feed rates as necessary.
 - .6 Visit project at specified intervals after commissioning is satisfactorily completed to verify that performance remains as set during commissioning (more often as required until system stabilizes at required level of performance).
 - .7 Advise Departmental Representative in writing on matters regarding installed water treatment systems.
- .6 Commissioning procedures - Closed Circuit Hydronic Systems:
 - .1 Analyze water in system.
 - .2 Based upon an assumed rate of loss approved by Departmental Representative, establish rate of chemical feed.
 - .3 Record types, quantities of chemicals applied.
- .7 Training:
 - .1 Commission systems, perform tests in presence of, and using assistance of, assigned O&M personnel.

- .8 Certificates:
 - .1 Upon completion, furnish certificates confirming satisfactory installation and performance.
- .9 Commissioning Reports:
 - .1 To include system schematics, test results, test certificates, raw and treated water analyses, design criteria, other data required by Departmental Representative.
- .10 Commissioning activities during Warranty Period:
 - .1 Check out water treatment systems on regular basis and submit written report to Departmental Representative.

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.
- .3 Provide a copy of recommended cleaning procedures and chemicals for approval by the Architect.
- .4 Thoroughly flush heating system lines and chilled water and condenser water lines with approved cleaning chemicals designed to remove deposition from construction such as pipe dope, oils, loose mill scale and other extraneous materials. Chemicals to inhibit corrosion of various system materials and be safe to handle and use.
- .5 During circulation of cleaning solution, periodically examine and clean filters and screens and monitor changes in pressure drop across equipment.
- .6 Drain and flush systems until total alkalinity of rinse water is equal to that of make-up water. Refill with clean water treated to prevent scale and corrosion during system operation.

3.8 WATER TREATMENT OF SYSTEMS

- .1 Hot Water Heating System:
 - .1 Pre-cleaning: Circulate with CSW600 cleaner at room temperature for a period of 24 to 48 hours. Periodically flush system low points, boiler main blowdown, heat exchangers to remove accumulated mill scale and debris. At the end of the cleaning period, drain the entire system. Refill and circulate. Repeat flushing procedure until city water quality has been achieved and iron level is below 2.0 ppm. Prior to last refill, open strainers and remove baskets.
Acceptable Product:
Molyfilm 315 Speciality Chemicals.
 - .2 Normal Treatment: Following cleaning procedure add Molyfilm 315 to 100/120 ppm Molybdate. Maintain 8.5/10 pH.
 - .3 To avoid bacterial contamination of the glycol add a biocide after the final fill.
- .2 Glycol Heating System:
 - .1 Pre-Cleaning: Circulate with CSW600 cleaner at room temperature for a period of 24 to 48 hours. Periodically flush system low points, pumps and coils to remove

accumulated mill scale and debris. At the end of the cleaning period, drain the entire system. Refill and circulate. Repeat flushing procedure until city water quality has been achieved and iron level is below 2.0 ppm. Prior to last refill, open strainers and remove baskets. Refill the system with specified percentage of glycol and water.

- .2 Normal Treatment: Following cleaning procedure add Molyfilm 315 to 100/120 ppm Molybdate. Maintain 8.5/10 pH.
- .3 To avoid bacterial contamination of the glycol add a biocide after the final fill.

3.9 SUBMISSION OF REPORTS

- .1 Provide a written report after completion of each task relating to cleaning, flushing and water treatment. Report to include the task carried out, the results and any corrective measures undertaken.

END

PART 1 GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation of low-pressure metallic ductwork, joints and accessories.
- .2 Related Sections:
 - .1 Section 01 33 00 - Submittal Procedures.
 - .2 Section 01 35 29 - Health and Safety Requirements.
 - .3 Section 01 74 121- Construction/Demolition Waste Management and Disposal.
 - .4 Section 02 62 00.01 - Hazardous Materials.
 - .5 Section 07 84 00 - Firestopping.
 - .6 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
 - .7 Section 23 05 93 – Testing, Adjusting and Balancing for HVAC.
 - .8 Section 23 44 00 – HVAC Air Filtration.

1.2 REFERENCES

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A480/A480M-03c, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
 - .2 ASTM A635/A635M-02, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.
 - .3 ASTM A653/A653M-03, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3 Department of Justice Canada (Jus).
 - .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .5 National Fire Protection Association (NFPA).
 - .1 NFPA 90A-02, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B-02, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
 - .3 NFPA 96-01, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .6 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

- .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2nd Edition 1995 and Addendum No. 1, 1997.
- .2 SMACNA HVAC Air Duct Leakage Test Manual, 1985, 1st Edition.
- .3 IAQ Guideline for Occupied Buildings Under Construction 1995, 1st Edition.
- .7 Transport Canada (TC).
 - .1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

1.3 SUBMITTALS

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Construction and Section 02 62 00.01 - Hazardous Materials for the following:
 - .1 Sealants.
 - .2 Tape.
 - .3 Proprietary Joints.
- .3 Co-ordinate submittal requirements and provide submittals in accordance with Division 01 as applicable.
- .4 Submit Indoor Air Quality (IAQ) Management Plan in accordance with Division 01 as applicable.

1.4 QUALITY ASSURANCE

- .1 Certification of Ratings:
 - .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.
- .3 Indoor Air Quality (IAQ) Management Plan.
 - .1 Develop and implement an Indoor Air Quality (IAQ) Management Plan in accordance with Division 01 as applicable. Construction for construction and preoccupancy phases of building.
 - .2 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings under Construction.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Protect on site stored or installed absorptive material from moisture damage.
- .2 Waste Management and Disposal:

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 47 21 - Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Separate for reuse and recycling and place in designated containers Steel Metal Plastic waste in accordance with Waste Management Plan.
- .5 Place materials defined as hazardous or toxic in designated containers.
- .6 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.
- .7 Fold up metal and plastic banding, flatten and place in designated area for recycling.

PART 2 PRODUCTS

2.1 SEAL CLASSIFICATION

- .1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
750	C
250	C
125	C
125	Unsealed

- .2 Seal classification:
 - .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.
 - .2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant.
 - .3 Class C: transverse joints and connections made air tight with gaskets sealant. Longitudinal seams unsealed.
 - .4 Unsealed seams and joints.

2.2 SEALANT

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

2.3 TAPE

- .1 Tape: polyvinyl treated, open weave fiberglass tape, 5 mm wide.

2.4 DUCT LEAKAGE

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

2.5 FITTINGS

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows.
 - .1 Rectangular: standard radius short radius with single thickness turning vanes
Centreline radius: 1.5 times width of duct.
 - .2 Round: smooth radius five piece. Centreline radius: 1.5 times diameter.
- .3 Mitred elbows, rectangular:
 - .1 To 400 mm: with single thickness turning vanes.
 - .2 Over 400 mm: with double thickness turning vanes.
- .4 Branches:
 - .1 Rectangular main and branch: with radius on branch 1.5 times width of duct 45 degrees entry on branch.
 - .2 Round main and branch: enter main duct at 45 degrees with conical connection.
 - .3 Provide volume control damper in branch duct near connection to main duct.
 - .4 Main duct branches: with splitter damper.
- .5 Transitions:
 - .1 Diverging: 20 degrees maximum included angle.
 - .2 Converging: 30 degrees maximum included angle.
- .6 Offsets:
 - .1 Full radiused elbows as indicated.
- .7 Obstruction deflectors: maintain full cross-sectional area.
 - .1 Maximum included angles: as for transitions.

2.6 LOW PRESSURE DUCTWORK

- .1 All supply ductwork in mechanical rooms and for VAV systems is to be constructed for 747 Pa (3.0"w.g.) operating pressure. Supply ductwork for constant volume systems is to be constructed for 498 Pa (2.0" w.g.) operating pressure. All return and exhaust ductwork to be constructed for 498 Pa (2.0" w.g.) operating pressure. Ductwork designed for 498 Pa (2.0" w.g.) operating pressure shall be constructed as per Table 1-5, SMACNA HVAC Duct Construction Standards.
- .2 Duct sizes 483mm (19") wide and larger with more than 0.929m² (10 sq. ft.) or embraced panel shall be beaded or cross broken. This shall also apply to 1.005mm (20 gauge) or less thickness and 747 Pa (3.0" w.g.) or less.
- .3 Concealed round branch ducts up to 406mm (16") diameter may be constructed with longitudinal seams. Concealed round branch ducts over 406mm (16") and all exposed round ducts shall be factory fabricated conduit consisting of helically wound galvanized steel strips with spiral lock seams. Fittings for these conduits shall be fabricated of 1.005mm (20 gauge) galvanized sheet steel with butt welded seams of standard dimensions. Long radius elbows shall be used where space permits. Where 90° take-offs are necessary, conical T's shall be used.

2.7 FIRE STOPPING

- .1 Retaining angles around duct, on both sides of fire separation in accordance with Section 07 84 00 - Firestopping.
- .2 Fire stopping material and installation must not distort duct.

2.8 GALVANIZED STEEL

- .1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA proprietary manufactured duct joint. Proprietary manufactured flanged duct joint to be considered to be a class A seal.

2.9 STAINLESS STEEL

- .1 To ASTM A480/A480M, Type 304 for fume hood exhaust.
- .2 Finish: No. 4.
- .3 Thickness, fabrication and reinforcement: to SMACNA as indicated.
- .4 Joints: to ASHRAE and SMACNA be continuous inert gas welded.

2.10 ALUMINUM

- .1 To ASHRAE and SMACNA. Aluminum type: 3003-H-14 for dishwasher exhaust.
- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA be continuous weld.

2.11 BLACK STEEL

- .1 To ASTM A635/A635M for kitchen hood exhaust.
- .2 Thickness: 1.2 mm or as indicated.
- .3 Fabrication: ducts and fittings to SMACNA.
- .4 Reinforcement: as indicated.
- .5 Joints: continuous weld.

2.12 HANGERS AND SUPPORTS

- .1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
 - .1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.

- .1 Maximum size duct supported by strap hanger: 500.
- .2 Hanger configuration: to ASHRAE and SMACNA.
- .3 Hangers: galvanized steel angle with galvanized steel rods to ASHRAE and SMACNA following table:

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

- .4 Upper hanger attachments:
 - .1 For concrete: manufactured concrete inserts.
 - .2 For steel joist: manufactured joist clamp.
 - .3 For steel beams: manufactured beam clamps.

PART 3 EXECUTION

3.1 GENERAL

- .1 Do work in accordance with NFPA 90A, NFPA 90B, ASHRAE, & SMACNA.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods.
 - .1 Insulate strap hangers 100 mm beyond insulated duct Ensure diffuser is fully seated.
- .3 Support risers in accordance with SMACNA as indicated.
- .4 Install breakaway joints in ductwork on sides of fire separation.
- .5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining where required.
- .7 Ground across flex connector with No. 2 braided copper 8 trap.
- .8 Seal and protect duct work during construction. Cover open ends.

3.2 HANGERS

- .1 Strap hangers: install in accordance with SMACNA.
- .2 Angle hangers: complete with locking nuts and washers.
- .3 Hanger spacing: in accordance with SMACNA as follows:

Duct Size (mm)	Spacing (mm)
To 1500	3000
1501 and over	2500

3.3 WATERTIGHT DUCT

- .1 Provide watertight duct for:
 - .1 Fresh air intake.
 - .2 Minimum 3000 mm from duct mounted humidifier in all directions.
 - .3 As indicated.
- .2 Form bottom of horizontal duct without longitudinal seams.
 - .1 Solder joints of bottom and side sheets.
 - .2 Seal other joints with duct sealer.
- .3 Slope horizontal branch ductwork down towards fume hoods served.
 - .1 Slope header ducts down toward risers.
- .4 Fit base of riser with 150 mm deep drain sump and 32 mm drain connected, with deep seal trap and valve and discharging to open funnel drain.

3.4 SEALING AND TAPING

- .1 Apply sealant to outside of joint to manufacturer's recommendations.
- .2 Bed tape in sealant and recoat with minimum of one coat of sealant to manufacturer's recommendations.

3.5 LEAKAGE TESTS

- .1 Refer to Section 23 05 93 – Testing, Adjusting and Balancing for HVAC.
- .2 In accordance with SMACNA HVAC Duct Leakage Test Manual.
- .3 Do leakage tests in sections.
- .4 Make trial leakage tests as instructed to demonstrate workmanship.
- .5 Do not install additional ductwork until trial test has been passed.
- .6 Test section minimum of 30 m long with not less than three branch takeoffs and two 90 degrees elbows.
- .7 Complete test before performance insulation or concealment Work.

3.6 FIELD QUALITY CONTROL

- .1 Verification requirements in accordance with Section 01 45 00 – Testing and Quality Control.
 - .1 Materials and resources.
 - .2 Storage and collection of recyclables.
 - .3 Construction waste management.
 - .4 Resource reuse.
 - .5 Recycled content.
 - .6 Local/regional materials.
 - .7 Low-emitting materials.

3.7 FRESH AIR AND EXHAUST OPENINGS

- .1 Install to SMACNA details.
- .2 Reinforce and brace air outlets and intakes for wind speed as per NBC for location.
- .3 Provide air inlet openings with 1.6129mm (16 gauge) thick 25mm (1") wire mesh screen and air outlet openings with 12mm (½") mesh screwed aluminum bird screens.
- .4 Slope plenum floors to drain.

3.8 INSTRUMENT AND TEST HOLES

- .1 Install 25mm (1") test plugs with chain and cap, where required to accommodate testing and balancing instruments.

3.9 DUCT LEAKAGE

- .1 Ductwork shall be free of audible leaks in quiet ambient.

3.10 SEALING AND TAPING

- .1 Apply sealant to outside of joint to manufacturer's recommendations.
- .2 Bed tape in sealant and recoat with minimum of one (1) coat of sealant to manufacturer's recommendations

END

PART 1 GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and performance criteria for sound attenuation for mechanical systems.
 - .1 Sustainable requirements for construction and verification.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 35 29 - Health and Safety Requirements.
- .3 Section 01 74 121- Construction/Demolition Waste Management and Disposal.
- .4 Section 23 05 00 – Common Work Results – Mechanical.

1.3 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A653/A653M-05, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM C423-02a, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - .3 ASTM E90-04, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
 - .4 ASTM E477-99, Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .4 National Building Code (NBC)-1995.
- .5 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

1.4 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.

- .2 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Shop Drawings: submit drawings stamped and signed by professional engineer registered or licensed in Provinces of Nova Scotia.
 - .2 Provide separate shop drawings for each piece of attenuation equipment system shop drawings complete with product data.
 - .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 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

1.5 PERFORMANCE REQUIREMENTS

- .1 Rating Data:
 - .1 Provide performance rating data, certified by professional Departmental Representative or accredited test laboratory and supported by calculations and verified by test results in accordance with referenced standards as follows:
 - .1 Silencer: insertion loss, pressure drop at design conditions, generated noise level as indicated on drawings.
 - .2 Acoustic plenums: transmission loss and acoustical absorption.
 - .3 Acoustical performance measurements in accordance with ASTM E477, ASTM E90 and ASTM C423, except where specified otherwise.

1.6 QUALITY ASSURANCE

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

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal.

PART 2 PRODUCTS

2.1 ABSORPTION AND INSULATING MEDIA

- .1 Acoustic quality, glass fibre, bacteria and fungus resistant; free of corrosion causing or accelerating agents; packed to density to meet performance requirements; and meet NBC fire requirements or requirements of authority having jurisdiction for duct lining.

2.2 ACOUSTIC PLENUMS

- .1 Panels: Pre-fabricated 100mm thick tongue and groove connection type, designed for specified indicated individual panel removal for equipment access without major dismantling of plenum.
 - .1 Outer sheet: 1.3 mm thick galvanized steel to ASTM A653/A653M, with coating designation Z90.
 - .2 Inner sheet: 0.085 mm thick galvanized steel to ASTM A653/A653M, with coating designation Z90 with 2 mm diameter clean cut perforations on 5 mm staggered centres.
 - .3 Fully framed with 1.3 mm thick galvanized steel channels.
 - .4 Horizontal stiffeners: 0.85 mm minimum galvanized steel on 800 mm centres to control media settlement.
 - .5 Access panels: sized for equipment removal; two handles per panel; screw at 100mm maximum centres; perimeter neoprene sponge gasket; materials same as standard panel.
- .2 Doors: access doors with minimum 510 x 1375 mm opening.
 - .1 Construction same as standard panel except interiors solid.
 - .2 Two butt-type nylon bushed hinges, two cam-type latches with inside and outside handles.
 - .3 Neoprene gasket seal.
 - .4 Zinc plated hardware.
 - .5 Open against air pressure.
- .3 Windows: inspection windows, 305 x 305 mm, double glazed with 6 mm wire reinforced glass mounted in neoprene "U" channels.
- .4 Assembly: base sections and flashings 1.3 mm minimum galvanized steel.
 - .1 Panel and flashing joints externally sealed with 5 mm diameter bead of non sag, non hardening sealant. Floor channel to floor connection sealed with 3 x 13 mm monolastomeric tape.
 - .2 Factory cut and frame openings where greatest dimension exceeds 300 mm. Smaller panel openings, site located and cut 50 mm larger in diameter, sleeved with 0.75 mm minimum galvanized steel.
 - .3 Fill space between pipe or conduit and sleeve with acoustic media, covered and mastic sealed in accordance with manufacturer's instructions.
 - .4 No sensory leakage at design pressure differential of 2500 Pa.
 - .5 Assembly RSI not less than 1.2 m².degrees C/W at 10 degrees C.
 - .6 Certified acoustical performance:

- .1 Transmission loss to ASTM E90.
- .2 Acoustical absorption to ASTM C423.

Octave bands, (Hz)	125	250	500	1000	2000	4000
Transmission loss, dB	21	28	39	50	53	56
Absorption coefficient	0.7	0.9	.99	.99	0.9	0.9

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 Noise flanking: where indicated, install in wall sleeve with uniform clearance around to ensure no contact of silencer with wall sleeve. Pack with flexible, non hardening caulking on both sides of sleeves.
- .2 Instrument test ports: install at inlet and outlet to permit measurement of insertion loss and pressure loss.
- .3 Suspension: to manufacturer's instructions.

3.3 FIELD QUALITY CONTROL

- .1 Testing:
 - .1 Experienced and competent sound and vibration testing professional Departmental Representative to take sound measurement after start up and testing, adjusting and balancing of systems to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .2 Sound measurements to extend over frequency range of to and taken:
 - .1 Upstream and downstream of each silencer and plenum.
 - .2 In areas adjacent to mechanical equipment rooms, duct and pipe shafts.
 - .3 At 1800 mm above floor adjacent to first air terminal.
 - .4 At following critical locations as indicated on drawings.
 - .3 Provide Departmental Representative with notice 24 h in advance of commencement of tests.
 - .4 Establish adequacy of equipment isolation, acceptability of noise levels in occupied areas, other conditions affecting acoustics and, where appropriate, recommendation for remedial measures and costs.
 - .5 Submit complete report of test results including sound curves.
- .2 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 Departmental Representative within 3 days of manufacturer representative's review.
- .3 Verification requirements in accordance with Section 01 45 00 – Testing and Quality Control:
 - .1 Materials and resources.
 - .2 Storage and collection of recyclables.
 - .3 Construction waste management.
 - .4 Resource reuse.
 - .5 Recycled content.
 - .6 Local/regional materials.
 - .7 Certified wood.
 - .8 Low-emitting materials.

3.4 ADJUSTING

- .1 Make adjustments and corrections in accordance with written report.
- .2 Provide Departmental Representative with notice 24 h in advance of visit.

3.5 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 00 – Common Work Results - Mechanical.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material, in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal facility as approved by Departmental Representative.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

1.3 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Indicate the following:
 - .1 Flexible connections.
 - .2 Duct access doors.
 - .3 Turning vanes.
 - .4 Instrument test ports.

1.4 COORDINATION

- .1 Refer to Division 01, 21, 22, 25 and 26 for other requirements as included and outlined in other sections of the specifications.

1.5 CERTIFICATION OF RATINGS

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

PART 2 PRODUCTS

2.1 GENERAL

- .1 Manufacture in accordance with CSA B228.1.

2.2 FLEXIBLE CONNECTIONS

- .1 Frame: galvanized sheet metal frame with fabric clenched by means of double locked seams.
- .2 Material:
 - .1 Fire resistant, self-extinguishing, neoprene coated glass fabric, temperature rated at minus 40°C to plus 90°C.

2.3 ACCESS DOORS IN DUCTS

- .1 Non-insulated ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum .85mm (22 gauge) thick complete with sheet metal angle frame and sealing gaskets.
- .2 Insulated ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum .85mm (22 gauge) thick complete with sheet metal angle frame and 25mm (1") thick rigid glass fibre insulation and sealing gaskets.
- .3 Gaskets: neoprene.
- .4 Hardware:
 - .1 Up to 300mm x 300mm (12" x 12"): 2 sash locks complete safety chain.
 - .2 300mm x 457mm (12" x 18"): 4 sash locks complete with safety chain.
 - .3 457mm x 1016mm (18" x 40"): piano hinge and minimum 2 sash locks.
 - .4 Doors over 1016mm (40"): piano hinge and 2 handles operable from both sides.
 - .5 Hold open devices.

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 PORTS

- .1 1.6129mm (16 gauge) thick steel zinc plated after manufacturer.
- .2 Cam lock handles with neoprene expansion plug and handle chain.
- .3 28.575mm (1-1/8") minimum inside diameter. Length to suit insulation thickness.
- .4 Neoprene mounting gasket.

PART 3 EXECUTION

3.1 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: 150mm (6").
 - .3 Minimum distance between metal parts when system in operation: 75mm (3").
 - .4 Install in accordance with recommendations of SMACNA.
 - .5 When fan is running:
 - .1 Ducting on each side of flexible connection to be in alignment.
 - .2 Ensure slack material in flexible connection.
 - .6 Provide a grounding strap at each flexible connection.
- .2 Access Doors:
 - .1 Size:
 - .1 600mm x 600mm (24" x 24") for person size entry.
 - .2 600mm x 600mm (24" x 24") for servicing entry.
 - .3 300mm x 300mm (12" x 12") for viewing.
 - .4 As indicated.
 - .2 Location:
 - .1 At fire and smoke dampers.
 - .2 At control dampers.
 - .3 At devices requiring maintenance.
 - .4 At locations required by code.
 - .5 Elsewhere as indicated.
 - .6 At 9.14m (30 ft.) intervals.
 - .7 At elbows with turning vanes.
 - .8 Fresh air and exhaust air plenums.
 - .9 At bottom of risers.
 - .10 Before and after coils.
 - .11 At filters.
 - .12 At fans.
 - .13 At automatic dampers.
- .3 Instrument test ports.
 - .1 General:
 - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
 - .2 Locations:
 - .1 For traverse readings:
 - .1 At ducted inlets to roof and wall exhausters.
 - .2 At inlets and outlets of other fan systems.
 - .3 At 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 And as indicated.
- .4 Turning vanes:
- .1 Install in accordance with recommendations of SMACNA and as indicated.
 - .2 Provide where long radius turns or two 45° elbows cannot be used because of space considerations.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 00 – Common Work Results – Mechanical.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material, in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal facility as approved by Departmental Representative.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

1.3 REFERENCES

- .1 Do work in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible-2005, except where specified otherwise.

1.4 COORDINATION

- .1 Refer to Division 01, 21, 22, 25 and 26 for other requirements as included and outlined in other sections of the specifications.

1.5 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures.

PART 2 PRODUCTS

2.1 GENERAL

- .1 Manufacture to SMACNA standards.
- .2 All damper rods to extend through both sides of the ducts.

2.2 SPLITTER DAMPERS

- .1 Of 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 Of same material as duct, but one sheet metal thickness heavier. V-groove stiffened.
- .2 Size and configuration to recommendations of SMACNA, except maximum height 200mm (8").
- .3 Locking quadrant.
- .4 Inside and outside 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 to recommendations of SMACNA.
- .3 Maximum blade height: 100mm (4").
- .4 Bearings: pin in bronze bushings.
- .5 Linkage: shaft extension with locking quadrant.
- .6 Channel frame of same material as adjacent duct, complete with angle stop.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .3 For supply, return and exhaust systems, balancing dampers are to be located in each branch duct.
- .4 Each grille, register and diffuser connection to have balancing damper located as close as possible to main ducts.
- .5 Install splitter damper blade, pivot and control rod in rigid manner to prevent vibration. Use splitter damper only where no other means are available.
- .6 Provide single blade dampers in branch take-offs for volumes up to 472 l/s (1000 CFM) and opposed blade dampers for volumes over 472 l/s (1000 CFM).

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 00 – Common Work Results – Mechanical.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material, in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal facility as approved by Departmental Representative.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

1.3 GENERAL

- .1 This section applies to operating dampers.

1.4 COORDINATION

- .1 Refer to Division 01, 21, 22, 25 and 26 for other requirements as included and outlined in other sections of the specifications.

1.5 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00– Submittal Procedures.
- .2 Indicate the following:
 - .1 Performance data.

1.6 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into manual specified in Section 01 77 00 – Closeout Procedures.

1.7 CERTIFICATION OF RATINGS

- .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency.

PART 2 PRODUCTS

2.1 BACK DRAFT DAMPERS

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

2.2 RELIEF DAMPERS

- .1 Automatic multi-leaf aluminum dampers with ball bearing centre pivoted and counter-weights set to open at 10 Pa static pressure.

2.3 DAMPER

- .1 Sizes:
 - .1 Blades maximum 150mm wide x 1219mm long (6" wide and 48" long).
 - .2 Modular maximum 1219mm x 2438mm (48" wide x 96" high).
 - .3 Multiple sections with stiffening mullions and jack shafts.
- .2 Materials:
 - .1 Frame: 2.752mm (12 gauge) thick galvanized sheet steel.
 - .2 Blades: two sheets .853mm (22 gauge) thick or 1.6129mm (16 gauge) thick galvanized sheet steel, insulated.
 - .3 Bearings: oil impregnated sintered nylon. Provide additional thrust bearings for vertical blades.
 - .4 Linkage and shafts: zinc plated steel.
 - .5 Seals: replaceable neoprene seals or "ss" spring on side, top and bottom of frame and along all blade edges and blade ends.
- .3 Provide performance characteristics as follows:
 - .1 5 l/s (10 cfm) per sq. ft. max. allowable leakage against 1000 kPa (145 psi) static pressure.
 - .2 Temperature range -40°C to 93°C.

2.4 MULTI-LEAF DAMPERS

- .1 Sizes: or parallel blade type as indicated.
- .2 Extruded aluminum, interlocking blades, complete with extruded vinyl seals, spring stainless steel side seals, structurally formed and welded galvanized steel extruded aluminum frame.

- .3 Pressure fit self-lubricated bronze bearings.
- .4 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.
- .5 Operator: electronic type provided by Division 25. Dampers and jack shifting by Division 23. Damper actuators by Division 25. Coordinate torque requirements with Division 25 for proper performance.
- .6 Performance:
 - .1 Leakage: in closed position less than 2% of rated air flow at 1250 Pa differential across damper.
 - .2 Pressure drop: at full open position less than 25 Pa differential across damper at 15 m/s.
- .7 Insulated Aluminum Dampers:
 - .1 Frames: insulated with extruded polystyrene foam with RSI 0.88 for all fresh air and exhaust air connections.
 - .2 Blades: constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, RSI 0.88.

PART 3 EXECUTION

3.1 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 Upon system start-up, ensure that dampers operate properly.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 00 – Common Work Results – Mechanical.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material, in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal facility as approved by Departmental Representative.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

1.3 REFERENCES

- .1 ANSI/NFPA 90A-2009 - Installation of Air Conditioning and Ventilating Systems.
- .2 CAN4-S112-M82(R1987) - Fire Test of Fire Damper Assemblies, except specified otherwise.
- .3 CAN4-S112.2-M84 - Fire Test of Ceiling Firestop Flap Assemblies.
- .4 ULC-S505 - Fusible Links for Fire Protection Service.

1.4 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Indicate the following:
 - .1 Fire dampers.
 - .2 Fire stop flaps.
 - .3 Fusible Links.

1.5 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into manual specified in Section 01 77 00 – Closeout Procedures.

1.6 MAINTENANCE MATERIALS

- .1 Provide following:
 - .1 Six (6) fusible links of each type.

1.7 COORDINATION

- .1 Refer to Division 01, 21, 22, 25 and 26 for other requirements as included and outlined in other sections of the specifications.

1.8 CERTIFICATION OF RATINGS

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

PART 2 PRODUCTS

2.1 FIRE DAMPERS

- .1 Fire dampers: listed and bear label of ULC, meet requirements of NFPA 90A.
- .2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
- .3 Top hinged: galvanized steel interlocking blades, guillotine type; sized to maintain full duct cross section.
- .4 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for horizontal position with vertical air flow.
- .5 38mm x 12mm x 3mm (1-1/2" x 1/2" x 1/8") retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Install in accordance with NFPA 90A and in accordance with conditions of ULC listing.
- .2 Fire damper assemblies to be fire tested in accordance with CAN4-S112.
- .3 Maintain integrity of fire separation.
- .4 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.
- .5 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.
- .6 Coordinate with installer of firestopping.
- .7 Use Type C fire dampers on round ductwork.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 00 – Common Work Results - Mechanical.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction/ Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material, in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal facility as approved by Departmental Representative.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

1.3 REFERENCE STANDARDS

- .1 Do work in accordance with the following standards except where specified otherwise:
 - .1 CAN/ULC S110-M07 for Fire Tests for Air Ducts.
 - .2 UL 181- 2005 for Factory Made Air Ducts and Connectors.
 - .3 ANSI/NFPA 90A - 2009 for Installation of Air Conditioning and Ventilating Systems.
 - .4 ANSI/NFPA 90B - 2009 for Installation of Warm Air Heating and Air Conditioning systems.
 - .5 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.

1.4 PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Indicate the following:
 - .1 Thermal properties.
 - .2 Friction loss.
 - .3 Acoustical loss.
 - .4 Leakage.
 - .5 Fire rating.

1.5 COORDINATION

- .1 Refer to Division 01, 21, 22, 25 and 26 for other requirements as included and outlined in other sections of the specifications.

1.6 CERTIFICATION OF RATINGS

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

PART 2 PRODUCTS

2.1 GENERAL

- .1 Factory fabricated to CAN/ULC 110.
- .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.

2.2 FLEXIBLE DUCTWORK

- .1 Comply with requirements of ULC "Standards for Safety, Air Ducts", ULC S110-2007, and NFPA 90A-2009.
- .2 Spiral wound, flexible perforated aluminum duct. Unit must withstand 2488 Pa (10" w.g.) internal pressure.
- .3 Thermally insulated ductwork: Flexible glass fibre, nominal thickness of 25mm (1") factory applied, unless otherwise specified, with PVC exterior vapour barrier.

PART 3 EXECUTION

3.1 DUCT INSTALLATION

- .1 Locate between air control boxes and all grilles, registers and diffusers.
- .2 Support flexible ducts at 1.21m (48") centers. Minimum of two hangers per length.
- .3 Maximum length of flexible duct connections shall be 2.43m (96").
- .4 Connections between flexible duct and terminal devices to be made airtight with duct tape.

- .5 No change in direction with flex ductwork shall exceed 15°. For changes in direction of more than 15° use rigid ductwork. Provide rigid sheet metal elbows at air terminal devices.
- .6 Connections between flexible duct and terminal devices to be made air tight with duct tape.

END

PART 1 GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Fans, motors, accessories and hardware for commercial use.

1.2 RELATED SECTIONS

- .1 Division 01 – General Requirements.

1.3 REFERENCES

- .1 Air Conditioning and Mechanical Contractors (AMCA)
 - .1 AMCA Publication 99-2003, Standards Handbook.
 - .2 AMCA 300-1996, Reverberant Room Method for Sound Testing of Fans.
 - .3 AMCA 301-1990, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .2 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ANSI/AMCA 210-1999, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.4 SYSTEM DESCRIPTION

- .1 Performance Requirements:
 - .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards in force.
 - .2 Capacity: flow rate, total static pressure, bhp Watts, efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.
 - .3 Fans: statically and dynamically balanced, constructed in conformity with AMCA 99.
 - .4 Sound ratings: comply with AMCA 301, tested to AMCA 300. Supply unit with AMCA certified sound rating seal.
 - .5 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210. Supply unit with AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter.

1.5 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Shop Drawings:
 - .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Shop Drawings: submit drawings stamped and signed by professional engineer registered or licensed in Provinces of Nova Scotia.
 - .3 Provide:
 - .1 Fan performance curves showing point of operation, BHP kW and efficiency.
 - .2 Sound rating data at point of operation.
 - .4 Indicate:
 - .1 Motors, sheaves, bearings, shaft details.
 - .2 Minimum performance achievable with variable speed controllers and variable inlet vanes as appropriate.
 - .5 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.
 - .6 Closeout Submittals:
 - .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.6 QUALITY ASSURANCE

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

1.7 MAINTENANCE

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .1 Spare parts to include:

- .1 Matched sets of belts.
- .2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:
 - .1 Bearings and seals.
 - .2 Addresses of suppliers.
 - .3 List of specialized tools necessary for adjusting, repairing or replacing.

1.8 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2 PRODUCTS

2.1 FANS GENERAL

- .1 Motors:
 - .1 In accordance with Section 23 05 13 - Common Motors Requirements for HVAC Equipment supplemented as specified herein.
 - .2 For use with variable speed controllers.
 - .3 Sizes as indicated specified.
- .2 Accessories and hardware: matched sets of V-belt drives, adjustable slide rail motor bases, belt guards, coupling guards fan inlet and or outlet safety screens as indicated and as specified in Section 23 05 13 - Common Motor Requirements for HVAC Equipment. Inlet outlet dampers and vanes and as indicated.
- .3 Factory primed before assembly in colour standard to manufacturer.
- .4 Scroll casing drains: as indicated.
- .5 Finish on fume hood exhaust fans.
- .6 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .7 Vibration isolation: to Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- .8 Flexible connections: to Section 23 33 00 - Air Duct Accessories.

- .9 Sound ratings shall comply with AMCA (Air Moving and Conditioning Association) 301-77 tested to AMCA 300-67. Unit shall bear the AMCA certified sound rating seal.
- .10 Fans shall be statically and dynamically balanced, constructed in conformity with AMCA 2408-69.
- .11 Base ratings on tests performed in accordance with AMCA 210-74, and ASHRAE 51-75. Unit shall bear AMCA certified rating seal, except for propeller fans smaller than 300mm. diameter.
- .12 Bearings: equip with heavy duty grease lubricated ball or roller bearings of self aligning type with oil retaining, dust excluding seals and 200,000 h service in accordance with ANSI B3.15-1972 for ball bearings and ANSI B3.16-1972 for roller bearings and AFBMA (Anti-Friction Bearing Manufacturers Association) L-10 life standard. Bearings to be split pillow block type.
- .13 The approval of equipment shall be subject to meeting the performance and sound power levels. If the sound power levels as noted are exceeded, the fan manufacturer shall be responsible for the additional attenuation and the resulting changes in fan static and motor size. The fan manufacturer shall also be responsible for all electrical changes caused by the change in motor size.

2.2 CENTRIFUGAL FANS

- .1 Fan wheels:
 - .1 Welded steel aluminum construction.
 - .2 Maximum operating speed of centrifugal fans not more than 40-50 % of first critical speed.
 - .3 Air foil forward curved backward inclined blades, as indicated.
- .2 Bearings: heavy duty split pillow-block flange mounted grease lubricated ball or roller self aligning type with oil retaining, dust excluding seals and a certified minimum rated life of 200,000 hours.
- .3 Shaft seals on laboratory fume hood and biological safety cabinet exhaust fans:
 - .1 Single disc multi-disc labyrinth water-cooled stuffing box carbon ring with nitrogen air purging seals.
- .4 Housings:
 - .1 Volute with inlet cones: fabricated steel for wheels 300 mm or greater, cast iron, steel, aluminum, for smaller wheels, braced, and with welded supports.
 - .2 For horizontally and vertically split housings provide flanges on each section for bolting together, with gaskets of non-oxidizing non-flammable material.
 - .3 Provide bolted latched airtight access doors with handles.
- .5 Variable volume control devices: Variable Speed Drives by Division 25.

2.3 CABINET FANS - GENERAL PURPOSE

- .1 Fan characteristics and construction: as centrifugal fans.
- .2 Casing floor mounted Cabinet hung single or multiple wheel with DWDI centrifugal fans in factory fabricated casing complete with vibration isolators and seismic control measures, motor, variable speed V-belt drive and guard inside or outside casing.
- .3 Fabricate casing of zinc coated or phosphate treated steel of 14 gage thickness reinforced and braced for rigidity. Provide removable panels for access to interior. Paint uncoated, steel parts with corrosion resistant paint to CAN/CGSB 1.181. Finish inside and out, over prime coat, with rust resistant enamel. Internally line cabinet with 50 mm thick rigid acoustic insulation, pinned and cemented, 45 kg/m³ density, complete with perforated metal liner complete with metal nosings on exposed edges.
- .4 Provide man-sized access doors on both sides of the cabinet complete with full gaskets.

2.4 UTILITY SETS

- .1 Characteristics and construction: for centrifugal fans.
- .2 Preassemble single width centrifugal fan with removable weatherproof protective hood with vents, and automatic spring loaded back draft dampers and 12 mm mesh birdscreens.
- .3 Provide belt driven sets with adjustable motor bed plate and variable pitch driver sheave.

2.5 AXIAL FLOW FANS (TUBE-AXIAL OR VANE-AXIAL)

- .1 Casings: welded steel with welded motor support, hinged or bolted access plates, streamlined inlet cone and discharge bell sections and integral silencer casing external silencer.
- .2 Blade material: steel aluminum. Hub material: steel aluminum.
- .3 Supports:
 - .1 Floor mounted units: reinforced legs.
 - .2 Ceiling suspended units: support brackets welded to side of casing. Extend grease lubrication facilities to outside of casing.
- .4 Bearings: ball or roller with extension tubes to outside of casing.
- .5 Direct drive:
 - .1 Adjustable Fixed blade wheels: totally-enclosed, air over motors.
 - .2 Diameter of wheel hub: at least equal to that of motor frame.
 - .3 Adjustable blades for varying range of volume and pressure. Provide permanent pitch angle indication vernier scale on hub. Provide adjustment set at factory before shipment for automatic adjustment while in motion. Provide adjustment stops to avoid overloading motor.

- .6 Belt drive:
 - .1 Drive fixed adjustable blades by externally mounted motors through V-belt drive. Provide internal belt fairing, external belt guards and adjustable motor mounts.
 - .2 Adjust blades for varying range of volume and pressure. Hubs to facilitate indexing of blade angle. Provide manual automatic adjustment stops to avoid overloading motor.

2.6 IN-LINE CENTRIFUGAL FANS

- .1 Characteristics and construction: as for centrifugal fan wheels, with axial flow construction and direct belt drive.
- .2 Provide AMCA arrangements 1 or 9 as indicated with stiffened flanges, smooth rounded inlets, and stationary guide vanes.

2.7 PROPELLER FANS

- .1 Fabricate multibladed propellers of sheet steel or aluminum of airfoil shape within bell mouth entrance on integral mounts, with grease lubricated ball bearings, with extended lubrication fittings, suited for operating in any position, direct or belt driven, complete with motor as indicated.
- .2 Provide blade guards, bird screen and automatic back draft dampers on discharge, with gasketed edges.

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 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 lubrication tubes to be easily accessible.
- .4 Access doors and access panels to be easily accessible.
- .5 Install flexible connector bonds between fan outlet and discharge ductwork.

3.3 ANCHOR BOLTS AND TEMPLATES

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

3.4 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.5 COMMISSIONING

- .1 Building Commissioning is a requirement of this project in order to comply with sections of Division 01 – General Requirements. A Commissioning Agent has been engaged and will provide all systems commissioning in conjunction with all trade contractors. The Commission Agent will provide a Commissioning Plan with commissioning start-up and test procedure sheets to be performed and completed by the various trade contractors.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 00 – Common Work Results - Mechanical.
- .3 Section 23 84 13 – Humidifiers.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material, in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal facility as approved by Departmental Representative.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

1.3 REFERENCES

- .1 AMCA 99 – 2010 - Standards Handbook.
- .2 ANSI/AMCA 210 – 2007 - Laboratory Methods of Testing Fans for Rating.
- .3 AMCA 300 2008- Reverberant Room Method for Sound Testing of Fans.
- .4 AMCA 301- 2008 - Methods of Calculating Fan Sound Ratings from Laboratory Test Data.
- .5 ANSI/ASHRAE 51 – 2007 - Laboratory Methods of Testing Fans for Rating.

1.4 COORDINATION

- .1 Refer to Division 01, 21, 22, 25 and 26 for other requirements as included and outlined in other sections of the specifications.

1.5 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 – Submittal
- .2 Product data to include fan curves and sound rating data.

1.6 OPERATION AND MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into manual specified in Section 01 77 00 – Closeout Procedures.

1.7 MAINTENANCE MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 77 00 –Closeout Procedures.
- .2 Furnish list of individual manufacturer's recommended spare parts for equipment, such as bearing and seals, addresses of suppliers, list of specialized tools necessary for adjusting, repairing or replacing, for inclusion into operating manual.

1.8 CERTIFICATION OF RATINGS

- .1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards in force.
- .2 Provide confirmation of testing.

PART 2 PRODUCTS

2.1 FANS GENERAL

- .1 Capacity: as indicated.
- .2 Sound ratings: comply with AMCA 301, tested to AMCA 300.
- .3 Statically and dynamically balanced. Constructed in conformity with AMCA 99.
- .4 Ratings: based on tests performed in accordance with ANSI/AMCA 210, and ANSI/ASHRAE 51, unit to bear AMCA certified rating seal.
- .5 Bearings: heavy duty grease lubricated ball or roller bearings of self-aligning type with oil retaining, dust excluding seals and a certified minimum rated life of 100,000h in accordance with AFBMA L10 life standard. Bearings to be rated and selected in accordance with AFBMA 9 and AFBMA 11.

2.2 ROOF EXHAUST INSTALLATION

- .1 Fans to be of centrifugal, belt driven type fan to be of complete aluminum construction. Wheels shall be statically and dynamically balanced. The entire drive assembly shall be mounted on vibration isolators.
- .2 Motors and drives shall be isolated from air stream.

- .3 Motors shall be of heavy duty type with permanently lubricated sealed ball bearings.
- .4 The motor pulleys shall be adjustable for final balancing.
- .5 Fans to be complete with disconnect switch, back draft damper and 400mm (16") high curb unless noted otherwise.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.
- .2 Coordinate installation of roof curb with roofing contractor.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 00 – Common Work Results – Mechanical.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .2 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material, in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .3 Divert unused metal materials from landfill to metal facility as approved by Departmental Representative.
- .4 Fold up metal banding, flatten and place in designated area for recycling.

1.3 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 – Submittals Procedures.
- .2 Indicate the following:
 - .1 Capacity.
 - .2 Throw and terminal velocity.
 - .3 Noise criteria.

1.4 MAINTENANCE MATERIALS

- .1 Include:
 - .1 Keys for volume control adjustment.
 - .2 Keys for air flow pattern adjustment.

1.5 MANUFACTURED ITEMS

- .1 Grilles, registers and diffusers shall be product of one manufacturer for generic type.

1.6 COORDINATION

- .1 Refer to Division 01, 21, 22, 25 and 26 for other requirements as included and outlined in other sections of the specifications.

1.7 CERTIFICATION OF RATINGS

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

PART 2 PRODUCTS

2.2 GENERAL

- .1 Standard product to meet capacity, throw, noise level, throat and outlet velocity as indicated.
- .2 Provide volume control dampers on all supply diffusers and concealed operators.
- .3 Sizes indicated are nominal. Provide correct standard product nearest to nominal for capacity throw, noise level, throat and outlet velocity.
- .4 Furnish factory prime coated steel frames for setting into fire protecting membrane. At aluminum diffusers, registers and grilles, provide 1.2mm thick minimum steel collar up to fire damper or fire stop flap, for suspending from the basic structure independently of membrane pierced to maintain fire protection membrane integrity.
- .5 Where penetrating fire partitions, provide approved steel sleeve attached to structure and secured in accord with NFPA 90A-1978. Where penetrating fire walls provide 3.510mm (10 gauge) thick steel sleeve with angle iron perimeter frame to NFPA 90A-2009.
- .6 Frames:
 - .1 Steel: standard cold rolled steel with exposed joints welded and ground flush and completely closed.
 - .2 Aluminum: satin finish with mechanical fasteners and completely closed corners.
 - .3 Provide full perimeter sponge rubber gaskets.
 - .4 Provide plaster frames as plaster stops set into gypsum board at all locations.
 - .5 Provide concealed fasteners and operators.
- .7 Finish:
 - .1 Off white baked enamel unless otherwise indicated.

2.3 RETURN / EXHAUST AIR GRILLES / REGISTERS

- .1 Type "RG/EG" Return Exhaust Air Grilles
 - .1 Heavy Duty Extruded aluminium construction with 45 degree deflection, 13mm blade spacing, 32mm border.

2.4 SUPPLY GRILLES AND REGISTERS

- .1 General: with opposed blade dampers.
- .2 Type SG: steel aluminum, 25 mm border, double deflection with airfoil shape, horizontal face and vertical rear bars. Model: as indicated on drawings.

2.5 DIFFUSERS

- .1 General: volume control dampers with flow straightening devices and blank off quadrants and gaskets.
- .2 Type SR: steel, round type, having fixed pattern, duct mounted. Model: as indicated on drawings.
- .3 Type S: steel aluminum, square type, having fixed pattern, lay in. Model: as indicated on drawings.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.
- .2 Install with cadmium plated screws in countersunk holes where fastenings are visible.
- .3 Examine ceiling plans and ceiling type to ensure the appropriate trim is provided to match diffusers/grilles with ceilings.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 00 – Common Work Results - Mechanical.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material, in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal facility as approved by Departmental Representative.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

1.3 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 – Submittals Procedures.
- .2 Indicate the following:
 - .1 Louvre free area.
 - .2 Louvre water penetration.

1.4 COORDINATION

- .1 Refer to Division 01, 21, 22, 25 and 26 for other requirements as included and outlined in other sections of the specifications.

1.5 CERTIFICATION OF RATINGS

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

1.6 TEST REPORTS

- .1 Submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E90.

PART 2 PRODUCTS

2.1 STATIONARY LOUVRES

- .1 Construction: welded with exposed joints ground flush and smooth.
- .2 Material: extruded aluminum alloy 6063-T5.
- .3 Blade: storm proof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1500mm (60").
- .4 Frame, head, sill and jamb: 100mm (4") deep one piece extruded aluminum, minimum 2.953mm (12 gauge) thick with approved caulking slot, integral to unit.
- .5 Mullions: at 1500mm (60") maximum centres.
- .6 Fastenings: stainless steel (Society of Automotive Engineers) SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, stainless steel washer and aluminum body.
- .7 Screen:
 - .1 Exhaust: 13mm (½"), 1.6mm (1/16") dia. wire aluminum birdscreen on inside face of louvres face of louvres in formed U-frame.
 - .2 Intake: 19mm (¾"), 1.6mm (1/16") dia. wire aluminum birdscreen mounted in solar wall panel opening as per drawings.
- .8 Finish: factory applied enamel. Colour: to Owner's approval.

2.2 ROOF RELIEF VENTS

- .2 Factory manufactured aluminum steel SS hinged at curb line.
 - .1 Complete with integral birdscreen of 2.7 mm diameter copper aluminum ss wire.
 - .2 Vertical backdraft dampers on four faces.
 - .3 Maximum loss through unit: 15 Pa exhaust static pressure.
 - .4 Maximum velocity through damper area: 1.5 m/s.
 - .5 Shape: as indicated on drawings.
- .3 Birdscreens:
 - .1 Complete with integral birdscreen of 2.7 mm diameter ss wire. Use 13 mm mesh on exhaust, 19 mm mesh on intake.

2.3 GOOSENECK HOODS

- .1 Thickness: to ASHRAE and SMACNA.
 - .1 Kitchen: to ANSI/NFPA 96.
 - .2 Elsewhere: to ASHRAE SMACNA.
- .2 Fabrication: to ASHRAE and SMACNA.
- .3 Joints: to ASHRAE and SMACNA and or proprietary manufactured duct joint. Proprietary manufactured flanged duct joint considered class A seal.

- .4 Supports: as indicated.
- .5 Complete with integral birdscreen of 2.7 mm diameter copper aluminum ss wire. Use 13 mm mesh on exhaust 19 mm mesh on intake.
- .6 Horizontal backdraft dampers

PART 3 EXECUTION

3.1 INSTALLATION

- .1 In accordance with manufacturers and SMACNA recommendations.
- .2 Reinforce and brace air vents, intakes and goosenecks as indicated.
- .3 Anchor securely into openings. Seal with caulking all around to ensure weather tightness.
- .4 Slope all plenums to drain connection in plenum. Flush inside of plenums with 100% coverage of blueskin “peel and stick” waterproofing. Lap Blueskin of plenum to drain to outside the wall assembly waterproofing.
- .5 Inspect all louvers to duct connections to ensure there is no ridge or fold that will retain water.
- .6 Contractor to provide field fabricated thermally insulated blank-off panel on all un-used louver openings. Panel construction shall be pan-in-Pan with 1.6mm aluminium sheet metal and 100mm thick semi rigid, non-combustible mineral wool, thermal insulation board, R-4.2 per 25mm and sealed to make water proof. Silicone exterior side of panel to match louver colour. Seal and mechanically fasten blank off panel to the interior face of louver.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 01 33 00 – Submittal Procedures.
- .2 Section 01 74 00 – Cleaning.
- .3 Section 01 78 00 – Closeout Submittals.
- .4 Section 24 05 00 – Common Work Results – Mechanical.

1.2 REFERENCES

- .1 American National Standards Institute/National Fire Prevention Association (ANSI/NFPA)
 - .1 ANSI/NFPA 96- 1994, Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .2 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 52.1- 1992, Gravimetric And Dust Spot for Testing Air-cleaning Devices Used in General Ventilation for Removing Particulate Matter.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-115.10- M90, Disposable Air Filters for the Removal of Particulate Matter from Ventilating Systems.
 - .2 CAN/CGSB-115.11- M85, Filters, Air, High Efficiency, Disposable, Bag Type (Reaffirmed April 1985).
 - .3 CAN/CGSB-115.12- M85, Filters, Air, Medium Efficiency, Disposable, Bag Type (Reaffirmed April 1985).
 - .4 CAN/CGSB-115.13- 85, Filter Media, Automatic Roll (Reaffirmed April 1985).
 - .5 CAN/CGSB-115.14- M91, High Efficiency Cartridge Type Supported Air Filters for the Removal of Particulate Matter from Ventilating Systems.
 - .6 CAN/CGSB-115.15- M91, High Efficiency Rigid Type Air Filters for Removal of Particulate Matter from Ventilating Systems.
 - .7 CAN/CGSB-115.16- M82, Activated Carbon for Odour Removal from Ventilating Systems.
 - .8 CAN/CGSB-115.18- M85, Filter, Air, Extended Area Panel Type, Medium Efficiency.
 - .9 CAN/CGSB-115.20- 95, Polarized Media Air Filter.
- .4 Underwriters= Laboratories of Canada
 - .1 ULC -S111- M80, "Fire Tests for Air Filter Units".
 - .2 ULC-S649-1993, Grease Filters for Commercial and Institutional Kitchen Exhaust Systems.

1.3 SHOP DRAWINGS AND PRODUCT DATA

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

1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Submit for all filters, frames and housings including air flow and pressure drop at clean and “dirty” conditions.

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21- Construction/Demolition Waste Management and Disposal, and with the Waste Reduction Workplan.
- .2 Place materials defined as hazardous or toxic waste in designated containers.
- .3 Ensure emptied containers are sealed and stored safely for disposal away from children.

1.6 MAINTENANCE MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Furnish list of individual manufacturer's recommended spare parts for equipment such as frames and filters, addresses of suppliers, list of specialized tools necessary for adjusting, repairing or replacing for inclusion in operating manual.

1.7 EXTRA MATERIALS

- .1 Spare filters: in addition to filters to be installed immediately prior to acceptance by Departmental Representative, supply 1 complete set of filters for each filter unit or filter bank in accordance with section 01 78 00 - Closeout Submittals.

PART 2 PRODUCTS

2.1 GENERAL

- .1 Provide filter media, frames, seals, gaskets for NFPA and ULC codes; and controls per CSA where applicable.
- .2 Use incombustible materials in fabrication of filter assembly.
- .3 Provide air filter gauges, one for each bank of filters. Gauge range to be two times the final pressure drop of the filter.
- .4 Efficiency: ASHRAE Standard 52-76 Sect 3-16, Atmospheric dust spot efficiency, “Absolute Filter” efficiency shall be tested with 0.3 micrometre dioctyl phthalate (DOP) smoke.
- .5 Dust hold capacity: Air Filter Institute (AFI) Test.

- .6 Frames:
 - .1 Provide prefabricated filter frame and supporting structure of galvanized steel with gasketing between frames and walls. Holding Frames: 1.6mm ("T" section construction).
- .7 Filters shall be suitable for air at 100% RH:
 - .1 Acceptable Products: All the products must be the detailed specifications of each product included in this section.

2.2 PRE-FILTERS

- .1 Pre-filters to be MERV 08 – three ply construction, polyester media heat sealed over an internal steel support frame.

2.3 HIGH EFFICIENCY FILTER-RIGID TYPE

- .1 Filters shall be extended media surface type rigid filter with all metal construction. Filter media shall be of synthetic construction held in place with plastic pleat separates. Filter pack shall be sealed into 0.7mm steel frame with non-fiberglass sealant. Filters to be provided with gaskets for tight sealing in side access housing. Filters to be treated with anti-microbial coating.
- .2 Filters to be 300mm deep and MERV-14. Final pressure drop not to exceed 373Pa.

2.4 ACCESSORIES

- .1 Holding frames: permanent "T" section or channel section construction of galvanized steel or extruded aluminum same material as casing/hood, 1.6 mm thick, except where specified otherwise.
- .2 Seals: to ensure leakproof operation.
- .3 Blank-off plates: as required, to fit all openings and of same material as holding frames.
- .4 Access and servicing: through doors/panels on each side and/or from upstream downstream face of filter bank.

2.5 FILTER GAUGES - DIAL TYPE

- .1 Diaphragm actuated, direct reading.
- .2 Range: 0 to 2 times initial pressure 0 to 250 Pa.
- .3 Acceptable material: Magnehelic.

PART 3 EXECUTION

3.1 INSTALLATION GENERAL

- .1 Install in accordance with manufacturer's recommendations and with adequate space for access, maintenance and replacement.

3.2 FILTER REPLACEMENTS

- .1 Install a complete set of filters prior to the start of air balancing. Replace the filter, if required, during air balancing and testing.
- .2 Replace all the filters three (3) days before the acceptance of the building by Departmental Representative.
- .3 Furnish one complete set of filters as spare filters. If the filters used during the air balancing have not reached the final air resistance, do not replace these at the time of acceptance of building by Departmental Representative and hand over two (2) complete set of filters to Departmental Representative. Allow for three (3) complete sets of filters.

3.3 FILTER GAUGES

- .1 Install type as indicated across each filter bank (pre-filter and final filter) in approved and easy readable location.
- .2 Mark each filter gauge with value of pressure drop for clean condition and manufacturer's recommended replacement (dirty) value.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

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

1.2 REFERENCES

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

1.3 PRODUCT DATA

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

1.4 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Clearly indicate following:
 - .1 Methods of sealing sections.
 - .2 Methods of expansion.
 - .3 Details of thimbles.

1.5 CLOSEOUT SUBMITTALS

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

1.6 COORDINATION

- .1 Refer to Division 01, 21, 22, 25 and 26 for other requirements as included and outlined in other sections of the specifications.

1.7 CERTIFICATIONS

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

1.8 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Divert unused metal materials from landfill to metal recycling facility approved by Departmental Representative.
- .3 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .4 Dispose of corrugated cardboard, polystyrene, and plastic packaging material in appropriate on-site bin for recycling in accordance with site waste management program.

PART 2 PRODUCTS

2.1 BREECHINGS

- .1 Shop fabricated 3.5 mm thick, stainless steel, with sweep bends from boiler outlet to thimble or chimney as indicated.

2.2 ALL FUELS PRESSURE CHIMNEY AND BREECHING

- .1 ULC labelled, 760°C rated, all fuels.
- .2 Sectional, prefabricated, double wall with mineral wool insulation with mated fittings and couplings.
 - .1 Liner: type 304 stainless steel.
 - .2 Shell: type 304 stainless steel aluminized steel.
 - .3 Outer seals between sections: to suit application.
 - .4 Inner seals between sections: to suit application.
- .3 Sectional, prefabricated, single wall with mated fittings and couplings to run inside existing masonry chimney
 - .1 Type 304 stainless steel.
 - .2 Seals between sections: to suit application.

2.3 ACCESSORIES

- .1 Cleanouts: bolted, gasketed type, full size of breeching, as indicated.
- .2 Barometric dampers: single acting, 70% of full size of breeching area.
- .3 Hangers and supports: in accordance with recommendations of Sheet Metal and Air Conditioning Contractors National Association Inc. (SMACNA) as indicated.

- .4 Exit cone.
- .5 Expansion sleeves with heat resistant caulking, held in place as indicated.

PART 3 EXECUTION

3.1 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 Rec-connect new breeching to existing stack and riser up through roof. No new roof penetrations are required for chimney/breeching, existing will be re-used.

END

PART 1 GENERAL

1.1 SUMMARY

- .1 Section Includes: Solar air heating system that uses solar energy to heat and ventilate indoor spaces. System is comprised of vent-slit-perforated modular metal panel system.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 – Submittal Procedures.
- .2 Sealants: Division 07 – Sealant.
- .3 Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .4 Section 23 05 00 – Common Work Results – Mechanical.
- .5 Section 23 33 14 – Dampers – Balancing.
- .6 Section 23 33 15 – Dampers – Operating.
- .7 Section 23 34 00 – HVAC Fans.
- .8 Section 23 37 20 – Louvers, Intakes and Vents.

1.3 REFERENCES

- .1 ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .2 ASTM D638 Standard Test Method of Tensile Properties of Plastics after weathering in accordance to ASTM G155.
- .3 ASTM D1003 - Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics ASTM G155.

1.4 SYSTEM DESCRIPTION

- .1 Performance Requirements:
 - .1 Solar air heating system shall be certified and rated by SAHWIA and bear the *Solar A Mark* Certificate to demonstrate that the system has been tested and the performance is independently verified.
 - .2 Solar air heating system shall be SRCC OG 100 certified. Specified flow rate must be within the range of the tested parameters.
 - .3 Supplier of solar air heating system must be ISO 9001:2008 certified by an accredited registrar.
 - .4 Air Intake: Provide a solar wall solar heating panel system. For capacity see drawings.
 - .5 Solar collector array to be connected to AHUs delivering heated outside air to the building in accordance with Division 23.
 - .6 Structural: Provide a panel system that will safely withstand dead and live loads indicated on the drawings.

1.5 SUBMITTALS

- .1 General: Submit listed submittals in accordance with Conditions of the Contract and Section 01 33 00 - Submittal Procedures.
- .2 Product Data: Submit product data, including manufacturer's Specifications sheet, for specified products.
- .3 Shop Drawings: Submit installation drawings that show the arrangement and orientation of panels. Include details of stand-off components, panel joints, flashing and trim for closures.
- .4 Samples:
 - .1 Submit color chart of manufacturer's range of standard colors for specified finish.
 - .2 Submit color chip of color to be selected
- .5 Performance Certificate:
 - .1 Submit Solar A Mark certificate from Solar Air Heating World Industries Association (SAHWIA)
 - .2 Submit SRCC Certificate
- .6 Paint Warranty.

1.6 QUALITY ASSURANCE

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.
- .2 Supplier Qualifications: Minimum of 10 years documented experience in both the design and manufacture of building integrated solar air heating systems; and past experience in designing comparable sized 2-Stage projects.
- .3 Solar A Mark: Quality assurance mark governing building-integrated solar air heating systems.
- .4 ISO 9001:2008 Certified: Quality management system for supplier of solar air heating system.
- .5 Site Inspection by Manufacturer: Ensure conformance to installation specifications.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 General: Comply with Division 01 Product Requirements Section.
- .2 Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- .3 Storage and Protection: Store materials horizontally on a flat pallet in a dry, clean and shaded location protected from exposure to harmful environmental conditions.

- .4 Handle metal and polycarbonate panels with care to avoid scratches, edge damage and puncturing.

1.8 WARRANTY

- .1 Project Warranty: Refer to Conditions of the Contract for project warranty provisions.
- .2 Manufacturer's Warranty: Submit in accordance with Section 01 78 00 – Closeout Submittals for Departmental Representative's acceptance manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Departmental Representative may have under Contract Documents.
- .3 Warranty Period:
 - .1 System: 12 months from the date of installation or 15 months from the date of shipment, whichever comes first.
 - .2 Exterior Panels: 12 months from the date of installation or 15 months from the date of shipment, whichever comes first.
 - .3 Paint: 40 years for silicon modified polyester.

PART 2 PRODUCTS

2.1 SOLAR ENERGY HEATING EQUIPMENT, SOLAR HEATING COLLECTORS, METAL ROOF AND WALL PANELS

- .1 Single stage solar wall: Comprised of vent-slit-perforated, unglazed, transpired solar collector with metal standoffs and a special internal framing system to balance air flow
- .2 Metal Panel Profile Type:
 - .1 Mounting Location: wall.
 - .2 Heating Stages: single
 - .3 Metal: Galvanized steel, 26 gauge, ASTM A653 and ASTM A755.
 - .4 Configuration: Standard roll-formed corrugated metal panels with high & low flats.
 - .5 Standard Finish: Silicon modified polyester (SMP) with inorganic and ceramic pigmentation.
 - .1 Standard 26 Gauge "Hot Colours": Black.
 - .6 Solar Reflectance (SR) value: Black to have SR of 0.06 or less or Solar Absortivity of 0.94 or greater. "Cool colour" formulations that reflect the sun are not acceptable. All other colours to have SR value of 0.25 or less or Solar Absortivity of 0.75 or greater.

2.2 ACCESSORIES

- .1 Stand-Off Components: Provide galvanized steel components to support the panels in a manner as recommended by the manufacturer.
- .2 Flashing: Provide flashing materials to match the metal and finish of the panels.

- .3 Fasteners: Provide corrosion resistant self-drilling screws and rivets as recommended by the manufacturer. Exposed fasteners must be finished to match the panels.

2.3 FABRICATION

- .1 Factory Finishing:
 - .1 Silicon modified polyester (SMP) with inorganic and ceramic pigmentation.

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: Comply with manufacturer's product data, including product technical bulletins, product catalog installation drawings and instructions.
- .2 Coordinate with mechanical to ensure Solar wall system is connected to fan inlet and ventilation system.
- .3 Coordinate with controls or building automation system to ensure sequence of operation of solar heater, fans and associated dampers

3.2 EXAMINATION

- 1. Site Verification of Conditions: Verify that substrate conditions are acceptable for product installation in accordance with manufacturer's instructions.

END

PART 1 GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation for piping and fittings used in HVAC heat exchangers.
 - .2 Sustainable requirements for construction and verification:
- .2 Related Sections:
 - .1 Division 01 – General Requirements
 - .2 Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
 - .3 Section 23 05 02 Facility Commissioning – Mechanical.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME Boiler and Pressure Vessel Code.
 - .1 BPVC-VIII B-2004, BPVC Section VIII - Rules for Construction of Pressure Vessels Division 1.
 - .2 BPVC-VIII-2 B-2004, BPVC Section VIII - Rules for Construction of Pressure Vessels Division 2 - Alternative Rules.
 - .3 BPVC-VIII-3 B-2004, BPVC Section VIII - Rules for Construction of Pressure Vessels Division 3 - Alternative Rules High Press Vessels.
- .2 Canadian Standards Association (CSA International)
 - .1 CSA B51-03, Boiler, Pressure Vessel, and Pressure Piping Code.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 – Submittals.
- .2 Co-ordinate submittal requirements and provide submittals required by Section 01 33 00 – Submittals.
- .3 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet for heat exchangers.
 - .2 Submit WHMIS MSDS in accordance with Section 01 33 00 – Submittal. Indicate VOC's for adhesive and solvents during application and curing.
- .4 Shop Drawings:
 - .1 Submit shop drawings to indicate project layout including layout, dimensions of heat exchangers and system. Indicate following information:
 - .1 Manufacturer's recommended clearances for tube withdrawal and manipulation of tube cleaning tools.
 - .2 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Instructions: submit manufacturer's installation instructions.
- .5 Manufacturer's Field Reports: manufacturer's field reports specified.
- .6 Closeout Submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 77 00 – Closeout Procedures and Section 01 78 00 – Closeout Submittals.

1.4 MAINTENANCE

- .1 Maintenance Materials:
 - .1 Provide maintenance materials in accordance with Section 01 77 00 – Closeout Procedures and Section 01 78 00 – Closeout Submittals.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan (WMP).
 - .4 Separate for reuse and recycling and place in designated containers Steel Metal Plastic waste in accordance with Waste Management Plan (WMP).
 - .5 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.

PART 2 PRODUCTS

2.1 PLATE HEAT EXCHANGER

- .1 General: Designed, constructed and tested in accordance with ASME Code Section VIII, CSA B51 and Provincial Pressure Vessel Regulations.
- .2 Frames: carbon steel with baked epoxy enamel paint, stainless steel side bolts and shroud.
- .3 Plates: titanium for seawater heat exchangers and type 304 stainless for water to glycol and glycol to water heat exchangers.
- .4 Gaskets: as recommended by manufacturer to suit fluid and temperature.
- .5 Nozzles: 150 psi, ASA rubber rated flange type.
- .6 Supports: as indicated.
- .7 Piping connections: as indicated.
- .8 Capacity: as indicated.

- .9 Dimensions: as indicated.
- .10 Base: Concrete housekeeping pad.

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 General: install level and firmly anchored to supports as indicated in accordance with manufacturer's recommendations.
- .2 Plate exchangers: install in accordance with manufacturer's recommendations.
- .3 Arrange piping so that heat exchanger can be removed after disconnecting two unions or flanges adjacent to head and without disturbing piping, equipment and systems.
- .4 Insulate as per Section 23 07 16.
- .5 Install thermometer and pressure gauges on inlet and outlet of primary and secondary sides.

3.3 APPURTENANCES

- .1 Install with safety relief valve piped to drain.
- .2 Install thermometer wells with thermometers on inlet and outlet of primary and secondary side.

3.4 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 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.
- .2 Upon completion of work, after cleaning is carried out.

- .3 Obtain reports within 3 days of review and submit immediately to Departmental Representative.
- .4 Start-up:
 - .1 General: perform start-up operations in accordance with Section 23 05 02 – Facility Commissioning Mechanical supplemented as specified herein.
 - .2 Check heater for cleanliness on primary and secondary sides.
 - .3 Check water treatment system is complete, operational and correct treatment is being applied.
 - .4 Check installation, settings, operation of relief valves and safety valves.
 - .5 Check installation, location, settings and operation of operating, limit and safety controls.
 - .6 Check supports, seismic restraint systems.
- .5 Performance Verification:
 - .1 General: perform performance verification in accordance with Section 23 05 02 – Facility Commissioning Mechanical supplemented as specified.
 - .2 Timing: only after TAB of hydronic systems have been successfully completed.
 - .3 Primary side:
 - .1 Measure flow rate, pressure drop, and water temperature at heater inlet and outlet.
 - .4 Control valve: verify proper operation without binding, slack in components. Measure pressure and temperature at control valve inlet.
 - .5 Secondary side:
 - .1 Measure flow rate, pressure drop and water temperature at heater inlet and outlet.
 - .2 Verify installation and operation of air elimination devices.
 - .6 Calculate heat transfer from primary and secondary sides.
 - .7 Simulate heating water temperature schedule and repeat above procedures.
 - .8 Verify settings, operation, safe discharge from safety valves and relief valves.
 - .9 Verify settings, operation of operating, limit and safety controls and alarms.

3.5 DEMONSTRATION

- .1 Training: provide training in accordance with Section 23 05 02 – Facility Commissioning - Mechanical supplemented as specified.

3.6 CLEANING

- .1 Perform cleaning operations as specified in Section and in accordance with manufacturer's recommendations and as per Section 01 74 11 – Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.7 COMMISSIONING

- .1 Building Commissioning is a requirement of this project in order to comply with sections of Division 01 - General Requirements. A Commissioning Agent has been engaged and will provide all systems commissioning in conjunction with all trade contractors. The

Commission Agent will provide a Commissioning Plan with commissioning start-up and test procedure sheets to be performed and completed by the various trade contractors.

END

PART 1 GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials, components and installation for heat reclaim devices.
- .2 Sustainable requirements for construction and verification.

1.2 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 01 33 00 Submittal Procedures.
- .3 Section 01 45 00 – Testing and Quality Control.
- .4 Section 01 77 00 - Closeout Procedures.
- .5 Section 01 78 00 - Closeout Submittals.
- .6 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .7 Section 23 05 00 – Common Work Results – Mechanical.

1.3 REFERENCES

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 84-2013, Method of Testing Air-to-Air Heat Exchangers (ANSI approved).
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.4 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .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 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

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

- .5 Certificates:
 - .1 Catalogued or published ratings: obtained from tests carried out by manufacturer or those ordered from independent testing agency signifying adherence to codes and standards in force.
 - .2 Provide confirmation of testing.

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.7 MAINTENANCE

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Furnish list of individual manufacturer's recommended spare parts for equipment include:
 - .1 Bearings and seals.
 - .2 Addresses of suppliers.
 - .3 List of specialized tools necessary for adjusting, repairing or replacing.

PART 2 PRODUCTS

2.1 GENERAL

- .1 Comply with ASHRAE 84.

2.2 ENERGY RECOVERY VENTILATORS

- .1 Casing:

- .1 Casing to be constructed of painted galvanized 22GA steel, with 25mm fiberglass insulation. Casing to have drain connection and drain pan. Casing to be supplied with base rails for supporting or hanging the unit.
- .2 Energy Recover Core:
 - .1 Core to recover both sensible and latent energy from exhaust air stream. Core to be constructed from a polymeric membrane. Energy recovery core to recover minimum 70% of sensible heat at design air flows. Energy recovery core to allow for complete operation without requiring defrost.
- .3 Blowers:
 - .1 Unit to have two backward inclined motorized fans with direct drive variable speed ECM motors.
- .4 Filters:
 - .1 Unit to be supplied with MERV 13 filters to protect blowers and heat recovery core.
- .5 Electrical:
 - .1 120VAC, 1ph, 60 hz connection.
- .6 Controls:
 - .1 Unit to have 24VAC 10VA output for supply and exhaust dampers. Low voltage dry contacts for control of ERV operation.
 - .2 Unit to be complete with wire 24V electronic multifunction control with 7 day operation schedule.

2.3 FABRICATION

- .1 Fabricate work square, true, straight and accurate to required size, with joints closely.

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install in accordance with manufacturers recommendations.

3.3 FIELD QUALITY CONTROL

- .1 Tests:
 - .1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical.

3.4 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.5 COMMISSIONING

- .1 Building Commissioning is a requirement of this project in order to comply with sections of Division 01 – General Requirements. A Commissioning Agent has been engaged and will provide all systems commissioning in conjunction with all trade contractors. The Commission Agent will provide a Commissioning Plan with commissioning start-up and test procedure sheets to be performed and completed by the various trade contractors.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .3 Section 01 78 00 - Closeout Submittals.
- .4 Section 09 91 23 - Interior Painting.
- .5 Section 23 05 48 - Vibration and Seismic Controls for HVAC.
- .6 Section 23 05 19 – Thermometers and Pressure Gauges – Piping Systems.
- .7 Section 23 07 18 – Thermal Insulation for Equipment.
- .8 Section 23 08 16 – Cleaning and Start-up of HVAC Piping Systems.
- .9 Section 23 33 00 - Air Duct Accessories.
- .10 Section 23 33 15 - Dampers - Operating.
- .11 Section 23 34 00 – HVAC Fans.

1.2 REFERENCES

- .1 American National Standards Institute/National Fire Prevention Association (ANSI/NFPA)
 - .1 ANSI/NFPA-90A-1999, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .2 Canadian General Standards Board (CGSB)
 - .1 CGSB 1-GP-181M-99, Ready-Mixed Organic Zinc-Rich Coating.
- .3 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA).
- .4 AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- .5 AMCA 99 – Standards Handbook.
- .6 AMCA 210 – Laboratory Methods of Testing Fans for Rating Purposes.
- .7 AMCA 300 – Test Code for Sound Rating Air Moving Devices.
- .8 AMCA 500 – Test Methods for Louvers, Dampers, and Shutters.
- .9 ARI 410 – Forced-Circulation Air-Cooling and Air-Heating Coils.
- .10 NEMA MG1 – Motors and Generators.
- .11 NFPA 70 – National Fire Protection Code.
- .12 SMACNA – HVAC Duct Construction Standards – Metal and Flexible.
- .13 UL 900 – Test Performance of Air Filter Units.
- .14 ASHRAE 62-89 – Ventilation for Acceptable Indoor Air Quality.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop drawings shall be clear and legible with an index format to identify different sections. Provide a cover page for each air handling unit, showing the project name, consulting Departmental Representative, mechanical contractor, tagging information, revision if applicable, and submission date, leaving adequate space for approval stamps.
- .3 Provide all technical information relevant to the product being provided, including but not limited to all the information shown in the schedules of the specification. It is the responsibility of the supplier to highlight any variances his equipment has with the requirements of this specification.
- .4 Shop drawings shall include appropriately scaled CAD drawings. Drawing files shall be available through the Internet or on disk.
- .5 Product data shall include dimensions, weights, capacities, component performances, electrical characteristics, construction details, required clearances, field connection details, proposed test descriptions and sample reports, pressure drops, vibration isolation, gauges and finishes of materials.
- .6 Provide fan performance curves depicting the operating point described on the schedule for each individual fan.
- .7 Provide coil selection data sheets, clearly showing input data with proper consideration for altitude, air density, glycol correction, as well as clearly indicating the selected coils' output data.
- .8 Provide details showing condensate drain connection height and required P-trap height.
- .9 Provide filter information, including initial APD, final APD, dust spot efficiency, final dust holding capacity, filter media description, filter frame details, filter replacement details, and filter gauge details if applicable.
- .10 Submit air handling unit inlet, discharge, and radiated sound power levels at nominal capacity.
- .11 Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring; clearly indicating factory installed and field installed wiring and accessories.
- .12 Submit manufacturer's recommended installation instructions.
- .13 Omission of any of the above information will cause submittal package to be immediately returned without review.

1.4 CLOSEOUT SUBMITTALS

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

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal and wiring materials from landfill to metal recycling facility approved by Departmental Representative.
- .5 Divert unused paint material from landfill to official hazardous material collections site approved by Departmental Representative.
- .6 Do not dispose of unused paint materials into sewer systems, into lakes, streams, onto ground or in other locations where it will pose health or environmental hazard.

1.6 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Furnish list of individual manufacturer's recommended spare parts for equipment 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.

1.7 COORDINATION

- .1 Refer to Division 01, 21, 22, 25 and 26 for other requirements as included and outlined in other sections of the specifications.

1.8 QUALITY ASSURANCE

- .1 A recognized manufacturer whose manufacturing process is ISO-9002 certified shall produce all units. Their quality control procedures must be thoroughly documented to ensure a consistently high quality product.
- .2 **Local service shall be available either directly from the factory or through the local certified factory representatives.**

- .3 Major components shall be products of recognized manufacturers regularly engaged in production of such equipment and whose products are in compliance with industry standards.
- .4 The following parameters shall establish the selection criteria and shall be as specified: airflow rates, external static pressures, and water flow rates. The following are to be as specified or improved: coil and filter face velocities, cabinet air leakage rate, inlet/discharge/radiated sound power levels, and internal static pressures/brake horsepower.
- .5 Unit shall be low leakage construction. Unit manufacturer shall provide tests to verify CASING AIR LEAKAGE. Casing leakage tests shall verify that unit casing leakage is less than 1 % of design airflow at 1.25 times the design static pressure or 1.1 times the fans peak static pressure at design RPM's.
- .6 Units shall be factory built and shipped in a single piece, multiple sections or as a knocked-down package depending on the project specification and/or field restrictions.
- .7 Fans shall conform to AMCA standards regarding testing and construction. Fans shall bear the AMCA certified rating seal for sound and airflow.
- .8 Heating and cooling coils shall be ARI certified.
- .9 Filter media shall be ULC listed.
- .10 Units provided with complete power packages and control wiring shall be CSA or ETL approved for electrical safety.

1.9 OPERATION AND MAINTENANCE DATA

- .1 Include instructions for lubrication, filter replacement, motor and drive adjustment and replacement, spare parts lists, and wiring diagrams.

1.10 DELIVERY, STORAGE AND HANDLING

- .1 Accept products on site in factory applied protective wrapping, and factory installed lifting lugs. Inspect for damage. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures and finish.

1.11 ENVIRONMENTAL REQUIREMENTS

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

1.12 APPROVED MANUFACTURERS

- .1 Companies specializing in manufacturing the products specified in this section and issuing complete catalog data on total product.
- .2 The manufacturer is subject to meeting the specification in its entirety.

PART 2 PRODUCTS

2.1 GENERAL

- .1 Provide factory assembled air handling unit in configuration as indicated on drawings. Unit shall include all specified components installed at the factory unless otherwise specified. Field fabrication of units and their components will not be acceptable. Prior to shipment, the units shall be available to the customer for a final inspection.

2.2 SIDE AND ROOF PANEL CONSTRUCTION

- .1 All side and roof panels shall be constructed of minimum 50 mm thick double wall thermal acoustic panels. They shall have a 50 mm thick cross-section and filled with 50 mm thick fiberglass insulation. The insulation shall have a density of 3.0 lb/cu. ft. and shall have a thermal resistance of 8.7. The wall liners shall individually cover each panel to provide a sturdy and uniform insulation protection. If required, the panels shall be internally reinforced with galvanized steel Z channel stiffeners for structural integrity and to prevent air induced internal vibrations.
 - .1 Exterior wall panels shall be a minimum of 16-gauge G-90 galvanized steel. The inner wall shall be a minimum of 22-gauge solid G-90 galvanized steel.
 - .2 All panels shall be internally fastened together with intermediate adjoining T-mullions and externally sealed with a heavy bead of polyurethane caulking compound to provide a visible assurance of seal. Units must be suitable for pressure differentials up to 2 Kpa static pressure.
 - .3 The insulation media shall have long resilient inorganic glass fibers bonded with a thermosetting resin.
- .2 The average thermal conductance shall not exceed 0.13 BTU/sq. ft. / HR / °F.

2.3 BASE CONSTRUCTION

- .1 Units shall be constructed from heavy gauge formed galvanized steel around the perimeter of each module, with intermediate formed galvanized channels spaced at no greater than 525 mm intervals. The minimum base height shall be 300 mm.
- .2 To minimize thermal conductivity and prevent condensation, the entire perimeter frame shall be uniformly insulated.
- .3 An 18-gauge galvanized steel floor surface shall be installed on the base and structural support grid. The floor shall be reinforced from below. All seams shall be sealed to form a watertight assembly. Base shall be provided with lifting lugs, a minimum of four (4) per unit section. The base shall be insulated with 50mm fiberglass insulation and underlined with a 22-gauge galvanized steel liner.
- .4 Provide integral drain pans in fan sections downstream of cooling coils, humidifiers, economizer fresh air intakes, in mixing boxes and all coil sections.

- .5 All drain connections on floor mounted air handling units shall terminate at the side of the unit.

2.4 ACCESS DOORS

- .1 Access doors shall be manufactured from 16-gauge galvanized steel. The doors shall be double wall construction with 22-gauge solid metal liner on the inside. The complete access door shall be uniformly insulated consistent with the wall panel construction specified herein.
- .2 Provide thermal inspection windows. The windows shall be made of two 6 mm thick tempered glass panels separated by a 12 mm air space. The inspection window shall be installed in the metal door with a heavy-duty rubber-mounting frame.
- .3 The doorframes shall be made from 16-gauge galvanized steel with the outside of the door flush with the unit. The corners of the frame shall have a 75 mm radius and shall include self-gripping automotive gasketing to ensure appropriate air tightness and durability.
- .4 Each door shall have two (2) cast iron latches operable from either side of door and a minimum of two (2) heavy-duty strap hinges. Hinges shall be made of electro- polished 10-gauge 304 stainless steel. Doors shall be removable by releasing setscrews and pushing the pins out of the hinges. Doors must open against the high-pressure side of the air handlers.

2.5 BLOWER SECTION

- .1 Fans shall be either backward inclined, airfoil or forward curved as indicated in the schedules or as implied by the specified equipment.
- .2 Fan performance shall be based on tests conducted in accordance with AMCA[®] standard test code for air moving devices. All fans shall be certified to bear the AMCA[®] certified rating seal. The fans shall have quiet and stable operation under all conditions. The fan manufacturer shall provide sound power ratings in the eight octave bands, which shall be based on AMCA[®] standards. Sound power ratings shall be in decibels referenced to 10⁻¹² watts.
- .3 Fans shall be dynamically balanced. An IRD or PMC analyzer shall be used to measure velocity, and the final reading shall not exceed 0.1 inch per second. The vibration level shall be recorded on the fans as proof of the final dynamic balance at the factory.
- .4 Fans and motors shall be mounted on all welded, structural steel, prime coated integral bases with 50 mm deflection spring isolators and supplied with flexible connection between the fan and the cabinet. If required, spring thrust restraints shall be supplied for stable operation and to protect the flexible connections from tearing. Less efficient 25 mm deflection isolators and rubber-in-shear isolators are not acceptable.
- .5 Housed centrifugal fans shall be double width and double inlet arrangement Type 3. Air inlets shall be at least 0.7 of a wheel diameter away from the cabinet wall to minimize airflow resistance. Fans shall be centered within the cabinet for best aerodynamics.

- .6 Fans shall be constructed of low carbon steel and painted with an approved coating. Each fan shall receive a documented inspection by a qualified inspector. The inspection shall include welding, dimensions, bearings, and overall workmanship.
- .7 Wheel diameters and discharge areas shall be in accordance with the standard sizes adopted by AMCA. Inlets shall be fully streamlined and housings shall be suitably braced to prevent vibration and pulsation. Housings shall be constructed of heavy-gauge steel and shall be continuously welded throughout. The standard coating shall be durable and heat resistant up to 260°C. Fan shafts shall be solid and keyed to fan wheels. They should also be keyed to the sheaves for positive wheel to shaft interlock.
- .8 The first critical shaft speeds shall be at least 125 % (Class I and II) and 142 % (Class III) of the fan's maximum operating speed. Bearings shall be designed for heavy-duty service with a minimum L-50 life of 200,000 hours. Bearing ratings are to be based on the fans' maximum catalogued operating speed and horsepower. Pillow block bearings shall be either single row ball or double row spherical roller type. Bearing bars shall be rigidly fixed to the base, bearing supports mounted to the inlet funnel are unacceptable. Bearing supports shall consist of two or more full-length structure uprights.
- .9 Fan speeds (rpm) and outlet velocities indicated in the equipment schedules on the drawings shall not be exceeded.

2.6 MOTORS AND DRIVES

- .1 Motors shall be supplied in accordance with electrical/mechanical specifications and schedules. They shall be mounted on slide bases for proper alignment and belt tension adjustment.
- .2 Provide V-belt, cast-iron sheaves, and reinforced rubber belts (minimum of 2 belts per drive). The belts and drives shall be selected for minimum 150 % of the motor nameplate horsepower. Provide adjustable motor sheaves on motors of 7.5kW (10 HP) and less.
- .3 Belt drive types and service factor shall be in accordance with the general mechanical specifications.
- .4 Provide a metal belt guard having sides and face of galvanized steel with openings for fan tachometer readings. Belt guard shall be sized to allow either sheave to be increased by two sizes.
- .5 Motors shall be premium efficiency, open drip-proof.

2.7 VIBRATION ISOLATION

- .1 An integral all welded structural steel vibration isolation base shall be provided for the fan and motor. Motor slide bases shall be the double adjustment type. Unpainted or galvanized, bolted together fan/motor bases are not acceptable. The base shall be free-floating on spring type isolators at all four corners.
- .2 Isolators shall be complete with levelling bolts and neoprene isolation pads, selected to a minimum efficiency of 95%.

- .3 Minimum spring deflection shall be 50 mm.

2.8 COILS

- .1 Coils shall be fully enclosed within the section and shall have double wall galvanized floor construction consistent with the unit casing construction.
- .2 Piping connections shall extend to the outside through rubber grommets. Cooling coil connections shall include dual rubber grommets: on the outer skin and inner liner.
- .3 Coils shall include galvanized steel blank off sheets to hold coils rigid and prevent air from bypassing the coils.
- .4 50 mm thick removable access panels shall be provided on access side to remove coils through casing wall. Coils shall be mounted on independent stainless steel racks and shall be individually removable.
- .5 Drain pans shall have a double slope for positive drainage, constructed of 16-gauge – 304 stainless steel and continuously welded.
- .6 Intermediate coils shall have double slope drain pans, constructed of 16-gauge – 304 stainless steel and continuously welded. Intermediate drain pans shall have 25 mm drains flowing into the main drain pan. High air volume units and/or high latent load units shall have individual drain connections for each stacked drain pan within the section.
- .7 All drain pans shall have floor drain hubs recessed in the pans to ensure complete drainage.
- .8 Coils shall be tested and rated in accordance with air conditioning and refrigeration institute (ARI) standard 410.
- .9 The complete coil core shall be tested with 2170 kPa pounds of air pressure under warm water and be suitable for operation at 1720 kPa working pressure. Water coils shall be circuited for drainability without removing individual plugs from each tube.
- .10 The primary surface of all coils shall be round seamless copper tubes. The secondary surface shall consist of rippled aluminum plate fins. Fins shall have full drawn collars to provide a continuous cover over the entire tube surface for maximum heat transfer. The tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire fin length.
- .11 Coil casings shall be constructed of galvanized steel. Coil side plates shall be of reinforced flange type construction.
- .12 Water coils shall have copper headers, steel male pipe connections, a vent connection at the highest point, and a drain connection at the lowest point.
- .13 Tube material & thickness: 16 mm OD, 0.5 mm thick copper.
- .14 Fin material & thickness: 0.2 mm aluminum.
- .15 Coil casing material: galvanized steel.

2.9 PRE-FILTER SECTION

- .1 Filter types, efficiencies and face areas shall be in accordance with 23 05 19 - Meters and Gauges for HVAC Piping.
- .2 Pre-filters shall be front loading type. Front loading filters shall be mounted on factory fabricated 16-gauge galvanized steel holding frames complete with 6 mm x 12 mm open cell gasket.

2.10 FINAL FILTER SECTION

- .1 Filter types, efficiencies and face areas shall be in accordance with the Section 23 05 19 - Meters and Gauges for HVAC Piping.
- .2 Filter section shall be factory fabricated as part of the air-handling unit. Extruded aluminum, front access filter rack shall accept both 50 mm pre-filters and single header final filters.
- .3 Provide access door on one side of unit as per the drawings and specifications.

2.11 FILTER GAUGES

- .1 Provide and flush mount air filter gauges.
- .2 Static pressure tips, shut off valves and tubing shall be provided and installed by the AHU manufacturer.
- .3 One gauge shall be provided for each filter bank.

2.12 MIXING BOX SECTION

- .1 Mixing box section shall be complete with parallel blade type dampers. They shall be positioned so that the airstreams are directed into a merging pattern. Driving linkages shall be accessible from outside the casing. Damper sizes shown are minimum allowable, in order to keep damper pressure drop and noise to a minimum. Where shown on plans, furnish access doors to service linkages and actuators.

2.13 AIR TO AIR THERMAL RECOVERY UNIT

- .1 Furnish and install Thermal Recovery Units of the air-to-air heat pipe exchanger type as shown in the schedule.
- .2 Thermal Recovery Units (TRU) shall be 5/8 inch diameter copper tubing and aluminum plate fins of corrugated design to produce maximum heat transfer efficiency. Heat pipe to be c/w here site coated protection.

- .1 The heat pipe shall have a capillary wick structure formed into the inner wall of each tube to provide a completely wetted surface form maximum heat transfer efficiency.
- .2 A partition shall be incorporated into the TRU to isolate the Exhaust and supply airstreams and prevent cross-contamination.
- .3 The TRU consist of the following items which are factory installed, wired and tested:
 - .1 Drain pan on exhaust leaving side of TRU.
 - .2 Access panels.
 - .3 Controls, as required, of the following functions:
 - .1 Frost protection.
 - .2 Supply temperature regulation.
 - .3 Interlock terminal strip of tie into EMCS.
 - .4 25mm (1") condensate drain.
- .4 The integrated Tilt Package (ITP) shall have 18 gauge roof and side panels, 12 gauge floor pan and support, access panels of similar construction to match unit and shall be suitable of connection of:
 - .1 Exhaust air ductwork.
 - .2 Supply air ductwork.
 - .3 1" condensate drain.

2.14 AIR STRATIFICATION ELIMINATORS

- .1 Stratification eliminators shall have no moving or adjustable parts and shall consist of heavy gauge all welded frame containing a set of directional changing vanes and a cone designed for almost perfect mixing of air streams of different temperatures and velocities.
- .2 Standard construction of all welded aluminum 0.081 framing, 0.081 turbulators and aluminum directional blades.
- .3 Air stream temperatures shall be mixed to within +3°C of the theoretical mixed air temperature.
- .4 Stratification eliminators must be selected with due and careful consideration of the required upstream and downstream distances.

2.15 ALUMINUM AIRFOIL DAMPERS

- .1 Extruded aluminum damper frame shall not be less than 12-gauge in thickness and 100 mm deep.
- .2 Damper blades shall be airfoil design, 150 mm wide and made of extruded aluminum profiles.
- .3 Blade gaskets shall be extruded EPDM elastomer secured in an integral slot within the aluminum extrusions. Frame seals shall be extruded TPE thermoplastic.

- .4 Pivot rods shall be 22 mm hexagon extruded aluminum interlocking into blade section. Bearings shall have a double seal with a Celcon inner bearing fixed to the rod within a polycarbonate outer bearing inserted into the frame so that the outer bearing cannot rotate.
- .5 Bearings shall be designed so that there is no metal-to-metal or metal-to-bearing contact.
- .6 Linkage hardware shall be installed outside the frame and constructed of aluminum and corrosion resistant, zinc and nickel-plated steel. Drive shaft rod shall be extendable on both sides of the dampers.
- .7 Dampers shall be designed for operation in temperatures ranging between -40°C and 100°C .
- .8 Damper seals shall be designed for minimum air leakage by means of overlapping seals. Air leakage through a 1.2 m X 1.2 m damper shall not exceed 52.3 L/S/m² against 1 kPa differential static pressure. Air leakage data shall be certified under the AMCA certified ratings program.
- .9 Outdoor air damper frames shall be insulated with polystyrene on all sides and have thermally broken blades. The complete blade shall have an insulating factor of R-2.29 and a temperature index of 55.
- .10 Shaft for actuator to extend outside of air handler casing to allow for mounting of actuator outside of air handling unit.
- .11 Actuators to be provided and installed by the EMCS controls contractor.

2.16 ELECTRICITY, POWER PACKAGE AND CONTROLS

- .1 Lights shall be wired to individual switches.
- .2 A 120V GFI service receptacle shall be located beside the supply fan section door.
- .3 Motors shall be wired to individual disconnects located outside their respective fan sections. Non-fused disconnects shall be provided by this section.
- .4 Fan shall be Powered by variable speed drives. Refer to Section 25 73 15 - EMCS: Variable Speed Drives for speed drive description. Motors shall be inverter duty rated.
- .5 All components shall be CSA and/or ULC approved.
- .6 Approved equipment shall have a CSA or ETL label.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Use all factory provided lifting lugs to rig the units or modules. Ensure that spreader bars are used to prevent damaging the cabinets.

- .2 Lift modules in an upright position.
- .3 Ensure housekeeping pads or mounting bases are level and in accordance with approved dimensions. Air handling units or modules shall be level, shim if necessary.
- .4 Mechanical contractor shall provide and install adequately sized P-traps for all condensate pipe connections. Disposal of condensate shall be in accordance with local codes.
- .5 Remove gussets, hold-down bolts and shipping fasteners.
- .6 Remove fans' shipping restraints and level spring isolators. Adjust thrust restraints.
- .7 Assemble modules together according to the installation manual.
- .8 Check fan motors for rotation and amp draw for each phase. Record information on the start-up data sheets.
- .9 Belt drives should be adjusted for tension and alignment.
- .10 Execute start-up, complete report and send to the air handling unit manufacturer for verification and as acknowledgment of warranty commencement.

3.2 FANS

- .1 Provide sheaves and belts required for final air balance.
- .2 Suspension for hung units: install four part hanger type, ceiling flange, top hanger, bottom hanger and vibration isolator with takeup for levelling.
- .3 Install flexible connections at fan inlets and outlets as indicated.
 - .1 Ensure metal bands of connectors are parallel and not touching when fan is running and when fan is stopped.
 - .2 Ensure that fan outlet and duct are aligned when fan is running.

3.3 DRIP PAN

- .1 Install deep deal P trap and trap seal primer on drain lines.
 - .1 Depth of water seal to be 1.5 times static pressure at this point.

3.4 COMMISSIONING

- .1 Building Commissioning is a requirement of this project in order to comply with sections of Division 01 – General Requirements. A Commissioning Agent has been engaged and will provide all systems commissioning in conjunction with all trade contractors. The Commission Agent will provide a Commissioning Plan with commissioning start-up and test procedure sheets to be performed and completed by the various trade contractors.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 01 33 00 – Submittal Procedures.
- .2 Section 01 91 13 - General Commissioning Requirements.
- .3 Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .4 Section 23 05 00 – Common Work Results – Mechanical.
- .5 Section 23 05 01 – Facility Mechanical Commissioning – General.
- .6 Section 23 05 02 – Facility Commissioning – Mechanical.

1.2 REFERENCES

- .1 ASHRAE 52.2-1999, Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
- .2 CAN/CGSB-51.40-M80, Thermal Insulation, Flexible, Elastomeric, Unicellular, Sheet and Pipe Covering.
- .3 CAN/CGSB-115.10-M90, Disposable Air Filters For Removal of Particulate Matter from Ventilating Systems.
- .4 CAN/CGSB-115.15-M91, High Efficiency, Rigid Type Air Filters for Removal of Particulate Matter from Ventilating Systems.
- .5 CSA B52-M1992, Mechanical Refrigeration Code.
- .6 CAN/CSA-C656-M92, Performance Standard for Single Package Central Air-Conditioners and Heat Pumps.
- .7 EPS 1/RA/1-1991, Code of Practice for the Reduction of Chlorofluorocarbons Emissions from Refrigeration and Air Conditioning Systems, Canadian Environmental Protection Act Code of Practice.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Indicate:
 - .1 Capacities.
 - .2 ARI Ratings.
 - .3 Sound Power levels.
 - .4 Refrigerant type.
 - .5 Accessories included.

1.4 OPERATION AND MAINTENANCE DATA

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 70 00 - Contract Close Out.

- .2 Include following:
 - .1 All control and wiring schematics.
 - .2 Trouble shooting brochure.
 - .3 Shop drawing, installation operation and maintenance materials.
 - .4 Recommended piping installation procedure.
 - .5 Supports.

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Separate for reuse and recycling and place in designated containers Steel Metal Plastic waste in accordance with Waste Management Plan.
- .5 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Departmental Representative.
- .6 Fold up metal banding, flatten and place in designated area for recycling.

1.6 WARRANTY

- .1 For heat pump, the 12 months warranty period shall be extended to 5 years including the compressors, condenser, evaporator, valves, piping, controls, and refrigerant.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Apply temporary protective coating to finished surfaces. Remove coating after erection. Do not use coatings that will become hard to remove or leave residue. Protect all outdoor equipment from scratches.
- .2 Leave protective covering in place until final cleaning of building.

PART 2 PRODUCTS

2.1 GENERAL

- .1 Heat pumps: CSA approved and carry ARI or CSA certification seal.

2.2 REFRIGERANTS

- .1 Type of Refrigerant: R-410A.

2.3 OUTDOOR UNITS WITH A CAPACITY GREATER THAN 15 KW

- .1 General:
 - .1 The unit must have a fused powder coated finish. The outdoor unit shall be completely factory assembled, piped and wired.
 - .2 The casing shall be fabricated of galvanized steel, bonderized and finished with a powder coated baked enamel. Units cabinets shall be able to withstand 960 hours of Salt Spray in accordance with JRA9002 (Japanese Refrigeration and Air-conditioning) testing criteria
 - .3 The panels on the outdoor unit shall be scratch free. If a scratch occurs the salt spray protection is compromised and the panel shall be replaced at the expense of the contractor.
 - .4 Outdoor unit shall have a sound pressure level (SPL) rating no higher than a maximum of 60 dB (A) individually or a collective maximum sound pressure rating of 65 dB (A) when combined with other modules in a system. The sound pressure rating is as measured a horizontal distance 1 m from the unit.
 - .5 Both refrigerant lines from the outdoor unit to indoor units shall be individually insulated as per section 23 07 20 Thermal Insulation for Piping
 - .6 The outdoor unit shall have an accumulator with refrigerant level sensors and controls. The outdoor unit shall have a high pressure safety switch, over-current protection and DC bus protection.
 - .7 The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.
- .2 Fan:
 - .1 The unit shall be furnished with a direct drive, inverter driven, variable speed propeller type fan.
 - .2 The condenser fan motor shall be a variable speed, direct current motor and shall have permanently lubricated bearings.
 - .3 The fan motor shall be mounted with vibration isolation for quiet operation.
 - .4 The outdoor unit shall have vertical discharge airflow.
- .3 Coil:
 - .1 The outdoor unit coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
 - .2 The coil shall be protected with an integral guard.
 - .3 The coil fins shall have a factory applied corrosion resistant finish.
- .4 Compressor:
 - .1 The compressor shall be a high performance, inverter driven, variable speed, scroll hematic type.
 - .2 The compressor will be equipped with an internal thermal overload.
 - .3 The compressor shall be mounted to avoid the transmission of vibration.
 - .4 A crankcase heater shall be factory mounted on each compressor
- .5 Electrical:
 - .1 The unit electrical power shall be 208V, 3Ph, 60Hz.
 - .2 The outdoor unit shall be controlled by integral microprocessors.

.6 Modular Configuration

- .1 The outdoor units shall consist of one or two modules each rated for the designated proportion of the total system cooling/heating capacity.
- .2 Each module is furnished with a inverter driven scroll compressor(s) and inverter driven variable speed propeller type condenser fan. Single or dual compressor individual outdoor condensing units with capacities in excess of 144,000 Btu's are not acceptable for this application based on reduced operational life cycles and limited compressor redundancy levels.
- .3 The modular outdoor unit combinations are designed so as to balance the run hours seen by each individual inverter driven scroll compressor in order to extend overall outdoor unit life cycle and reduced on going maintenance costs.
- .4 The modules shall be installed in a side by side configuration without the need for intermediate oil balancing pipework.

.7 Factory Twinning Kits

- .1 Factory manufactured twinning kits will be supplied loose to facilitate the field connection of a maximum of two (2) modular condensing units per system.

.8 Performance:

- .1 Minimum heating operating temperature: -17 °C
- .2 Refer to schedule on drawings.

2.4 HEAT RECOVERY UNITS

.1 General:

- .1 These units shall be equipped with a circuit board that interfaces to the controls system and shall perform all functions necessary for operation.
- .2 The unit shall have a galvanized steel finish.
- .3 The unit shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory.
- .4 This unit shall be mounted indoors, with access and service clearance provided for each controller.

.2 Configuration

- .1 The unit shall also include a tube in tube heat exchanger which will recover waste heat from units in cooling operation and distribute this to units requiring heating. The opposite will happen in cooling operation.
- .2 An integral condensate pan and drain shall be provided.
- .3 The refrigeration process in the unit shall be maintained by LEV's (linear expansion valves) which will be controlled by pressure and temperature sensors.
- .4 A brass header pipe with three solenoid valves for each distribution port shall distribute the correct phase of refrigerant to each indoor unit.
- .5 Service shut-off valves shall be field-provided/installed for each branch to allow service to any indoor unit without field interruption to overall system operation.

- .3 Electrical
 - .1 The unit shall operate on 208V/1Ph/60Hz.
 - .2 The unit shall be controlled from the outdoor condensing unit.

2.5 WALL MOUNTED INDOOR UNITS

- .1 General:
 - .1 The indoor unit shall be fully factory assembled and wired. Contained within the indoor unit shall be all factory wiring, piping, control circuit board, fan, and fan motor. The unit shall have a self-diagnostic function, 3 minute restart time delay mechanism, an auto restart function, an emergency/test operation
- .2 Fan
 - .1 The indoor fan shall be an assembly with one or two fan direct driven by a single motor.
 - .2 The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
 - .3 A manual adjustable guide vane shall be provided with the ability to change the airflow from side to side (left to right).
 - .4 A motorized air sweep louver shall provide an automatic change in airflow by directing the air up and down to provide uniform air distribution.
- .3 Filter:
 - .1 Return air shall be filtered by means of an easily removable, washable filter.
- .4 Coil:
 - .1 The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
 - .2 All tube joints shall be brazed with phos-copper or silver alloy.
 - .3 The coils shall be pressure tested at the factory.
 - .4 A condensate pan and drain shall be provided under the coil.
- .5 Electrical:
 - .1 The unit electrical power shall be 208V, 1Ph, 60Hz.
- .6 Controls:
 - .1 The unit shall be to control external heat source. External heat may be energized as back-up or a second stage with 1°C – 5°C adjustable deadband from set point.

2.6 4- WAY CEILING CASSETTE INDOOR UNITS

- .1 General:
 - .1 The indoor unit shall be fully factory assembled and wired. Contained within the indoor unit shall be all factory wiring, piping, control circuit board, fan, and fan motor. The unit shall have a self-diagnostic function, 3 minute restart time delay mechanism, an auto restart function, an emergency/test operation
 - .2 The cabinet shall be able to fit within a standard 600 mm square suspended ceiling grid.
 - .3 The cabinet panel shall have provisions for a field installed filtered outside air intake.
 - .4 A four-way grille shall be fixed to bottom of cabinet.
- .2 Fan
 - .1 The indoor fan shall be an assembly with a fan direct driven by a single motor.
 - .2 The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
 - .3 The indoor fan shall have multiple speed settings.
- .3 Filter:
 - .1 Return air shall be filtered by means of an easily removable, washable filter.
- .4 Coil:
 - .1 The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
 - .2 All tube joints shall be brazed with phos-copper or silver alloy.
 - .3 The coils shall be pressure tested at the factory.
 - .4 A condensate pan and drain shall be provided under the coil.
 - .5 The unit shall be provided with an integral condensate lift mechanism
- .5 Electrical:
 - .1 The unit electrical power shall be 208V, 1Ph, 60Hz.
- .6 Controls:
 - .1 The unit shall be to control external heat source. External heat may be energized as back-up or a second stage with 1°C – 5°C adjustable deadband from set point.

2.7 DUCTED FAN COIL INDOOR UNITS

- .1 General:
 - .1 The indoor unit shall be fully factory assembled and wired. Contained within the indoor unit shall be all factory wiring, piping, control circuit board, fan, and fan

motor. The unit shall have a self-diagnostic function, 3 minute restart time delay mechanism, an auto restart function, an emergency/test operation

- .2 Fan
 - .1 The indoor fan shall be an assembly with one or two fans direct driven by a single motor.
 - .2 The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
 - .3 The indoor fan shall have multiple speed settings.
- .3 Filter:
 - .1 Return air shall be filtered by means of a standard factory installed return air filter.
- .4 Coil:
 - .1 The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
 - .2 All tube joints shall be brazed with phos-copper or silver alloy.
 - .3 The coils shall be pressure tested at the factory.
 - .4 A condensate pan and drain shall be provided under the coil.
- .5 Electrical:
 - .1 The unit electrical power shall be 208V, 1Ph, 60Hz.
- .6 Controls:
 - .1 The unit shall be to control external heat source. External heat may be energized as back-up or a second stage with 1°C – 5°C adjustable deadband from set point.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Install where indicated and in accordance with manufacturer's instructions.
- .2 Make piping connections.
- .3 Make duct connections through flexible connections.
- .4 Nothing to obstruct ready access to components or to prevent removal of components for servicing.
- .5 Install on vibration isolation pads. Refer to Section 23 05 48.

3.2 DRAIN PANS

- .1 Install so that no water can accumulate and arrange for easy access for cleaning.
- .2 Trap and vent condensate drain lines as per manufacturer's recommendations.

3.3 CONTROLS

- .1 Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit, and to the outdoor unit. Control wiring to remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit.
- .2 Indoor units shall be controlled by a programmable wired thermostat.
- .3 System shall be BACnet compatible.

3.4 START-UP AND COMMISSIONING

- .1 Manufacturer to certify installation and provide resume of proposed technician for approval by the Departmental Representative and Commissioning Authority.
- .2 Manufacturer certified, factory trained technician to start up and test units and certify performance.
- .3 Manufacturer to provide verbal, video, and written instructions to operating personnel.
- .4 Submit written report to Departmental Representative.
- .5 Manufacturer certified, factory trained technician to participate in Commissioning and Functional Performance Testing.

3.5 COMMISSIONING

- .1 Building Commissioning is a requirement of this project in order to comply with the requirements of Division 01 – General Requirements. A Commissioning Agent has been engaged and will provide all systems Commissioning in conjunction with all trade contractors. The Commission Agent will provide a Commissioning Plan with Commissioning start-up and test procedure sheets to be performed and completed by the various trade contractors.

END

PART 1 GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Base board and finned tube radiation, and cabinet convectors including installation.
 - .2 Sustainable requirements for construction and verification.

1.2 SECTION INCLUDES

- .1 Section 01 33 00 – Submittal Procedures.
- .2 Section 01 91 13 - General Commissioning Requirements.
- .3 Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .4 Section 23 05 00 – Common Work Results – Mechanical.
- .5 Section 23 05 01 – Facility Mechanical Commissioning – General.
- .6 Section 23 05 02 – Facility Commissioning – Mechanical.

1.3 REFERENCES

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS):
 - .1 Material Safety Data Sheets (MSDS).
- .2 Hydronic Institute of Boiler and Radiator Manufacturers (IBR).

1.4 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 – Submittal Procedure. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS).
- .2 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Shop drawings: submit drawings stamped and signed by professional engineer registered to practice in the Province of Nova Scotia.
 - .2 Indicate:
 - .1 Equipment, capacity, piping, and connections.
 - .2 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, sizes and location of mounting bolt holes.

- .3 Samples:
 - .1 Submit samples in accordance with sections of Section 01 33 00 – Submittal Procedures.
- .4 Quality assurance submittals: submit following in accordance with Section 01 45 00 – Testing and 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.
- .5 Closeout Submittals:
 - .1 Submit maintenance data for incorporation into manual specified in with sections of Section 01 78 00 – Closeout Submittals.

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 with sections of Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.

PART 2 PRODUCTS

2.1 CAPACITY

- .1 As indicated in schedule on drawings, based on 125°F average water temperature, 30°F temperature drop and 65°F at entering air temperature.

2.2 FINNED TUBE RADIATION

- .1 Heating elements: 1-1/4" seamless copper with 4" x 4" aluminum fins. Fins to be stamped for rigidity and have integral collars to provide even spacing of 50 fins/foot. Tube ends to be suitable for sweat connecting.
- .2 Element hangers: nylon roller bearings to allow for free expansion. Space hangers 48" on centre minimum.
- .3 Enclosures:
 - .1 Material: 16 ga. satin coat steel with electrostatically applied powder coat prime finish. Colour by Architect.
 - .2 Provide components for wall-to-wall or complete with die formed end caps having no knock-outs, with inside and outside corners as indicated.
 - .2 Provide full length channel and sealer strip at top of wall edge.
 - .3 Height: as per schedule and details.

- .4 Joints and filler pieces flush with cabinet. Joints and filler pieces clear of grilles located to provide easy access to valves and vents.
- .5 Provide access doors for valves, vents and traps.
- .4 Dimensions for enclosures: measure site conditions. Do not scale from drawing.
- .5 Provide for noiseless expansion of components.
- .6 Capacities: as per schedule.

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.
- .2 Install in accordance with piping layout and approved reviewed shop drawings.
- .3 Provide for pipe movement during normal operation.
- .4 Maintain sufficient clearance to permit performance of service maintenance.
- .5 Check final location with Departmental Representative if different from that indicated prior to installation. Should deviations beyond allowable clearances arise, request and follow Department Representatives' directive.
- .6 Valves:
 - .1 Install valves with stems upright or horizontal unless approved otherwise.
 - .2 Install isolating gate valves on inlet and lockshield globe balancing valves on outlet of each unit.
- .7 Venting:
 - .1 Install screwdriver vent on cabinet convector, terminating flush with surface of cabinet.
 - .2 Install automatic air vent standard air vent with cock on continuous finned tube radiation.
- .8 Clean finned tubes and comb straight.

3.3 COMMISSIONING

- .1 Building Commissioning is a requirement of this project in order to comply with sections of Division 01 - General Requirements. A Commissioning Agent has been engaged and will provide all systems commissioning in conjunction with all trade contractors. The Commission Agent will provide a Commissioning Plan with commissioning start-up and test procedure sheets to be performed and completed by the various trade contractors.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 01 33 00 – Submittal Procedures.
- .3 Section 01 91 13 - General Commissioning Requirements.
- .4 Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .5 Section 23 05 00 – Common Work Results – Mechanical.
- .6 Section 23 05 01 – Facility Mechanical Commissioning – General.
- .7 Section 23 05 02 – Facility Commissioning – Mechanical.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 Construction /Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material, in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal facility as approved by Departmental Representative.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Indicate:
 - .1 Equipment, capacity, piping and connections.
 - .2 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, sizes and location of mounting bolt holes.

1.4 COORDINATION

- .1 Refer to Division 01, 21, 22, 25 and 26 for other requirements as included and outlined in other sections of the specifications.

1.5 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into manual specified in Section 01 77 00 – Closeout Procedures.

PART 2 PRODUCTS

2.1 HORIZONTAL UNIT HEATERS

- .1 Casing 1.2 mm (18 gauge) thick cold rolled steel, powder coat finish, with threaded connections for hanger rods.
- .2 Coils: Seamless copper, tubing, silver brazed to steel headers with evenly spaced aluminum fins mechanically bonded to tubing. Hydrostatically test to 1206 kPa (175 psi.)
- .3 Fan: Direct drive propeller type, factory balanced, with anti-corrosive finish and fan guard.
- .4 Motor: speed as indicated continuous duty, built-in overload protection, and resilient motor supports.
- .5 Air Outlet: Adjustable louvres.
- .6 Capacity: as indicated.
- .7 Control: Unit to be controlled via DDC Sensor provided by EMCS Contractor. Provide contact to suit EMCS signal.

2.2 VERTICAL UNIT HEATERS

- .1 Casing: 1.2 mm (18 gauge) thick cold rolled steel, powder coat finish, with four threaded connections for hanger rods.
- .2 Coils: Seamless copper, tubing, silver brazed to steel headers with evenly spaced aluminium fins mechanically bonded to tubing. Hydrostatically test to 1206 kPa (175 psi.)
- .3 Fan: Direct drive propeller type, factory balanced, with anti-corrosive finish and fan guard.
- .4 Motor: speed as indicated continuous duty, built-in overload protection, and resilient motor supports.
- .5 Capacity: as indicated.
- .6 Control: Unit to be controlled via DDC Sensor provided by EMCS Contractor. Provide contact to suit EMCS signal.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.
- .2 Install in accordance with piping layout and approved shop drawings.
- .3 Provide double swing pipe joints as indicated.

- .4 Check final location with Departmental Representative if different from that indicated prior to installation. Should deviations beyond allowable clearance arise, request and follow Departmental Representative's directive.
- .5 Hot water units: for each unit, install gate valve on inlet and circuit balancing valve on outlet of each unit. Install drain valve at low point. Install manual air vent at high point complete with flow measuring fittings.
- .6 Clean finned tubes and comb straight.
- .7 Provide supplementary suspension steel as required.
- .8 Thermostats on outside walls: mount on insulated backplates.
- .9 Before acceptance, set discharge patterns and fan speeds to suit requirements.

3.2 **COMMISSIONING**

- .1 Building Commissioning is a requirement of this project in order to comply with sections of Division 01 – General Requirements. A Commissioning Agent has been engaged and will provide all systems commissioning in conjunction with all trade contractors. The Commission Agent will provide a Commissioning Plan with commissioning start-up and test procedure sheets to be performed and completed by the various trade contractors.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 01 33 00 – Submittal Procedures.
- .2 Section 01 91 13 - General Commissioning Requirements.
- .3 Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .4 Section 23 05 00 – Common Work Results – Mechanical.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material, in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal facility as approved by Departmental Representative.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

1.3 SHOP DRAWINGS AND PRODUCT DATA

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

1.4 COORDINATION

- .1 Refer to Division 01, 21, 22, 25 and 26 for other requirements as included and outlined in other sections of the specifications.

1.5 MAINTENANCE MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 77 00 – Closeout Procedures.
- .2 Furnish list of individual manufacturer's recommended spare parts for equipment, addresses of suppliers, list of specialized tools necessary for adjusting, repairing or replacing, for inclusion into operating manual.

1.6 MANUFACTURED ITEMS

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

PART 2 PRODUCTS

2.1 PACKAGED ELECTRODE STEAM GENERATING TYPE

- .1 CSA certified and ULC listed.
- .2 All components housed in factory fabricated cabinet with factory enamelled finish and electrically interlocked door.
- .3 Factory sealed disposable steam cylinder complete with factory installed electrodes to suit water condition and drain cooler.
- .4 Controls:
 - .1 Solid state panel.
 - .2 Solenoid valve on water and drain lines.
 - .3 Start signal from EMCS plus 0-100% modulating control.
 - .4 Airflow proving switch.
 - .5 Adjustable flush cycle timer.
 - .6 Amp meter.
 - .7 Cylinder replacement indicator light.
 - .8 High limit humidistat.
- .5 Unit shall also have the following features:
 - .1 Multifunction, Backlight, LCD graphic display with keypad programming.
 - .2 Total Control technology with standard BMS communication inference for remote monitoring and control via Native BACnet.
 - .3 Modulating output down to 20%.
 - .4 Real time clock to indicate operating performance with time and data stamp status.
 - .5 Cylinder operating status in hours.
 - .6 Foam detection and correction capability.
 - .7 On screen troubleshooting centre with corrective action.
 - .8 On screen indication of service history.
 - .9 On screen graphic indication of humidity demand trends.
 - .10 Continuous display of operating parameters and self-monitoring.
 - .11 Long Life Status Indicator LEDs on front of unit.
 - .12 Auto-Adaptive System for optional water management control.
 - .13 Continuous self-diagnostics with self-correction.
 - .14 Dual modulation input capable.
 - .15 Integral P+I controller, and humidity setpoint, for use with humidity sensor(s)/transducer(s).
 - .16 Independent On/Off control 'Security Loop'.
 - .17 Limited Capacity manually adjustable 50-100%.
 - .18 Disposable cylinder has published life expectancy.

- .19 Hygienic automatic drain down after three days without a call for humidification.
 - .20 Attractive, durable front access housing.
 - .21 Door can be lifted off in cases of reduced frontal clearance.
 - .22 Internal drain Water tempering to 60°C (140°F) maximum, meeting local plumbing codes.
 - .23 Fill cup with internal one inch air gap.
 - .24 UL Listed.
 - .25 Two year limited warranty or 30 months from ship date.
 - .26 Status Indication relay capable to provide dry contacts for remote status indication (DI) and Control (AO).
- .6 Insulated short absorption manifolds complete with condensate drain and supply hose. Tube insulation shall consist of two (2) 304 Stainless Steel shields with insulating airgap.
- .7 Capacity: Refer to Humidifier Schedule on Drawing.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.
- .2 Provide trap legs equal to fan static pressure plus 50mm (2") and 250mm (10") minimum on steam manifold.
- .3 Install high limit humidistat and air proving switch in supply air duct.
- .4 Provide water service overflow drain to Manufacturer's recommendations.
- .5 Install in accessible location as indicated on drawings.
- .6 Provide drain connection at low point induct.

3.2 COMMISSIONING

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END