

PART 1 - GENERAL

1.1 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.

1.2 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Shop drawings; submit drawings stamped and signed by professional engineer registered or licensed in Province of Nova Scotia, Canada when requested.
 - .3 Shop drawings to show:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances.
 - .4 Shop drawings and product data accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.
 - .3 Points of operation on performance curves.
 - .4 Manufacturer to certify current model production.
 - .5 Certification of compliance to applicable codes.
 - .5 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.
 - .6 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 approved by, and final copies deposited with, Departmental Representative before final inspection.
 - .3 Operation data to include:
 - .1 Control schematics for systems including environmental controls.
 - .2 Description of systems and their controls.
 - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for systems and component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.
 - .4 Maintenance data to include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
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- .5 Performance data to include:
 - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified.
 - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .6 Approvals:
 - .1 Submit 3 copies of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless directed by Departmental Representative.
 - .2 Make changes as required and re-submit as directed by Departmental Representative.
 - .7 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
 - .8 Site records:
 - .1 Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
 - .2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.
 - .3 Use different colour waterproof ink for each service.
 - .4 Make available for reference purposes and inspection.
 - .9 As-built drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
 - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
 - .3 Submit to Departmental Representative for approval and make corrections as directed.
 - .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
 - .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
 - .10 Submit copies of as-built drawings for inclusion in final
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1.3 QUALITY ASSURANCE

- .1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.
- .2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

1.4 MAINTENANCE

- .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 filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.
- .2 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 00 - Closeout Submittals.
- .3 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 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

Not applicable

PART 3 - EXECUTION

3.1 PAINTING REPAIRS AND RESTORATION

- .1 Apply at least one coat of corrosion resistant primer and fished enameled coat to site fabricated steel supports and uninsulated steel piping.
 - .2 Prime and touch up marred finished paintwork to match original.
 - .3 Restore to new condition, finishes which have been damaged.
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3.2 CLEANING

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

3.3 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

3.4 DEMONSTRATION

- .1 Departmental Representative will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .3 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- .4 Instruction duration time requirements: In accordance with allowances in Section 01 79 00 Demonstration and Training. Specialized instruction time for particular equipment as noted in equipment sections.
- .5 Departmental Representative will record these demonstrations on video tape for future reference.

3.5 PROTECTION

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

PART 1 – GENERAL

1.1 RELATED SECTIONS

- .1 Section 01 74 11 - Cleaning.
- .2 Section 01 74 21 - Construction/Demolition Waste Management and Construction.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA) International
 - .1 CSA B149.1-10 Natural Gas and Propane Installation Code Handbook.

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.

PART 2 – PRODUCTS

Not applicable

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, as well as applicable local codes and standards.
 - .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.
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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: NPS 3/4 ball valves unless indicated otherwise, with hose end male thread, cap and chain.

3.4 AIR VENTS

- .1 Install manual air vents at high points in piping systems.
- .2 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 NPS 2 and under: isolating unions or bronze valves.
- .4 Over NPS 2: 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 not be used
 - .6 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
 - .7 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
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- .8 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .9 Group piping wherever possible and as indicated.
- .10 Ream pipes, remove scale and other foreign material before assembly.
- .11 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .12 Provide for thermal expansion as indicated.
- .13 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 butterfly 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 Use chain operators on gate and globe valves NPS 2-1/2 and larger where installed more than 2400 mm above floor in Mechanical Rooms.
- .14 Check Valves:
 - .1 Install swing check valves in horizontal lines on discharge of pumps and elsewhere as indicated.

3.7 SLEEVES

- .1 General: Install where pipes pass through masonry, concrete structures, fire rated assemblies (except drywall 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.

- .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 FLUSHING OUT OF PIPING SYSTEMS

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

3.9 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

- .1 Advise Departmental Representative 48 hours minimum prior to performance of pressure tests.
- .2 Pework: Test as specified in relevant sections of Division 22 and 23. Where specific pressure testing criteria does not exist, pressure test piping to the greater of 860 kPa or 1-1/2 times the maximum system operating pressure.
- .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.

PART 1 - GENERAL

1.1 RELATED SECTIONS

- .1 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Section 23 34 00 – HVAC Fans.

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 90.1-2013, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).
- .2 Electrical Equipment Manufacturers' Association Council (EEMAC)
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .3 Quality Control: in accordance with Section 01 45 00 - Quality Control.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.
 - .4 Closeout Submittals
 - .1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
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1.4 QUALITY ASSURANCE

- .1 Regulatory Requirements: work to be performed in compliance with CEPA, CEAA, TDGA, and applicable Provincial regulations.

PART 2 - PRODUCTS

2.1 GENERAL

- .1 Motors: high efficiency, in accordance with local power company standards and to ASHRAE 90.1-13.

2.2 MOTORS

- .1 Provide motors for mechanical equipment as specified.
- .2 Motors under 373 W: speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.
- .3 Motors 373 W and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40 degrees C, 3 phase, 600 V, unless otherwise indicated.
- .4 Provide inverter duty motors for variable speed applications.

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 stainless steel sheaves secured to shafts with removable keys unless otherwise indicated.
 - .3 For motors under 7.5 kW: standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.
 - .4 Correct size of sheave determined during TAB.
 - .5 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
 - .6 Motor slide rail adjustment plates to allow for centre line adjustment.
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- .7 Supply one set of spare belts for each set installed in accordance with Section 01 78 00 - Closeout Submittals.

2.5 DRIVE GUARDS

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

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

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

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in Section 01 33 00 - Submittal Procedures.

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.

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 53.01 - Mechanical Identification.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME).
 - .1 ASME B40.100-2013, Pressure Gauges and Gauge Attachments.
 - .2 ASME B40.200-2008, Thermometers, Direct Reading and Remote Reading.
- .2 Canadian General Standards Board (CGSB).
 - .1 CAN/CGSB-14.4-M88, Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.
 - .2 CAN/CGSB-14.5-M88, Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit shop drawings and product data.
- .3 Submit manufacturer's product data for following items:
 - .1 Thermometers.
 - .2 Pressure gauges.
 - .3 Stop cocks.
 - .4 Wells.

1.4 HEALTH AND SAFETY

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

PART 2 - PRODUCTS

2.1 GENERAL

- .1 Design point to be at mid point of scale or range.
 - .2 Ranges: as indicated.
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2.2 PRESSURE GAUGES

- .1 112 mm, dial type: to ASME B40.100-2005, Grade 2A, stainless steel bourdon tube having 0.5% accuracy full scale unless otherwise specified.
 - .1 Provide:
 - .1 Snubber for pulsating operation.
 - .2 PVC Pressure gauge isolators complete with teflon diaphragm and SS fasteners. Diaphragm assembly for corrosive/saltwater service.
 - .2 Gasketed pressure relief back with solid front.
 - .3 Bronze stop cock for fresh water, PVC ball valve for saltwater between isolator and salt water pipe.
 - .4 Glycerine filled.

PART 3 - EXECUTION

3.1 GENERAL

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

3.2 PRESSURE GAUGES

- .1 Install in following locations:
 - .1 Upstream and downstream of control valves.
 - .2 Suction and discharge of pumps
 - .3 In other locations as indicated.
- .2 Install gauge cocks for balancing purposes, elsewhere as indicated.
- .3 Use extensions where pressure gauges are installed through insulation.

3.3 NAMEPLATES

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

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 35 29 - Health and Safety Requirements.
- .4 Section 01 78 00 - Closeout Submittals.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME).
 - .1 ANSI/ASME B1.20.1-2013, Pipe Threads, General Purpose (Inch).
 - .2 ANSI/ASME B16.18-2012, Cast Copper Alloy Solder Joint Pressure Fittings.
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A 276-16, Specification for Stainless Steel Bars and Shapes.
 - .2 ASTM B 62-15, Specification for Composition Bronze or Ounce Metal Castings.
 - .3 ASTM B 283-14a, Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
 - .4 ASTM B 505/B505M-14, Specification for Copper-Base Alloy Continuous Castings.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
 - .1 MSS-SP-25-2013, Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 MSS-SP-80-2013, Bronze Gate Globe, Angle and Check Valves.
 - .3 MSS-SP-110-2010, 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:
 - .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.
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- .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 MAINTENANCE

- .1 Extra Materials:
- .2 Furnish following spare parts:
 - .1 Valve seats: one for every 10 valves each size, minimum 1.
 - .2 Discs: one for every 10 valves, each size. Minimum 1.
- .3 Stem packing: one for every 10 valves, each size. Minimum 1.
- .4 Valve handles: 2 of each size.
- .5 Gaskets for flanges: one for every 10 flanged joints.

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 B16.18-2001(R2005).
 - .3 Lockshield Keys:
 - .1 Where lockshield valves are specified, provide 10 keys of each size: malleable iron cadmium plated.
- .3 Gate Valves:
 - .1 Requirements common to gate valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: union with hexagonal shoulders.
 - .1 Connections: screwed with hexagonal shoulders.

- .2 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - .3 Packing: non-asbestos.
 - .4 Handwheel: non-ferrous.
 - .5 Handwheel Nut: bronze to ASTM B 62-09.
 - .2 NPS 2 and under, non-rising stem, solid wedge disc, Class 125
 - .1 Body: with long disc guides, union or screwed bonnet with stem retaining nut.
 - .2 Disc: solid wedge, bronze to ASTM B283, loosely secured to stem.
 - .3 Operator: Handwheel.
 - .3 NPS 2 and under, rising stem, split wedge disc, Class 125:
 - .1 Body: with long disc guides, union or screwed bonnet.
 - .2 Disc: split wedge, bronze to ASTM B 283, loosely secured to stem.
 - .3 Operator: Handwheel.
 - .4 NPS 2 and under, rising stem, solid wedge disc, Class 125:
 - .1 Body: with long disc guides, union or screwed bonnet.
 - .2 Disc: solid wedge, bronze to ASTM B283, loosely secured to stem.
 - .3 Operator: Handwheel.
- .4 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 B 62-09.
 - .2 NPS 2 and under, composition disc, Class 125:
 - .1 Body and bonnet: union or screwed bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc, regrindable bronze seat, loosely secured to bronze stem to ASTM B 505M-09.
 - .3 Operator: Handwheel.
 - .3 NPS 2 and under, plug disc, Class 150, screwed ends:
 - .1 Body and bonnet: union or screwed bonnet.
 - .2 Disc and seat ring: tapered plug type with disc stem ring of AISI S420 stainless steel to ASTM A 276-08a, loosely secured to stem.
 - .3 Operator: Handwheel.

- .5 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, Class 150:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
- .7 Ball Valves:
 - .1 NPS 2 and under:
 - .1 Body and cap: cast high tensile bronze to ASTM B 62.
 - .2 Pressure rating: Class 125.
 - .3 Connections: Screwed ends to ANSI B1.20.1 with hexagonal shoulders, or solder ends to ANSI as specified in relevant sections of Division 22 and 23.
 - .4 Stem: tamperproof ball drive.
 - .5 Stem packing nut: external to body.
 - .6 Ball and seat: replaceable 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.

PART 1 - GENERAL

1.1 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME).
 - .1 ANSI/ASME B16.1-2015, Cast Iron Pipe Flanges and Flanged Fittings.
- .2 American Society for Testing and Materials International (ASTM).
 - .1 ASTM A 49-12, Specification for Heat-Treated Carbon Steel Joint Bars.
 - .2 ASTM A 126-04(2014), Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - .3 ASTM B 61-15, Specification for Steam or Valve Bronze Castings.
 - .4 ASTM B 62-15, Specification for Composition Bronze or Ounce Metal Castings.
 - .5 ASTM B85/B85M-14, Specification for Aluminum-Alloy Die Castings.
 - .6 ASTM B 209-14, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
 - .1 MSS SP-70-2011, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .2 MSS SP-71-2011, Grey Iron Swing Check Valves, Flanged and Threaded Ends.
- .4 MSS SP-85-2011, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.2 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Closeout Submittals:
 - .1 Submit maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.3 MAINTENANCE

- .1 Extra Materials:
- .2 Furnish following spare parts:
 - .1 Valve seats: one for every 10 valves each size, minimum 1.
 - .2 Discs: one for every 10 valves, each size. Minimum 1.
- .3 Stem packing: one for every 10 valves, each size. Minimum 1.

- .4 Valve handles: 2 of each size.
- .5 Gaskets for flanges: one for every 10 flanged joints.

PART 2 - PRODUCTS

2.1 MATERIAL

- .1 Valves:
 - .1 Except for speciality 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 B 209 Class B.
 - .2 Connections: flanged ends, plain face, to ANSI B16.1.
 - .3 Inspection and pressure testing: to MSS SP-82.
 - .4 Bonnet gasket: non-asbestos.
 - .5 Stem: to have precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut.
 - .6 Stuffing box: non-galling two-piece ball-jointed packing gland, gland bolts and nuts.
 - .7 Gland packing: non-asbestos.
 - .8 Handwheel: Die-cast aluminum alloy to ASTM B 85 or malleable iron to ASTM A 49. Nut of bronze to ASTM B 62.
 - .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, outside screw and yoke (OS&Y), bronze trim, solid wedge disc:
 - .1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, yoke, yoke hub, yoke sleeve and nut. Class 125.
 - .2 Disc: solid offset taper wedge, bronze to ASTM B 62 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.
 - .6 Seat rings: integral with body.
 - .7 Stem: nickel-plated steel.

- .8 Pressure-lubricated operating mechanism.
- .9 Operator: Handwheel.

2.3 GLOBE VALVES

- .1 NPS 2 1/2 - 10, OS&Y:
 - .1 Body: with multiple-bolted bonnet.
 - .2 WP: 1.4 MPa CWP.
 - .3 Bonnet-yoke gasket: non-asbestos.
 - .4 Disc: bronze to ASTM B 62, 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 B 62.
 - .7 Operator: Handwheel.

2.4 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.

2.5 CHECK VALVE

- .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 A 126 Class B.
 - .2 Ratings:
 - .1 NPS 2 1/2 - 12: 1.4 MPa CWP.
 - .3 Disc: rotating for extended life.
 - .1 Up to NPS 6: bronze to ASTM B 62.
 - .4 Seat rings: renewable bronze to ASTM B 62 screwed into body.
 - .5 Hinge pin, bushings: renewable bronze to ASTM B 62.
 - .6 Disc: ASTM 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.

PART 3 - EXECUTION

3.1 INSTALLATION

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

PART 1 – GENERAL

1.1 SUMMARY

- .1 Related Sections:
 - .1 Section 01 33 00 - Submittal Procedures.
 - .2 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
 - .4 Section 01 35 29- Health and Safety Requirements.
 - .5 Section 01 78 00 - Closeout Submittals.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME).
 - .1 ANSI/ASME B1.20.1-2013, Pipe Threads, General Purpose (Inch).
 - .2 ANSI/ASME B16.1-2015, Cast Iron Pipe Flanges and Flanged Fittings.
 - .3 ANSI/ASME B16.5-2013, Pipe Flanges and Flanged Fittings.
 - .4 ANSI/ASME B16.11-2011, Forged Fittings, Socket-Welding and Threaded.
 - .5 ANSI/ASME B16.25-2012, Buttwelding Ends.
 - .6 ANSI/ASME B16.34-2013, Valves - Flanged, Threaded and Welding Ends.
- .2 American National Standards Institute (ANSI)/American Petroleum Institute (API).
 - .1 ANSI/API 609-2009, Lug- and Water-Type Butterfly Valves.
- .3 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A 126-04(2014), Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - .2 ASTM B 62-15, Specification for Composition Bronze or Ounce Metal Castings.
 - .3 ASTM B 209M-14, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .4 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
 - .1 MSS SP-67-2011, Butterfly Valves.

1.3 SUBMITTALS

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

- .3 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .4 Submit data for valves specified this section.
- .5 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 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management And Disposal

PART 2 - PRODUCTS

2.1 BUTTERFLY VALVES - RESILIENT SEAT - 200 PSIG

- .1 Except for 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 psig (1380 kPa).
 - .6 Minimum seat temperature ratings to 135 degrees C.
 - .7 Application: on-off operation.
 - .8 Full lug body (threaded).
 - .9 Operators:
 - .1 Gear operator baked epoxy coated waterproof housing, PVC cover and handwheel shaft and O-ring seal. 316 SS fasteners, sealed visual position indicator. Open closed travel stops to adjust for seat wear.
 - .2 Handwheel with position indicator and lockable position on valves indicated as balancing.
 - .10 Designed to comply with MSS SP-67 and API 609.
-

- .11 Compatible with ANSI Class 125/Class 150 flanges

PART 3 - EXECUTION

3.1 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 to pipe wall thickness, taper bore adjacent piping to remove interference.

PART 1 – GENERAL

1.1 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 21 - Demolition/Construction Waste Management and Disposal.
- .3 Section 01 35 29 - Health and Safety Requirements.
- .4 Section 01 78 00 - Closeout Submittals.
- .5 Section 22 13 19 - Non-Potable Water Piping.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME).
 - .1 ANSI/ASME B1.20.1-2013, Pipe Threads, General Purpose (Inch).
 - .2 ANSI/ASME B16.1-2015, Cast Iron Pipe Flanges and Flanged Fittings.
 - .3 ANSI/ASME B16.5-2013, Pipe Flanges and Flanged Fittings.
 - .4 ANSI/ASME B16.11-2011, Forged Fittings, Socket-Welding and Threaded.
 - .5 ANSI/ASME B16.25-2012, Buttwelding Ends.
 - .6 ANSI/ASME B16.34-2013, 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 A 126-04(R2014), Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - .2 ASTM B 62-15, Specification for Composition Bronze or Ounce Metal Castings.
 - .3 ASTM B 209M-14, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - .4 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
 - .1 MSS SP-67-2011, Butterfly Valves.
-

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
 - .3 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:
 - .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2 – PRODUCTS

2.1 BUTTERFLY VALVES - RESILIENT SEAT - 200 PSIG

- .1 Except for specialty valves, to be of single manufacturer.
- .2 To be suitable for dead-end service.
- .3 Sizes: Wafer type: NPS 2 to 30.
- .4 Pressure rating for tight shut-off at temperatures up to maximum for seat material.
 - .1 NPS 2 - 12: 1380 kPa
- .5 Application: on-off operation.
- .6 Full lug body (threaded).
- .7 Operators:
 - .1 Gear operator, FRP body, 316 SS handwheel shaft. 316 SS fasteners, sealed visual position indicator. Open closed travel stops to adjust for seat wear.

- .2 Handwheel with position indicator and lockable position on valves indicated as balancing.
- .8 Designed to comply with MSS SP-67.
- .9 Compatible with PVC ANSI Class 150 flanges.
- .10 Construction:
 - .1 Body PVC.
 - .2 Disc: Polypropylene.
 - .3 Seat: EPDM.
 - .4 Shaft: 316 stainless steel.
 - .5 Taper pin: 316 SS
 - .6 Key: stainless.
 - .7 O-Ring: EPDM.
 - .8 Bushings: Teflon.
 - .9 Stabilizing Ring: 316 Stainless steel

2.2 BALL VALVES

- .1 Connections: Full port union ends for connection to PVC piping.
- .2 Ball Valves:
 - .1 PVC body, handle and ball to ASTM D1784-06, Cell Classification 12454, rated for 1034 kPa normal operating pressure, stem with double blowout-proof o-rings.

PART 3 – EXECUTION

3.1 PREPARATION

- .1 Valve and mating flange preparation.
 - .1 Inspect adjacent pipeline, remove 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 to pipe wall thickness, taper bore adjacent piping to remove interference.

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.

1.2 REFERENCES

- .1 American National Standards Institute/ American Society of Mechanical Engineers (ANSI/ASME)
 - .1 ANSI/ASME B31.1-2014, Power Piping, (SI Edition).
- .2 American Society for Testing and Materials (ASTM)
 - .1 ASTM A125-96(2013)e1, Specification for Steel Springs, Helical, Heat-Treated.
 - .2 ASTM A 307-14, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .3 ASTM A 563-15, Specification for Carbon and Alloy Steel Nuts.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .4 Factory Mutual (FM)
- .5 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP-58-2009, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - .2 MSS SP-69-2003, Pipe Hangers and Supports - Selection and Application.
 - .3 MSS SP-89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .6 Underwriter's Laboratories of Canada (ULC)

1.3 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 SP-58.
-

- .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 all 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 to be in accordance with MSS SP-58.

1.4 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit shop drawings and product data for following items:
 - .1 Bases, hangers and supports.
 - .2 Connections to equipment and structure.
 - .3 Structural assemblies.

1.5 CLOSEOUT SUBMITTALS

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

PART 2 - PRODUCTS

2.1 GENERAL

- .1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS SP-58.
- .2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

2.2 PIPE HANGERS

- .1 Finishes:
 - .1 For all areas except lower level pumping unit: Pipe hangers and supports: galvanized after manufacture, using hot dipped galvanizing process. For pump pit: 316 SS for all items connected to piping within 1 m above pit floor.
 - .2 Ensure steel hangers in contact with copper piping are epoxy coated.
-

- .3 Supports and fasteners at the floor level of the salt-water pumps shall be 316 SS.
- .2 Upper attachment structural: Suspension from lower flange of I-Beam.
 - .1 Cold piping NPS 2 maximum: Malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
 - .1 Rod: 13 mm UL listed, FM approved.
 - .2 Cold piping NPS 2 1/2 or greater, all hot piping: Malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed to MSS SP-58 and MSS SP-69.
- .3 Upper attachment structural: Suspension from upper flange of I-Beam.
 - .1 Cold piping NPS 2 maximum: Ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed to MSS SP-69.
 - .2 Cold piping NPS 2 1/2 or greater, all hot piping: Malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed.
- .4 Shop and field-fabricated assemblies.
 - .1 Trapeze hanger assemblies.
 - .2 Steel bracket.
- .5 Hanger rods: threaded rod material to MSS SP-58.
 - .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 SP-58.
 - .1 Attachments for copper piping: copper plated steel.
 - .2 Use insulation shields for hot pipework.
 - .3 Oversize pipe hangers and supports.
- .7 Adjustable clevis: material to MSS SP-69 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 U-bolts: galvanized to MSS SP-69 with 2 nuts at each end to ASTM A 563.
 - .1 Finishes for copper, glass, brass or aluminum pipework: black, with formed portion epoxy coated.

2.3 RISER CLAMPS

- .1 Copper pipe: carbon steel copper plated to MSS SP-58, type 42.
-

.2 Bolts: to ASTM A307.

.3 Nuts: to ASTM A 563.

2.4 INSULATION PROTECTION SHIELDS

.1 Insulated cold piping:

.1 64 kg/m³ density insulation plus insulation protection shield to: MSS SP-69, 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 SP-69.

2.5 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

2.6 HOUSE-KEEPING PADS

.1 For base-mounted equipment: Concrete, at least 100 mm high, 100 mm larger all around than equipment, and with chamfered edges, 10M bar reinforcement mesh on 300mm centers .

.2 To CSA-A23.1-04/A23.2-04, Concrete Materials and Methods of Concrete Construction. Portland cement type GU, 20mm course aggregate, 25 MPa minimum compressive strength.

.3 Coordinate to have work performed by general contractor.

PART 3 - EXECUTION

3.1 INSTALLATION

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

.2 Vibration Control Devices and seismic restraint:

.1 Install on piping systems at pumps, boilers, elsewhere 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 be to industry standards.

- .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 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.

3.2 HANGER SPACING

- .1 Plumbing piping: most stringent requirements of Canadian Plumbing Code, Provincial Code and authority having jurisdiction.

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

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

Maximum Pipe Size: NPS	Maximum Spacing Steel	Maximum Spacing Copper
Up to 1-1/4	2.1 m	1.8 m
1-1/2	2.7 m	2.4 m
2	3.0 m	2.7 m
2-1/2	3.6 m	3.0 m
3	3.6 m	3.0 m
3-1/2	3.9 m	3.3 m
4	4.2 m	3.6 m
5	4.8 m	
6	5.1 m	
8	5.7 m	
10	6.6 m	
12	6.9 m	

- .4 Saltwater Piping: to Canadian Plumbing Code for PVC.

- .6 Pipework greater than NPS 12: to MSS SP-69.

3.3 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.

3.4 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.

3.5 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.

3.6 HOUSEKEEPING PADS

- .1 Roughen surface of underlying floor slab and dowel-in 10m bar reinforcement at 300mm on centers at perimeter of housekeeping pad.
- .2 Keep 40mm cover over bars

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.

1.2 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.
 - .2 CAN/CGSB-24.3-92, Identification of Piping Systems.

1.3 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

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

2.2 SYSTEM NAMEPLATES

- .1 Colours:
 - .1 Hazardous: red letters, white background.
-

- .2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).
- .2 Construction:
- .1 3 mm thick laminated plastic or white anodized aluminum, matte finish, with square corners, letters accurately aligned and machine engraved into core.
- .3 Sizes:
- .1 Conform to following table:
- | Size # mm | Sizes (mm) | No. of Lines | Height of Letters (mm) |
|-----------|------------|--------------|------------------------|
| 1 | 10 x 50 | 1 | 3 |
| 2 | 13 x 75 | 1 | 5 |
| 3 | 13 x 75 | 2 | 3 |
| 4 | 20 x 100 | 1 | 8 |
| 5 | 20 x 100 | 2 | 5 |
| 6 | 20 x 200 | 1 | 8 |
| 7 | 25 x 125 | 1 | 12 |
| 8 | 25 x 125 | 2 | 8 |
| 9 | 35 x 200 | 1 | 20 |
- .2 Use maximum of 25 letters/numbers per line.
- .4 Locations:
- .1 Terminal cabinets, control panels: use size # 5.
- .2 Equipment in Mechanical Rooms: use size # 9.

2.3 PIPING SYSTEMS GOVERNED BY CODES

- .1 Identification:
- .1 Propane gas: to CSA/CGA B149.1.
- .2 Sprinklers: to NFPA 13.

2.4 IDENTIFICATION OF PIPING SYSTEMS

- .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3-92 except where specified otherwise.
- .2 Pictograms:
- .1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.

- .3 Legend:
 - .1 Block capitals to sizes and colours listed in CAN/CGSB 24.3-92.
- .4 Arrows showing direction of flow:
 - .1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.
 - .2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.
 - .3 Use double-headed arrows where flow is reversible.
- .5 Extent of background colour marking:
 - .1 To full circumference of pipe or insulation.
 - .2 Length to accommodate pictogram, full length of legend and arrows.
- .6 Materials for background colour marking, legend, arrows:
 - .1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.
 - .2 Other pipes: pressure sensitive plastic-coated cloth vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.
- .7 Colours and Legends:
 - .1 Where not listed, obtain direction from Departmental Representative.
 - .2 Colours for legends, arrows: to following table:

Background colour: Legend, arrows:

Yellow	BLACK
Green	WHITE
Red	WHITE

- .3 Background colour marking and legends for piping systems:

Contents	Background colour marking	Legend
Domestic cold water supply	Green	DOM. CWS
Salt water	Green	SALT WATER
Chilled water supply	Green	CHWS
Chilled water return	Green	CHWR
Condenser water	Green	CW

2.5 IDENTIFICATION DUCTWORK SYSTEMS

- .1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.
- .2 Colours: black, or co-ordinated with base colour to ensure strong contrast.

2.6 VALVES, CONTROLLERS

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

2.7 CONTROLS COMPONENTS IDENTIFICATION

- .1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.
- .2 Inscriptions to include function and (where appropriate) fail-safe position.

2.8 LANGUAGE

- .1 Identification in English.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Perform work in accordance with CAN/CGSB-24.3-92 except as specified otherwise.
 - .2 Provide ULC and/or CSA registration plates as required by respective agency.
-

3.3 NAMEPLATES

- .1 Locations:
 - .1 In conspicuous location to facilitate easy reading and identification from operating floor.
- .2 Standoffs:
 - .1 Provide for nameplates on hot and/or insulated surfaces.
- .3 Protection:
 - .1 Do not paint, insulate or cover.

3.4 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

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

3.5 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.

3.6 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.

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 other work as specified in this section.

1.2 PURPOSE OF TAB

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

1.3 EXCEPTIONS

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

1.4 CO-ORDINATION

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

1.5 PRE-TAB REVIEW

- .1 Review contract documents before project construction is started and confirm in writing to Departmental Representative adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.
 - .2 Review specified standards and report to Departmental Representative in writing all proposed procedures which vary from standard.
-

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

1.6 START-UP

- .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
- .2 Follow special start-up procedures specified elsewhere in Divisions 22 and 23.

1.7 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.

1.8 START OF TAB

- .1 Notify Departmental Representative 7 days prior to start of TAB.
- .2 Start TAB when building is essentially completed, including:
 - .1 Installation of ceilings, doors, windows, other construction affecting TAB.
 - .2 Application of weatherstripping, sealing, caulking.
 - .3 All pressure, leakage, other tests specified elsewhere Divisions 22 and 23.
 - .4 All provisions for TAB installed and operational.
 - .5 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
 - .1 Proper thermal overload protection in place for electrical equipment.
 - .2 Air systems:
 - .1 Filters in place, clean.
 - .2 Duct systems clean.
 - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
 - .4 Correct fan rotation.
 - .5 Fire, smoke, volume control dampers installed and open.
 - .6 Coil fins combed, clean.
 - .7 Access doors, installed, closed.
 - .8 Outlets installed, volume control dampers open.
 - .3 Liquid systems:
 - .1 Flushed, filled, vented.
 - .2 Correct pump rotation.
 - .3 Strainers in place, baskets clean.
 - .4 Isolating and balancing valves installed, open.
 - .5 Calibrated balancing valves installed, at factory settings.
 - .6 Chemical treatment systems complete, operational.

1.9 APPLICATION TOLERANCES

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

1.10 ACCURACY TOLERANCES

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

1.11 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.

1.12 SUBMITTALS

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

1.13 PRELIMINARY TAB REPORT

- .1 Submit for checking and approval of Departmental Representative, prior to submission of formal TAB report, sample of rough TAB sheets. Include:
 - .1 Details of instruments used.
 - .2 Details of TAB procedures employed.
 - .3 Calculations procedures.
 - .4 Summaries.

1.14 TAB REPORT

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

1.15 VERIFICATION

- .1 Reported results subject to verification by Departmental Representative.
- .2 Provide manpower and instrumentation to verify up to 30 % of 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.

1.16 SETTINGS

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

1.17 COMPLETION OF TAB

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

1.18 AIR SYSTEMS

- .1 Standard: TAB to be to most stringent of this section or TAB standards of AABC, NEBB, SMACNA and ASHRAE.
 - .2 Do TAB of systems, equipment, components, controls specified in Divisions 22 and 23.
 - .3 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
 - .4 Locations of equipment measurements: To include, but not be limited to, following as appropriate:
 - .1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.
 - .2 At controllers, controlled device.
-

- .5 Locations of systems measurements to include, but not be limited to, following as appropriate: Main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

1.19 OTHER SYSTEMS

- .1 Plumbing systems:
 - .1 TAB procedures:
 - .1 Flush valves: adjust to suit project pressure conditions.

1.20 POST OCCUPANCY TAB

- .1 Measure DBT, WBT, air velocity, air flow patterns, in occupied areas as designated.
- .2 Participate in systems checks twice during warranty period - #1 approximately 3 months after acceptance and #2 within 1 month of termination of warranty period.

PART 2 – PRODUCTS

Not applicable.

PART 3 – EXECUTION

Not applicable.

PART 1 - GENERAL

1.1 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ASHRAE Standard 90.1-2013, 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 C 335-10e1, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .2 ASTM C 411-11, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .3 ASTM C 449/C449M-07(2013), Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .4 ASTM C 547-15, Mineral Fiber Pipe Insulation.
 - .5 ASTM C 921-10(2015), Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
 - .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .2 CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts.
 - .4 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
 - .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
 - .6 Manufacturer's Trade Associations
 - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).
 - .7 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-10, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701-11, Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - .3 CAN/ULC-S702-2014, Thermal Insulation, Mineral Fibre, for Buildings.
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- .4 CAN/ULC-S702.2-15, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

1.2 DEFINITIONS

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

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

- .1 Installer: specialist in performing work of this Section, and qualified to standards of TIAC.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
 - .2 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/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 FIRE AND SMOKE RATING

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

2.2 INSULATION

- .1 Mineral fibre specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C 335.
- .3 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC-S702.
- .4 TIAC Code C-2: mineral fibre blanket faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
 - .1 Mineral fibre: to CAN/ULC-S702.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC-S702.
- .5 TIAC Code A-6: flexible unicellular tubular elastomer.
 - .1 Insulation: with vapour retarder jacket.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Certified by manufacturer: free of potential stress corrosion cracking corrodants.

2.3 INSULATION SECUREMENT

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

2.4 CEMENT

- .1 Thermal insulating and finishing cement:
 - .1 Hydraulic setting or Air drying on mineral wool, to ASTM C 449/C449M.

2.5 VAPOUR RETARDER LAP ADHESIVE

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

2.6 INDOOR VAPOUR RETARDER FINISH

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

2.7 JACKETS

- .1 Polyvinyl Chloride (PVC):
 - .1 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.
 - .2 Minimum service temperatures: -20 degrees C.
 - .3 Maximum service temperature: 65 degrees C.
 - .4 Moisture vapour transmission: 0.02 perm.
 - .5 Thickness: 0.5 mm.
 - .6 Fastenings:
 - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.
 - .3 Pressure sensitive vinyl tape of matching colour.
 - .7 Special requirements:
 - .1 Outdoor: UV rated material at least 0.5 mm thick.

2.8 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

- .1 Same insulation thickness and vapour barrier as adjoining piping systems.
-

- .2 Woven fabric jacket with reusable tie-wire securement.
- .3 Designed to permit periodic removal and re-installation without requiring repair to adjacent insulated surfaces.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PRE-INSTALLATION REQUIREMENT

- .1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.
- .2 Surfaces clean, dry, free from foreign material.

3.3 INSTALLATION

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturers' instructions and this specification.
- .3 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Install hangers, supports outside vapour retarder jacket.
- .5 Supports, Hangers:
 - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

- .1 Application: at expansion joints, valves, primary flow measuring elements flanges and unions at equipment.
-

3.5 INSTALLATION OF ELASTOMERIC INSULATION

- .1 Insulation to remain dry. Overlaps to manufacturers instructions. Ensure tight joints.
- .2 Provide vapour retarder as recommended by manufacturer.

3.6 PIPING INSULATION SCHEDULES

- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 TIAC Code: A-3.
 - .1 Securements: SS wire bands, Tape at 300 mm on centre.
 - .2 Seals: VR lap seal adhesive, VR lagging adhesive. Installation: TIAC Code: 1501-C.

Appli- cation	Temp degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness mm)					
			Run Out	to 1	1 ¼ to 2	2 ½ to 4	5 to 6	8 & over
Chilled water supply and return		A-6	25	25	25	38	38	38
Condenser water supply and return		A-6	25	25	25	25	25	25
Above ground storm, non-potable salt water		A-6	25	25	25	25	25	25

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

3.7 CLEANING

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

PART 1 - GENERAL

1.1 RELATED SECTIONS

- .1 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Section 22 42 01 - Plumbing Specialties and Accessories.
- .3 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

1.2 POTABLE AND SALT WATER

- .1 Coordinate with requirements of Commissioning Plan, Domestic Water System Verification of Operation Form.
- .2 When cleaning is completed and system filled:
 - .1 Verify performance of equipment and systems as specified elsewhere in Division 22.
 - .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 as a result of flushing and/or cleaning.
 - .4 Bleed off measured flow rate of water from pressure tank. Measure cumulative length of time that booster pumps operate to recover pressure.

1.3 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS

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

1.4 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 Heat Exchanger.
 - .3 Pressure bypass open/closed.

- .4 Control pressure failure.
- .5 Maximum cooling demand.
- .6 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.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

PART 1 – GENERAL

1.1 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E 202-10, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.2 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Instructions: submit manufacturer's installation instructions.

PART 2 – PRODUCTS

2.1 CLEANING SOLUTIONS

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

PART 3 – EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 CLEANING HYDRONIC SYSTEMS

- .1 Timing: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.
- .2 Cleaning Agency:
 - .1 Retain qualified water treatment specialist to perform system cleaning.
- .3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.
- .4 Cleaning procedures:
 - .1 Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:
 - .1 Cleaning procedures, flow rates, elapsed time.
 - .2 Chemicals and concentrations used.
 - .3 Inhibitors and concentrations.
 - .4 Specific requirements for completion of work.
 - .5 Special precautions for protecting piping system materials and components.
 - .6 Complete analysis of water used to ensure water will not damage systems or equipment.
- .5 Conditions at time of cleaning of systems:
 - .1 Systems: free from construction debris, dirt and other foreign material.
 - .2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.
 - .3 Strainers: clean prior to initial fill.
 - .4 Install temporary filters on pumps not equipped with permanent filters.
 - .5 Install pressure gauges on strainers to detect plugging.
- .6 Report on Completion of Cleaning:
 - .1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier. The report is to show that the cleaner is no longer in the piping system and it is acceptable to add the inhibitor.
- .7 Hydronic Systems:
 - .1 Fill system with water, ensure air is vented from system.
 - .2 Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (does not apply to diaphragm type expansion tanks).
 - .3 Use water metre to record volume of water in system to +/- 0.5%.
 - .4 Add chemicals under direct supervision of chemical treatment supplier.
 - .5 Closed loop systems: circulate system cleaner at 60 degrees C for at least 36 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 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 degrees C minimum. Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38 degrees C. Drain as quickly as possible. Refill with clean water. Circulate for 6 h at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water testing for residual cleaner. The cleaner is to be clear from the system before the inhibitor is to be added.

3.3 START-UP OF HYDRONIC SYSTEMS

- .1 After cleaning is completed and system is filled:
 - .1 Establish circulation and expansion tank level, set pressure controls.
 - .2 Ensure air is removed.
 - .3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.
 - .4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.
 - .5 Clean out strainers repeatedly until system is clean.
 - .6 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.
 - .7 Repeat with water at design temperature.
 - .8 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.
 - .9 Bring system up to design temperature and pressure slowly over a 48 hour period.
 - .10 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .11 Adjust pipe supports, hangers, springs as necessary.
 - .12 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
 - .13 If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.
 - .14 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.
 - .15 Check operation of drain valves.
 - .16 Adjust valve stem packings as systems settle down.
 - .17 Fully open balancing valves (except those that are factory-set).
 - .18 Check operation of over-temperature protection devices on circulating pumps.

- .19 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

3.4 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.

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 35 29 - Health and Safety Requirements.
- .4 Section 01 78 00 - Closeout Submittals.
- .5 Section 23 05 00 - Common Work Results – For HVAC.
- .6 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
- .7 Section 23 05 05 - Installation of Pipework.
- .8 Section 23 05 23.01 - Valves - Bronze.
- .9 Section 23 05 23.02 - Valves - Cast Iron.
- .10 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME).
 - .1 ASME B16.1-2015, Cast Iron Pipe Flanges and Flanged Fittings.
 - .2 ASME B16.3-2011, Malleable Iron Threaded Fittings.
 - .3 ASME B16.5-2013, Pipe Flanges and Flanged Fittings.
 - .4 ASME B16.9-2012, Factory-Made Wrought Butt welding Fittings.
 - .5 ASME B18.2.1-2012, Square and Hex Bolts and Screws (Inch Series).
 - .6 ASME B18.2.2-2015, Square and Hex Nuts (Inch Series).
 - .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A 47/A47M-99(20014), Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A 53/A53M-12, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
 - .3 ASTM A 536-84(2014), Standard Specification for Ductile Iron Castings.
 - .4 ASTM B 61-15, Standard Specification for Steam or Valve Bronze Castings.
 - .5 ASTM B 62-15, Standard Specification for Composition Bronze or Ounce Metal Castings.
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- .6 ASTM E 202-12, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.
- .3 American Water Works Association (AWWA).
 - .1 AWWA C111-12, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .4 Canadian Standards Association (CSA International).
 - .1 CSA B242-05(R2011), Groove and Shoulder Type Mechanical Pipe Couplings.
 - .2 CAN/CSA W48-14, 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-67-2011, Butterfly Valves.
 - .2 MSS-SP-70-2011, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS-SP-71-2011, Cast Iron Swing Check Valves Flanged and Threaded Ends.
 - .4 MSS-SP-80-2013, Bronze Gate, Globe, Angle and Check Valves.
 - .5 MSS-SP-85-2011, 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 and include following:
 - .1 Special servicing requirements.

1.4 QUALITY ASSURANCE

- .1 Health and Safety.
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.
- .2 Hydronic piping to be TSSA inspected and approved.

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 - Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 PIPE

- .1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:
 - .1 NPS 3/4 to NPS 14: Schedule 40.
 - .2 NPS 1/2 and under: Schedule 80.

2.2 PIPE JOINTS

- .1 NPS 2 and under: screwed fittings with PTFE tape.
- .2 NPS 2 1/2 and over: Rolled Grooved.
 - .1 Couplings to CSA B242.
 - .2 Coupling to be Rigid type, housing shall be cast with offsetting angle pattern bolt pads and system support and hanging in accordance with ANSI B31.1.
- .3 Flanges: plain face, slip-on to AWWA C111, roll grooved adaptors or welded.
- .4 Orifice flanges: slip-on raised face, 2100 kPa.
- .5 Flange gaskets: to AWWA C111.
- .6 Pipe thread: taper.
- .7 Bolts and nuts: to ASME B18.2.1 and ASME B18.2.2.
- .8 Roll grooved coupling gaskets: EPDM.

2.3 FITTINGS

- .1 Screwed fittings: malleable iron, to ASTM A47/A47M, and to ASME B16.3, Class 150.
 - .2 Pipe flanges and flanged fittings:
 - .1 Steel: to ASTM A105/105M, and to ASME B16.5, Class 150
 - .3 Butt-welding fittings: steel, to ASTM A234/A234M, WPB and to ASME B16.9.
 - .4 Unions: malleable iron, to ASTM A 47/A47M and ASME B16.3.
 - .5 Couplings and fittings for roll grooved piping: ductile iron to ASTM A536.
Couplings to be rigid or flexible as recommended by Manufacturer, to allow for some thermal expansion and flexible connections to equipment, while maintaining rigidity of piping system.
-

2.4 VALVES

- .1 Connections:
 - .1 NPS2 and smaller: screwed ends.
 - .2 Gate valves: to MSS-SP-80 Application: Isolating equipment, control valves, pipelines:
 - .1 NPS2 and under:
 - .1 Class 125, rising stem, solid or split wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS 2 1/2 and over:
 - .1 Class 125, rising stem, solid wedge disc, as specified Section 23 05 23.02 - Valves - Cast Iron.
 - .3 Butterfly valves: to MSS-SP-67 Application: Isolating equipment, control valves in accordance with Section 23 05 23.05 - Butterfly Valves.
 - .1 Connections: grooved ends, compatible with roll grooved pipe couplings, Class 200.
 - .4 Globe valves: to MSS-SP- 80 85 Application: Throttling, flow control, emergency bypass:
 - .1 NPS2 and under:
 - .1 With PTFE disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS 2 1/2 and up:
 - .1 With bronze disc, as specified Section 23 05 23.02 - Valves - Cast Iron.
 - .5 Balancing, for TAB:
 - .1 Y-pattern globe style with 4 full turns handwheel, hidden memory feature and drain connection with protective cap. Suitable for bubble tight shut off.
 - .2 Threaded pressure taps with protective cover, integral check valve.
 - .3 Preformed polyurethane shipping container to be used as insulation cover once installed.
 - .4 NPS 1/2 to2: bronze body, screwed ends.
 - .5 NPS 2 1/2 and up: cast iron body, roll grooved ends.
 - .6 Drain valves: Gate, Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze
 - .7 Swing check valves: to MSS-SP-71.
 - .1 NPS 2 and under:
 - .1 Class 125, swing, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.
-

- .2 NPS 2 1/2 and over:
 - .1 Flanged ends bronze disc, as specified in Section 23 05 23.02 - Valves - Cast Iron.
- .8 Ball valves:
 - .1 NPS 2 1/2 and under: as specified Section 23 05 23.01 - Valves - Bronze.

2.5 FLEXIBLE CONNECTION

- .1 Application: to suit motion as required.
- .2 Minimum length in accordance with manufacturer's recommendations to suit offset.
- .3 Inner hose: stainless steel, corrugated.
- .4 Braided wire mesh stainless steel outer jacket.
- .5 Diameter and type of end connection:
 - .1 NPS 2 and under: threaded,
 - .2 NPS 2-1/2 and above: flanged.
- .6 Operating conditions:
 - .1 Working pressure: 1034 kPa.
 - .2 Working temperature: 100 degrees C.
 - .3 To match system requirements.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- .1 Install pipework in accordance with Section 23 05 05 - Installation of Pipe Work.

3.2 CIRCUIT BALANCING VALVES

- .1 Install flow measuring stations and flow balancing valves on each branch (zone) circuit off main hydronic loop and as indicated.
- .2 Remove handwheel after installation and when TAB is complete.
- .3 Install performed polyurethane insulation covers on valves after systems have been balanced.

3.3 CLEANING, FLUSHING AND START-UP

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

3.4 TESTING

- .1 Test system in accordance with Section 23 05 05 - Installation of Pipework.
Pressure test piping to 860 kPa for minimum 4 hours without loss of pressure.

3.5 FILLING OF SYSTEM

- .1 Refill system with inhibited glycol solution as specified.

3.6 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.

3.7 PERFORMANCE VERIFICATION

- .1 In accordance with Section 23 08 01 - Performance Verification.

3.8 FLEXIBLE CONNECTORS

- .1 Install with stainless steel bolting and hardware.

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 The supply and installation of Hydronic Specialties Equipment.
- .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 08 01 - Performance Verification of Mechanical Piping Systems.

1.2 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 A 47/A 47M-99(2009), Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A 278M-01(2006), Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (345 degrees C).
 - .3 ASTM A 516/A 516M-10, Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.
 - .4 ASTM A 536-84(2009), Specification for Ductile Iron Castings.
 - .5 ASTM B 62-09, Specification for Composition Bronze or Ounce Metal Castings.
- .3 Canadian Standards Association (CSA International).
 - .1 CSA B51-09, Boiler, Pressure Vessel, and Pressure Piping Code.

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .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 and strainers.

- .3 Closeout Submittals:
 - .1 Submit maintenance data in accordance with 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:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Waste Management And Disposal.
 - .2 Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging material for recycling in accordance with Waste Management Plan.

PART 2 - PRODUCTS

2.1 AUTOMATIC AIR VENT

- .1 Standard automatic float vent: brass body and NPS 1/8 connection and rated at up to 690 kPa working pressure.
- .2 Float: solid material suitable for 115°C working temperature.

2.2 PIPE LINE STRAINER

- .1 NPS 1/2 to 2: bronze body to ASTM B 62-02, screwed connections, Y pattern.
 - .2 NPS 2 1/2 to 12: cast iron body to ASTM A126, roll grooved ends or flanged connections.
 - .3 Blowdown connection: NPS 1.
 - .4 Screen: stainless steel brass with 1.19 mm perforations.
 - .5 Working pressure: up to 860 kPa.
-

2.3 SUCTION DIFFUSER

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

2.4 LOW PRESSURE RELIEF VALVE

- .1 Bronze/brass housing, full nozzle and disc, spring loaded relief valve.
- .2 Capacity: matched to pump run-out setting. Relief settings as indicated on drawings.

PART 3 - EXECUTION

3.1 GENERAL

- .1 Install as indicated and to manufacturer's recommendations. Install floor mounted equipment on housekeeping pads.
 - .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 tapings 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 except at radiant heating zone valves and as indicated.

3.3 AUTOMATIC AIR VENTS

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

3.4 PRESSURE SAFETY RELIEF VALVES

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

3.5 SUCTION DIFFUSERS

- .1 Install on inlet to pumps having suction size greater than NPS 2 where suction piping changes direction immediately before pump suction. Install additional reducing spool pieces as required, as indicated in drawing details.

3.6 PERFORMANCE VERIFICATION

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

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 35 29- Health and Safety Requirements.
- .4 Section 01 78 00 - Closeout Submittals.
- .5 Section 01 91 00 - Commissioning.
- .6 Section 23 21 13.02 - Hydronic Systems: Steel.
- .7 Section 25 30 01 – Building Controllers.

1.2 REFERENCES

- .1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE).
 - .1 Standard 90.1-2013 Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 Canadian Standards Association (CSA International).
 - .1 CAN/CSA-B214-12, Installation Code for Hydronic Heating Systems.
- .3 National Electrical Manufacturers Association (NEMA).
 - .1 NEMA MG 1-2014, Motors and Generators.

1.3 SUBMITTALS

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures
 - .2 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.
 - .3 Submit product data of pump curves for review showing point of operation and including; hydraulic efficiency, NPSH, BHP.
-

- .4 Indicate piping, valves and fittings shipped loose by packaged equipment supplier, showing their final location in field assembly.
- .5 Detailed material of construction of pump components, seals, bearings, couplings, guards, motor supports, frame, finishes.
- .6 Electrical motor power factor, service factor, starting current, full load current, locked rotor current, NEMA ratings, efficiency
- .7 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 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 SINGLE END SUCTION CENTRIFUGAL PUMP

- .1 Base: mounted horizontally on a rigid, single piece baseplate, with guard.
 - .2 Volute: cast iron radically split, end suction, flanged suction and discharge, with drain plug and vent cock, such and discharge pressure gauge tapings.
 - .3 Impeller: cast bronze enclosed type, dynamically balanced, keyed drive with locking nut or screw.
 - .4 Shaft: alloy steel with bronze sleeve bearing with two point support, integral thrust collar.
 - .5 Seal assembly: mechanical seal for service to 135°C.
 - .6 Split coupled shaft to allow easy servicing of mechanical seal.
 - .7 Motor: EEMAC Class B, squirrel cage induction, drip proof, sleeve. Motor speeds and kW as indicated on schedule. Install inverter-duty motors for variable speed pumps.
 - .8 Capacity: as indicated.
-

- .9 Design Pressure: 1200 kPa.

2.3 SALTWATER SINGLE END SUCTION CENTRIFUGAL PUMP

- .1 Base: mounted horizontally on a rigid, single piece baseplate, with guard to be 316 stainless steel.
 - .2 Only Vendors with local service capabilities will be accepted.
 - .3 Volute: 316 stainless steel radically split, end suction, flanged suction and discharge, with drain plug and vent cock, suction and discharge pressure gauge tapings.
 - .4 Impeller: 316 stainless steel enclosed type, dynamically balanced, keyed drive with locking nut or screw.
 - .5 Shaft: 316 stainless steel with double row thrust bearing in bearing housing sealed to prevent contamination from corrosive atmosphere, leakage and washdown. Housing to have sight glass to monitor oil level in chamber.
 - .6 Seal assembly: silicon carbide rotating and stationary faces. Maximum operating temperature of 71°C, suitable for salt water.
 - .7 Split coupled shaft to allow easy servicing of mechanical seal.
 - .8 Provide stainless steel, type 316 anchor bolts for the pump support frame.
 - .9 Provide high efficiency, squirrel cage induction type motors, EEMAC B type with the following features:
 - .1 Designed for 575 volt, 3 phase, and operation by variable frequency speed drive. The motor shall be NEMA rated and meet the requirements of NEMA MG1 Part 31 specifications for inverter duty motor 1.15 service factor.
 - .2 Sized to operate over the entire pump operating range without overloading the motor.
 - .3 To operate continuously at full load with the winding temperature rise not to exceed 80°C above 40°C ambient temperature measured by resistance when carrying the rated load.
 - .4 Provide for a power factor at full load of 0.78 or better.
 - .5 Motor enclosure to be TEFC.
 - .6 Impregnate the insulation of the motor to prevent moisture absorption.
 - .7 Provide extra heavy duty anti-friction type motor bearings having a B-10 rating of 100,000 hours according to the requirements of the Anti-Friction Bearing Manufacturers Association. Oil lubricated bearings complete with bearing housing, oil reservoir and sight glass.
-

- .8 The motor shall have a starting torque and breakdown torque according to EEMAC requirements MG 1-12, and a locked rotor current not exceeding 5.5 times the full load current. Provide breakdown torque as required by EEMAC standard.
- .9 Do not exceed vibration levels outlined in EEMAC MG.1-12 requirements.
- .10 Provide lifting lugs on the motor.
- .11 Maximum 85 db noise level taken at 1.0 meter distance.
- .12 Provide nameplates for motor, including all pertinent Motor Data. Data to be in Metric Units.
- .13 The motor shall not exceed its nameplate rating including service factor at any point on the pump curve.
- .10 Capacity:
 - .1 Head: 21.9m.
 - .2 Flow: 75.7 L/s.
 - .3 NPSHA: 1.7m.
 - .4 Fluid Pumped: Seawater.
 - .5 Motor HP: 29.8kW.
 - .6 Motor RPM: 1100.
 - .7 Suction Size: 200.
 - .8 Nominal Impeller: 406.
 - .9 Discharge Size: 150.
 - .10 Hydraulic Efficiency at duty point: 74%.
 - .11 Shut-off Head: 24 m.
- .11 Acceptable Material:
 - .1 Rotech 1196 series supplied by Specified Solutions.
 - .2 FlowServe 3K8x6-14ARV M3 ST supplied by Sansom Equipment Limited.
 - .3 Sulzer NB 8x6 – 16 SO.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 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.
- .2 Pipe drain tapping to floor drain.
- .3 Install volute venting pet cock in accessible location.
- .4 Check rotation prior to start-up.

- .5 Install pressure gauge test cocks.
- .6 Install floor-mounted pumps on concrete housekeeping pads.

PART 1 - GENERAL

1.1 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with 01 33 00 – Submittal Procedures.
- .2 Indicate the following:
 - .1 General arrangement showing terminal points, instrumentation test connections.
 - .2 Clearances for operation, maintenance, servicing.
 - .3 Piping hook-ups.
 - .4 Equipment electrical drawings.
 - .5 All miscellaneous equipment.

1.2 CLOSEOUT SUBMITTALS

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

1.3 MAINTENANCE MATERIALS, SPECIAL TOOLS AND SPARE PARTS

- .1 Maintenance materials to include: special tools for Operation and Maintenance.

1.4 EXTRA MATERIALS

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

PART 2 - PRODUCTS

2.1 VACUUM PRIMING VALVE ASSEMBLY

- .1 The priming valve shall have 5/16" orifice, 1" NPT pipe inlet, 1/2" NPT pipe outlet and a plugged 1/2" NPT opening for level switch mechanism connection. The materials shall be cast iron body and cover, 316 SS level frame and float, Buna-N needle level switch with a single float mechanism with PVC or 316 SS piping and fittings, 316 SS stem, and Buna-N float.
 - .2 Controls: The switch shall be powered with 1/60/110 volt electrical supply, wired in such a way that the float is activated to shut down the vacuum pump before the priming valve orifice is sealed by its needle plug. The vacuum pump will keep on running until the time delay located in the control panel runs out.
-

- .3 Acceptable material:
 - .1 The only acceptable materials are as manufactured by Premier Fluid Systems Inc.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install in accordance with regulations of Province Territory having jurisdiction, except where specified otherwise, and manufacturers recommendations.
- .2 Make all required piping connections to all inlets and outlets recommended by manufacturer.
- .3 Maintain clearances as indicated or if not indicated, as recommended by manufacturer for operation, servicing and maintenance without disruption of operation of any other equipment/system.

3.2 COMMISSIONING

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

PART 1 - GENERAL

1.1 REFERENCES

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
- .2 ASTM International
 - .1 ASTM A 480/A 480M-12, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
 - .2 ASTM A 635/A 635M-15, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.
 - .3 ASTM A 653/A 653M-15, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3 National Fire Protection Association (NFPA)
 - .1 NFPA 90A-12, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B-12, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
 - .3 NFPA 96-11, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.
 - .2 SMACNA HVAC Air Duct Leakage Test Manual, 2012.
 - .3 IAQ Guideline for Occupied Buildings Under Construction 2007.
- .5 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
 - .1 SCAQMD Rule 1168-A2005, Adhesives and Sealants Applications.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for metal ducts 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, Canada.
- .4 Test and Evaluation Reports:
 - .1 Certification of Ratings:
 - .1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .5 Construction Waste Management:
 - .1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .6 Construction IAQ Management Plan:
 - .1 Submit Indoor Air Quality (IAQ) Plan for construction and pre-occupancy phases of building.
 - .2 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings Under Construction.

1.3 DELIVERY, STORAGE AND HANDLING

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

PART 2 - PRODUCTS

2.1 SEAL CLASSIFICATION

- .1 Classification as follows:

<u>Maximum Pressure Pa</u>	<u>SMACNA Seal Class</u>
500	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 tape or combination thereof.
 - .3 Class C: transverse joints and connections made air tight with gaskets sealant tape or combination thereof. Longitudinal seams unsealed.
 - .4 Unsealed seams and joints.

2.2 SEALANT

- .1 Sealant: oil resistant, water borne, 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, 50 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 double 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 Short radiused elbows as indicated.
- .7 Obstruction deflectors: maintain full cross-sectional area.
 - .1 Maximum included angles: as for transitions.

2.6 FIRE STOPPING

- .1 Retaining angles around duct, on both sides of fire separation.
- .2 Fire stopping material and installation must not distort duct.

2.7 ALUMINUM

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

2.8 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: black galvanized steel angle with black galvanized steel rods to ASHRAE and SMACNA following table:

<u>Duct Size</u> (mm)	<u>Angle Size</u> (mm)	<u>Rod Size</u> (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
<u>2401 and over</u>	<u>50 x 50 x 6</u>	<u>10</u>
- .4 Upper hanger attachments:
 - .1 For concrete: manufactured concrete inserts.
 - .2 For steel joist: manufactured joist clamp steel plate washer.
 - .3 For steel beams: manufactured beam clamps:

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 GENERAL

- .1 Do work in accordance with NFPA 90A NFPA 90B ASHRAE SMACNA as indicated.
- .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 ASHRAE 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.

3.3 HANGERS

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

<u>Duct Size</u>	<u>Spacing</u>
(mm)	(mm)
to 1500	3000
<u>1501 and over</u>	<u>2500</u>

3.4 WATERTIGHT DUCT

- .1 Provide watertight duct for:
 - .1 Fresh air intake
 - .2 As indicated.
- .2 Form bottom of horizontal duct without longitudinal seams.
 - .1 Solder Weld joints of bottom and side sheets.
 - .2 Seal other joints with duct sealer.
- .3 Fit base of riser with 150 mm deep drain sump and 32 mm drain connected, with deep seal trap and valve trap primer and discharging to open funnel drain as indicated.

3.5 SEALING AND TAPING

- .1 Apply sealant in accordance with SMACNA and to manufacturer's recommendations.
- .2 Bed tape in sealant and recoat with minimum of 1 coat of sealant to manufacturers recommendations.

3.6 LEAKAGE TESTS

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

3.7 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

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.

1.2 REFERENCES

- .1 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 2005.

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.

1.4 CERTIFICATION OF RATINGS

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

PART 2 - PRODUCTS

2.1 GENERAL

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

2.2 FLEXIBLE CONNECTIONS

- .1 Frame: 2 mm 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, density of 1.3 kg/m².
-

2.3 ACCESS DOORS IN DUCTS

- .1 Non-insulated ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.
- .2 Insulated ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.
- .3 Gaskets: neoprene or foam rubber.
- .4 Hardware:
 - .1 Up to 300 x 300 mm: two sash locks complete with safety chain.
 - .2 301 to 450 mm: four sash locks complete with safety chain.
 - .3 451 to 1000 mm: piano hinge and minimum two sash locks.
 - .4 Doors over 1000 mm: piano hinge and two handles operable from both sides.
 - .5 Hold open devices.
 - .6 300 x 300 mm glass viewing panels.

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: 100 mm.
 - .3 Minimum distance between metal parts when system in operation: 75 mm.
 - .4 Install in accordance with recommendations of SMACNA.
 - .5 When fan is running:
 - .1 Ducting on sides of flexible connection to be in alignment.
 - .2 Ensure slack material in flexible connection.
- .2 Access doors and viewing panels:
 - .1 Size:
 - .1 609x609 mm for person size entry.
 - .2 457x457 mm for servicing entry.
 - .3 300x300 mm for viewing.
 - .4 As indicated.

- .2 Locations:
 - .1 Fire and smoke dampers.
 - .2 Control dampers.
 - .3 Devices requiring maintenance.
 - .4 Required by code.
 - .5 Elsewhere as indicated.

PART 1 - GENERAL

1.1 REFERENCES

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

1.2 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.

2.2 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 100 mm.
- .3 Locking quadrant with shaft extension to accommodate insulation thickness.
- .4 Inside and outside nylon end bearings.
- .5 Channel frame of same material as adjacent duct, complete with angle stop.

2.3 MULTI-BLADED DAMPERS

- .1 Factory manufactured of material compatible with duct.
 - .2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.
 - .3 Maximum blade height: 100 mm.
 - .4 Bearings: self-lubricating nylon.
 - .5 Linkage: shaft extension with locking quadrant.
 - .6 Channel frame of same material as adjacent duct, complete with angle stop.
 - .7 Maximum leakage: 4% AT 500 Pa
-

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, locate balancing dampers in each branch duct.
- .4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.
- .5 All dampers to be vibration free.
- .6 Ensure damper operators are observable and accessible.

PART 1 – GENERAL

1.1 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A 653/A 653M-15, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .3 American National Standards Institute (ANSI)
 - .1 ANSI/AMCA Standard 500-D-12, Laboratory Methods of Testing Dampers for Rating.

1.2 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Indicate the following:
 - .1 Performance data.
 - .2 Leakage.
 - .3 Pressure drop.
 - .4 Torque required.
- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
- .3 Closeout Submittals
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

PART 2 - PRODUCTS

2.1 MULTI-LEAF DAMPERS

- .1 Opposed for modulating service and parallel blade type for isolating.
 - .2 Extruded aluminum, interlocking blades, complete with extruded vinyl seals, spring stainless steel side seals, structurally formed and welded galvanized steel 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 Performance:
 - .1 Leakage: in closed position less than 2% of rated air flow at 1000 Pa differential across damper.
 - .2 Pressure drop: at full open position less than 25 Pa differential across damper at 5 m/s.
- .6 Insulated aluminum dampers for all fresh air and exhaust air applications:
 - .1 Frames: insulated with extruded polystyrene foam with RSI 0.88.
 - .2 Blades: constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, RSI 0.88.

PART 3 – EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- .3 Seal multiple damper modules with silicon sealant.
- .4 Install access door adjacent to each damper. See Section 23 33 03 - Air Duct Accessories.
- .5 Ensure dampers are observable and accessible.

3.3 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.

PART 1 – GENERAL

1.1 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.

1.2 REFERENCES

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- .2 Department of Justice Canada (Jus).
 - .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
 - .2 Transportation of Dangerous Goods Act, 2008 (TDGA), c. 34.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .4 National Fire Protection Association (NFPA).
 - .1 NFPA 90A-12, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B-12, Standard for Installation of Warm Air Heating and Air-Conditioning Systems.
- .5 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA).
 - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005, 3rd Edition.
 - .2 SMACNA IAQ Guideline for Occupied Buildings under Construction, 2007, 2nd Edition.
- .6 Underwriters' Laboratories Inc. (UL).
 - .1 UL 181, Standard for Factory-Made Air Ducts and Air Connectors.
- .7 Underwriters' Laboratories of Canada (ULC).
 - .1 CAN/ULC-S110-13, Fire Tests for Air Ducts.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

- .1 Certification of Ratings:
-

- .1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Protect on site stored or installed absorptive material from moisture damage.

PART 2 - PRODUCTS

2.1 GENERAL

- .1 Factory fabricated to CAN/ULC-S110-07.
- .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 METALLIC - INSULATED

- .1 Type 1: spiral wound flexible aluminum.
- .2 Performance:
 - .1 Factory tested to 2.5 kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.
 - .3 Minimum 25mm thick mineral wool or fibreglass insulation complete with vapour barrier and jacket.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- .1 Install in accordance with: CAN/ULC-S110-07, UL-181, NFPA 90A, NFPA 90B, SMACNA and the requirements of the jurisdictional authority.
- .2 Maximum length of flexible ducting is 2.4m.

PART 1 - GENERAL

1.1 RELATED SECTIONS

- .1 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Section 23 33 03 - Air Duct Accessories.

1.2 REFERENCES

- .1 AMCA 99, Standards Handbook.
- .2 ANSI/AMCA 210-07, Laboratory Methods of Testing Fans for Rating.
- .3 AMCA 300-08, Reverberant Room Method for Sound Testing of Fans.
- .4 AMCA 301-06, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .5 ANSI/ASHRAE 51-2007/AMCA 210-07, Laboratory Methods of Testing Fans for Rating.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Provide:
 - .1 Fan performance curves showing point of operation, BHP, kW and efficiency.
 - .2 Sound rating data at point of operation.
- .3 Indicate:
 - .1 Motors, sheaves, bearings, shaft details
 - .2 Minimum performance achievable with variable speed controllers and variable inlet vanes as appropriate.

1.4 CLOSEOUT SUBMITTALS

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

1.5 EXTRA MATERIALS

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

- .1 Spare parts to include:
 - .1 Matched sets of belts.
- .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.

1.6 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 FANS GENERAL

- .1 Capacity: flow rate, total static pressure, W, efficiency, revolutions per minute, power, model, size, and sound power data as indicated on schedule.
 - .2 Fans: statically and dynamically balanced, constructed in conformity with AMCA 99.
 - .3 Sound ratings: comply with AMCA 301-06, tested to AMCA 300-08. Unit shall bear AMCA certified sound rating seal.
 - .4 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210-07, and ANSI/ASHRAE 51-2007/AMCA 210-07. Unit shall bear AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter.
 - .5 Motors:
 - .1 In accordance with Section 23 05 13 - Common Motors Requirements for HVAC Equipment supplemented as specified herein.
 - .2 Sizes as indicated.
 - .3 Motors to be electronically controlled DC motors.
 - .6 Accessories and hardware: matched sets of V-belt drives, adjustable slide rail motor bases, belt guards, coupling guards. Fan inlet safety screens as indicated and as specified in Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
 - .7 Factory primed before assembly in colour standard to manufacturer.
-

- .8 Scroll casing drains: as indicated.
- .9 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .10 Flexible connections: to Section 23 33 03 - Air Duct Accessories.

2.2 IN-LINE CENTRIFUGAL FANS

- .1 Fan wheels: Characteristics and construction:
 - .1 Welded steel construction.
 - .2 Maximum operating speed of centrifugal fans not more than 40% of first critical speed.
 - .3 Forward curved blades.
 - .2 Provide AMCA arrangements 1 or 9 as indicated with stiffened flanges, smooth rounded inlets, and stationary guide vanes.
 - .3 Bearings: 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.
 - .4 Housings:
 - .1 Volute with inlet cones: fabricated steel for wheels 300 mm or greater, 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 airtight access doors with handles.
 - .5 Performance:
 - .1 Flow: 1660 L/s
 - .2 ESP: 500 Pa
 - .3 RPM: 1664
 - .4 HP: 1.5 kW
-

PART 3 – EXECUTION

3.1 FAN INSTALLATION

- .1 Provide sheaves and belts required for final air balance.
- .2 Bearings and extension tubes to be easily accessible.
- .3 Access doors and access panels to be easily accessible.
- .4 Size anchor bolts to withstand seismic acceleration and velocity forces.
- .5 Arrange connecting duct work to follow manufacturer's recommendation regarding proper air flow patterns entering and exiting unit to avoid system fan effects.

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 Procedures.

1.2 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate the following:
 - .1 Capacity.
 - .2 Throw and terminal velocity.
 - .3 Noise criteria.
 - .4 Pressure drop.
 - .5 Neck velocity.

1.3 SAMPLES

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

1.4 CERTIFICATIONS

- .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.

1.5 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Procedures.
 - .2 Include:
 - .1 Keys for volume control adjustment.
 - .2 Keys for air flow pattern adjustment.
-

PART 2 - PRODUCTS

2.1 GENERAL

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

2.2 MANUFACTURED UNITS

- .1 Grilles, registers and diffusers of same generic type to be product of one manufacturer.

2.3 RETURN AND EXHAUST GRILLES AND REGISTERS

- .1 General: with opposed blade dampers.
- .2 Aluminum, 19mm border, aluminum eggcrate. Finish: aluminum based enamel finish.
- .3 Specific size and type: as indicated.

2.4 SUPPLY GRILLES AND REGISTERS

- .1 General: with opposed blade dampers.
- .2 Aluminum, 19 mm border, double deflection with airfoil shape, horizontal face and vertical rear bars. Finish B12 white powder coat.

2.5 DIFFUSERS

- .1 General: volume control dampers with flow straightening devices and blank-off quadrants and gaskets.
 - .3 Steel, round type, having fixed pattern, duct mounted. Finish: white enamel finish.
 - .4 Specific size and type: as indicated.
-

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.
- .2 Install with flat head stainless steel screws in countersunk holes where fastenings are visible.
- .3 Provide seismic restraints on suspended ceiling components.

PART 1 - GENERAL

1.1 REFERENCES

- .1 Statutes of Canada 1999 Chapter 33: "Canadian Environmental Protection Act 1999".
 - .1 SOR/2003-289: "Federal Halocarbon Regulations 2003".
- .2 Environmental Code of Practice for Eliminations of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems (the Environment Canada "Refrigeration Code of Practice", and the Report EPS 1 RA/2 dated March 1996).

1.2 GENERAL

- .1 Contractors and their personnel shall be familiar with the Section and its requirements.
- .2 The Contractor will comply with all Federal, Provincial, and Municipal regulatory requirements and guidelines for environmental protection and natural resources conservation, including the references noted above.

1.3 HALOCARBONS

- .1 All work relating to halocarbons to comply with referenced standards outlined above in Paragraph 1.1 - References.
 - .2 All work related to halocarbon equipment installation, servicing, etc., to be carried out by, or under direct supervision of a technician licensed by the Province of Nova Scotia as a refrigeration mechanic.
 - .3 Technician to provide to Departmental Representative:
 - .1 Copy of Province of Nova Scotia license.
 - .2 Certificate issued by the Heating, Refrigeration, and Air Conditioning Institute of Canada.
 - .3 Ozone Depletion Prevention Substance Awareness Card.
 - .4 The following are the only halocarbons that are acceptable as refrigerants (non-halocarbon refrigerants are also acceptable):
 - .1 HFC 134A.
 - .5 All work related to halocarbon equipment installation, servicing, decommissioning, leak testing to be documented on Departmental Representative supplied "Refrigeration and Air Conditioning Service Log". Copy(s) of the "Refrigeration and
-

Air Conditioning Service Log" form will be supplied to the Contractor during pre-commencement meeting.

- .6 Immediately report all releases of halocarbons to Departmental Representative.
- .7 Factory-charged halocarbon-containing shall be leak-tested by this Contractor in accordance with the "Refrigeration Code of Practice" within one working day after delivery to the site.
 - .1 No payment for delivery of this equipment to be site will be made until it is documented to be leak-free.
- .8 Non-factory sealed halocarbon-containing equipment shall be leak-tested using "triple evacuation": evacuate the system to 400 micron.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

PART 1 - GENERAL

1.1 SUMMARY

- .1 Related Sections:
 - .1 Section 01 33 00 - Submittal Procedures.
 - .2 Section 01 45 00 - Quality Control.
 - .3 Section 01 23 29 - Health and Safety Requirements.
 - .4 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .5 Section 01 78 00 - Closeout Submittals.
 - .6 Section 01 91 13 - Facility Commissioning General.

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 B51-14, Boiler, Pressure Vessel, and Pressure Piping Code.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .4 Air-Conditioning, Heating and Refrigeration Institute (AHRI)
 - .1 ANSI/AHRI Standard 400 (IP), Performance Rating of Liquid to Liquid Heat Exchangers.

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Co-ordinate submittal requirements and provide submittals required by Section 01 33 00 – Submittal Procedures.
-

- .3 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet for heat exchangers.
- .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 78 00 - Closeout Submittals.

1.4 MAINTENANCE

- .1 Maintenance Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Supply following spare parts:
 - .1 Head gaskets.

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 and 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:
 - .1 Salt water to water.
 - .2 Designed, constructed and tested in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, CSA B51-14 and provincial pressure vessel regulations.
 - .2 Frames: carbon steel with baked epoxy enamel paint, stainless steel tie rods/ side bolts and shroud.
 - .3 Plates: titanium, 0.5 mm thick.
 - .4 Gaskets: EPDM or as recommended by manufacturer to suit fluid temperature and service.
 - .5 Nozzles: 1034 kPa, ASA rubber rated flange type.
 - .6 Supports: as indicated.
 - .7 Piping connections: 250mm.
 - .8 Capacity: heat exchanger is to be sized to meet the most demanding of the following duty points:
 - .1 Duty Point 1.
 - .1 Cold side:
 - .1 Fluid: seawater.
 - .2 Inlet temperature (fixed): 4.4°C.
 - .3 Flow (fixed): 151 L/s.
 - .4 Pressure drop (maximum): 80 kPa.
 - .2 Hot side:
 - .1 Fluid: water.
 - .2 Inlet temperature (fixed): 15°C.
 - .3 Outlet temperature (maximum): 9.4°C.
 - .4 Flow: 151 L/s.
 - .5 Pressure drop (maximum): 75 kPa.
 - .3 Heat exchanged (minimum): 3780 kW.
-

- .2 Duty Point 2
 - .1 Cold side:
 - .1 Fluid: seawater.
 - .2 Inlet temperature (fixed): 8.3°C.
 - .3 Flow (fixed): 113 L/s.
 - .4 Pressure drop (maximum): 45 kPa.
 - .2 Hot side:
 - .1 Fluid: water.
 - .2 Inlet temperature(fixed): 15.4°C.
 - .3 Outlet temperature(maximum): 9.4°C.
 - .4 Flow(fixed): 82 L/s.
 - .5 Pressure drop(maximum): 30 kPa.
 - .3 Heat exchanged (minimum): 2060 kW
- .3 Duty Point 3
 - .1 Cold side:
 - .1 Fluid: seawater.
 - .2 Inlet temperature(fixed): 4.4°C.
 - .3 Flow (fixed): 75.5 L/s.
 - .4 Pressure drop (maximum): 26 kPa.
 - .2 Hot side:
 - .1 Fluid: water.
 - .2 Inlet temperature (fixed): 11.1°C.
 - .3 Outlet temperature (maximum): 5.6°C.
 - .4 Flow (fixed): 82 L/s.
 - .5 Pressure drop (maximum): 29 kPa.
 - .3 Heat exchanged (minimum): 1890 kW
- .9 Fouling factor: 10%.
- .10 Working pressure: primary 860 kPa, secondary 860 kPa. Max. test pressure 1045 kPa.
- .11 Dimensions: maximum: (HxWxD) 2705mm x 845mm x 2450 mm.
- .12 To have AHRI certification.

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.

3.3 FIELD QUALITY CONTROL

- .1 Start-up:
 - .1 General: perform start-up operations in accordance with Section 01 91 13 - Facility Commissioning General: General Requirements, 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.
 - .2 Performance Verification:
 - .1 General: perform performance verification in accordance with Section 01 91 13 - Facility Commissioning General : General Requirements, supplemented as specified.
 - .2 Timing: only after TAB of hydronic systems have been successfully completed.
 - .3 Primary side:
 - .1 Measure flow rate, pressure drop, steam pressure at heater.
 - .2 Verify operation of steam traps. Measure temperature of condensate return at trap outlet.
 - .4 Control valve: verify proper operation without binding, slack in components. Measure steam pressure 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.
 - .10 Reports:
 - .1 In accordance with Section 01 91 13 - Facility Commissioning General: Reports, supplemented as specified herein.
-

3.4 DEMONSTRATION

- .1 Training: provide training in accordance with Section 01 91 13 - Facility Commissioning General: Training of O&M Personnel, supplemented as specified.

3.5 CLEANING

- .1 Perform cleaning operations as specified in Section 23 08 01 - Performance Verification Mechanical Piping and in accordance with manufacturer's recommendations.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .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 25 30 02 - EMCS: Field Control Devices.

1.2 REFERENCES

- .1 Air-Conditioning, Heating and Refrigeration Institute (AHRI)
 - .1 AHRI-550/590-03, Performance Rating of Water Chilling Packages Using the Vapor Compression Cycle.
- .2 CSA International
 - .1 CSA B52, Mechanical Refrigeration Code.
 - .2 CSA B51, Boiler, Pressure Vessel and Pressure Piping Code.
 - .3 CSA C22.2 No. 236 and C743-02.
- .3 Environment Canada, (EC)/Environmental Protection Services (EPS)
 - .1 EPS 1/RA/2-1996, Environmental Code of Practice for Elimination of Fluorocarbons Emissions from Refrigeration and Air Conditioning Systems.
- .4 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE Standard 135-2012, BACnet – A Data Communication Protocol for Automation and Control Networks.

1.3 SHOP DRAWINGS

- .1 Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for rotary-screw water chillers and include product characteristics, performance criteria, physical size, finish and limitations.
 - .3 Indicate:
 - .1 Equipment including connections, piping and fittings, valves, strainers,
-

- control assemblies and ancillaries, identifying factory and field assembled.
- .2 Wiring as assembled and schematics.
- .3 Dimensions, construction details, recommended installation and support, mounting bolt hole sizes and locations and point loads.
- .4 Type of refrigerant used.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for rotary-screw water chillers for incorporation into manual.
- .3 Data to include:
 - .1 Description of equipment giving manufacturers name, model type and year, capacity and serial numbers.
 - .2 Provide part load performance curves.
 - .3 Details on operation, servicing and maintenance.
 - .4 Recommended spare parts list.

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.

1.6 EXTRA MATERIALS

- .1 Furnish as recommended by spare parts as recommended by chiller manufacturer.

1.7 DELIVERY, STORAGE AND HANDLING

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

PART 2 - PRODUCTS

2.1 GENERAL

- .1 Provide complete factory tested water cooled screw type chiller package including: compressors; evaporator; water cooled condenser, motor and motor starter; vibration isolators; controls; control centre; piping; wiring; refrigeration and oil charge; ready for connection to chilled water circuit condenser water circuit interlocks, and electric power source, installed in welded steel frame with heavy gauge louvered panels coated finished to manufacturers standard.
- .2 Overall dimensions: as indicated.
- .3 CSA approved at factory.
- .4 CRN numbers for pressure containing components as required by CSA B51 Boiler, Pressure Vessel and Pressure Piping Code.
- .5 CSA B52 Mechanical Refrigerant Code and Provincial requirements.

2.2 CAPACITY

- .1 Certified ratings based on AHRI 550/590:
 - .1 1055 kW, when cooling 65.1 L/s of water from 9.4 degrees C to 5.5 degrees C.
 - .2 Water cooled condenser supplied with 16°C entering water design temperature.
 - .3 Fouling factor: 0.0001.
 - .4 Maximum chilled water head loss through chiller: 59 kPa or as indicated.
 - .5 Refrigerant: R134a, or as specified in Section 23 54 14 - Halocarbon Management.
 - .6 Efficiency ratings:
 - .1 Maximum efficiency 0.461 kW/Ton.
 - .2 NPLV 0.504 kW/Ton.
 - .7 Electrical: Power supply: 575V/60 Hz/3ph.
 - .8 Maximum sound power tested to AHRI Standard 370.
 - .9 Maximum Dimensions: (LXWxH), 2795 mm x 1730 mm x 1980 mm.
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2.3 COMPRESSOR

- .1 Single compressors Hermetic or Semi-hermetic screw design cooled motors with suction at 100% load:
 - .1 Unit to be complete with maximum sound reduction package.
- .2 Unloaded start with capacity modulation by continuous linear modulation of slide valve in response to load change.
- .3 Compressor to include suction and discharge shut-off valves; oil sight glass; separate circuit crankcase heater; hot gas bypass; and cylinder unloading device.
- .4 Provide nameplate to show capacity at design temperature, type of refrigerant used and total weight in system.

2.4 COMPRESSOR MOTOR

- .1 Hermetic type with overload protection and manual restart.

2.5 EVAPORATOR AND CONDENSER

- .1 Labelling: to CSA B52 and provincial requirements.
 - .2 Evaporator and condenser shall be shell-and-tube type and have separate sheets. Heat exchangers shall be designed, constructed, tested and stamped according to the requirements of the ASME Code, Section VIII Code Case 1518-5. They shall have a copper wall of 0.025 in. wall thickness. In the evaporator, refrigerant shall be in the shell and water inside the tubes. The water sides shall be designed for a minimum of 145 psig or as specified. The water connections for the evaporator and condenser shall be grooved suitable for Victaulic couplings or flanged. Vents and drains shall be provided. The refrigerant side of each vessel shall bear the ASME Code stamp, code case section VII. Vessels shall pass a test pressure of 1.1 times the working pressure but not less than 100 psig. Provide intermediate tube supports spaced to enable equal liquid and gas flow across multiple compressor suction ports. The evaporator water connections shall also be equipped with right-hand or left-hand connection, interchangeable.
 - .3 Tubes shall be individually replaceable and have internally and externally enhanced surfaces designed for refrigeration duty. Tubes shall have smooth full tube wall landings at the tube-sheet ends and at intermediate tube supports. Tubes shall be mechanically roller expanded into steel tube sheets containing a minimum of three concentric grooves.
 - .4 The evaporator shall be provided with spring loaded reseating-type pressure relief valves according to ASHRAE-15.
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- .5 The condenser shall be provided with dual relief valves equipped with a transfer valve so one valve can be removed for testing or replacement without loss of refrigerant or removal of refrigerant from the vessel.
- .6 A perforated plate designed for vapour disengagement shall be installed inside the evaporator above the tubing to assure effective liquid droplet removal to prevent liquid damage to compressors and equalized suction pressure across evaporators with multiple compressors.
- .7 Distribution arranged to prevent direct high velocity impingement on tubes and uniform heat exchange through whole of heat exchanger surface.

2.6 CONTROL CENTRE

- .1 Provide all programming of LCP to meet sequence of operations as indicated.
- .2 Controls to be native BACnet integrated and include:
 - .1 Controls housed in NEMA 3R/12 powder painted steel cabinet with hinged, latched and gasket sealed door.
 - .2 Control circuit ON/OFF switch.
 - .3 Oil pressure safety switch.
 - .4 High and low pressure safety switch.
 - .5 Water temperature controller.
 - .6 Suction and discharge pressure gauges and shut-off valves.
 - .7 Chilled water flow switch (NEMA 4X).
 - .8 Condenser water flow switch.
 - .9 Compressor short cycling and restart delay timer.
 - .10 Starting sequence switches.
 - .11 Compressor circuit breakers.
 - .12 Reset low water temperature cut-out switch.
 - .13 Motor contactors, control relays and indicator lights to include: "start-stop" switch; anti-recycle 30 minute time delay; low chilled water temperature cutout and automatic reset; excess purge signal light and reset switch; manual/automatic oil pump operating switch and signal light; oil heater signal light; manual reset power failure and signal light; chilled water flow interruption light metre to indicate number of compressor starts and elapsed running time.
 - .14 Field power and control circuit terminal blocks.
 - .15 Alarm for refrigerant leakage.
 - .16 Low ambient control for unit operation to 0°F ambient
 - .17 High ambient control for unit operation to 115°F
 - .18 Remote panel for display of chilled liquid, refrigerant, oil and ambient temperature, refrigerant and oil pressures, % motor current, operating hours and number of starts.

- .3 Provide BACnet/IP Interface Devices for each unit and common Manager Controller for connection to the EMCS. BACnet to ANSI/ASHRAE Standard 135. The following minimum objects are to be mapped to the EMCS.
 - .1 Enable: BV input.
 - .2 CHW setpoint: BV input.
 - .3 Water flow switch: BV output.
 - .4 CHW leaving temp: AV output.
 - .5 CHW return temp: AV output.
 - .6 Comp run: BV output (one object for each comp).
 - .7 Staging %: AV output.
 - .8 Chiller Amperage: AV output.
 - .9 Common alarm: BV output.

2.7 ELECTRICAL

- .1 Power supply: single point power supply with lockable means of isolation, 575/60/3.
- .2 Provide integral control transformer, as required.
- .3 Exposed compressor, control and fan motor power wiring shall be routed in liquid tight conduit.

2.8 ELECTRICAL WIRING

- .1 All wiring to be done in accordance with the Electrical Safety Code, most recent edition and Division 26 requirements.
- .2 All field wiring to be done in liquid tight conduit except liquid tight flex at vibrating components.

2.9 SHUT OFF VALVES

- .1 Butterfly type, manual override handwheel, position indicator, suited for exterior installation.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for rotary-screw water chiller installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions

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

3.2 APPLICATION

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

3.3 GENERAL

- .1 Provide appropriate protection apparatus.
- .2 Install unit as indicated, to manufacturers recommendations, and in accordance with EPS 1/RA/2. Install on concrete housekeeping pad with elastomeric vibration isolators pads under the full width of support legs.
- .3 Ensure adequate clearances for servicing and maintenance.
- .4 Manufacturer to approve installation, to supervise startup and to instruct operators. Each stage to include separate site visits. Allow 2 hours to demonstrate and train.
- .5 Provide technical programming assistance and coordination with EMCS contractor for chiller controls systems during commissioning process.

3.4 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
 - .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.
 - .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.
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3.5 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by rotary-screw water chiller installation.