

PART 1 GENERAL

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA B139-09, Installation Code for Oil Burning Equipment, Includes Update No. 1 (2010).
 - .2 National Fire Code of Canada (NFCC 2010)

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications and datasheets for piping and equipment and include product characteristics, performance criteria, physical size, finish and limitations in accordance with Section 01 33 00 - Submittal Procedures.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address in accordance with Section 01 00 10 - General Instructions and Section 01 52 00 - Construction Facilities.
 - .2 Packaging Waste Management: remove for reuse and return of pallets and packaging materials.

PART 2 PRODUCTS

2.1 NOT USED

- .1 Not used.

PART 3 EXECUTION

3.1 APPLICATION

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

3.2 CONNECTIONS TO EQUIPMENT

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

3.3 CLEARANCES

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer and National Fire Code of Canada and CSA B139.
- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer and CSA B139 as indicated without interrupting operation of other system, equipment, components.

3.4 DRAINS

- .1 Install piping with grade in direction of flow except as indicated.
- .2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.
- .3 Pipe each drain valve discharge separately to above floor drain.
 - .1 Discharge to be visible.
- .4 Drain valves: NPS 3/4 gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

3.5 AIR VENTS

- .1 Install manual air vents to CSA B139 at high points in piping systems.
- .2 Install isolating valve at each automatic air valve.
- .3 Install drain piping to approved location and terminate where discharge is visible.

3.6 DIELECTRIC COUPLINGS

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

- .2 Locations: where dissimilar metals are joined.
- .3 NPS 2 and under: isolating unions or bronze valves.
- .4 Over NPS 2: isolating flanges.

3.7 PIPEWORK INSTALLATION

- .1 Install pipework to CSA B139.
- .2 Screwed fittings jointed with Teflon tape.
- .3 Protect openings against entry of foreign material.
- .4 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .5 Assemble piping using fittings manufactured to ANSI standards.
- .6 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.
 - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .7 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .8 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- .9 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .10 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .11 Group piping wherever possible and as indicated.
- .12 Ream pipes, remove scale and other foreign material before assembly.
- .13 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .14 Provide for thermal expansion as indicated.
- .15 Valves:
 - .1 Install in accessible locations.
 - .2 Remove interior parts before soldering.
 - .3 Install with stems above horizontal position unless indicated.
 - .4 Valves accessible for maintenance without removing adjacent piping.

3.8 REPARATION FOR FIRE STOPPING

- .1 Install firestopping within annular space between pipes, ducts, insulation and adjacent fire separation in accordance with National Building Code.
- .2 Uninsulated unheated pipes not subject to movement: no special preparation.
- .3 Uninsulated heated pipes subject to movement: wrap with non-combustible smooth material to permit pipe movement without damaging firestopping material or installation.
- .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barriers.

3.9 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

- .1 Advise Departmental Representative 48 hours minimum prior to performance of pressure tests.
- .2 Pipework: test as specified in relevant sections of heating, ventilating and air conditioning work.
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.
- .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .5 Conduct tests in presence of Departmental Representative.
- .6 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after approval and certification of tests by Departmental Representative.

3.10 EXISTING SYSTEMS

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

PART 1 GENERAL1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Instructions.
- .2 Section 21 05 01 - Common Work Results for Mechanical.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.11-2011, Forged Fittings, Socket-Welding and Threaded.
 - .2 ASME B31.1-2012, Power Piping.
 - .3 ASME B31.3-2012, Process Piping.
 - .4 ASME Boiler and Pressure Vessel Code (BPVC):
 - .1 BPVC 2013 Section I: Power Boilers.
 - .2 BPVC 2013 Section V: Nondestructive Examination.
 - .3 BPVC 2013 Section IX: Welding and Brazing Qualifications.
- .2 American Water Works Association (AWWA)
 - .1 AWWA C206-11 Field Welding of Steel Water Pipe.
- .3 American Welding Society (AWS)
 - .1 AWS A5.1/A5.1M-2012, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
 - .2 AWS B3.0-1977, Welding Procedure and Performance Qualification (Historical).
 - .3 AWS C1.1M/C1.1-2012, Recommended Practices for Resistance Welding.
 - .4 AWS W1-2000, Welding Inspection Handbook.
 - .5 AWS Z49.1-2012, Safety in Welding, Cutting and Allied Process.
- .4 Canadian Standards Association (CSA International)
 - .1 CSA W47.2-11, Certification of Companies for Fusion Welding of Aluminum, Includes Update No. 1 (2011), Update No. 2 (2012).
 - .2 CSA W48-06 (R2011), Filler Metals and Allied Materials for Metal Arc Welding.
 - .3 CSA W48.1-M1991 (R1998), Carbon Steel Covered Electrodes for Shielded Metal Arc Welding.
 - .4 CSA B51-09, Boiler, Pressure Vessel and Pressure Piping Code, Includes Update No. 1 (2009).
 - .5 CSA W117.2-12, Safety in Welding, Cutting and Allied Processes, Includes Update No. 1 (2013).
 - .6 CSA W178.1-08 (R2013), Certification of Welding Inspection Organizations.
 - .7 CSA W178.2-08 (R2013), Certification of Welding Inspectors.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 QUALITY ASSURANCE

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

PART 2 PRODUCTS

2.1 ELECTRODES

- .1 Electrodes: in accordance with CSA W48 Series.
- .2 Store in dry, heated area free of moisture and dampness. Damaged rods or electrodes will be rejected.

PART 3 EXECUTION

3.1 APPLICATION

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

3.2 QUALITY OF WORK

- .1 Welding: in accordance with ASME B31.1, B31.3, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to AWS B3.0, AWS C1.1, and special procedures specified elsewhere in Division 23, applicable requirements of provincial Authority Having Jurisdiction.

3.3 INSTALLATION REQUIREMENTS

- .1 Identify each weld with welder's identification symbol.
- .2 Backing rings:
 - .1 Where used, fit to minimize gaps between ring and pipe bore.
 - .2 Do not install at orifice flanges.
- .3 Fittings:
 - .1 NPS 2 and smaller: install welding type sockets.
 - .2 Branch connections: install welding tees or forged branch outlet fittings.
- .4 Welding:
 - .1 Prepare field bevels and shop bevels by mechanical means or flame cutting in conformance with recognized standards. Clean bevels of scale and oxidation just prior to welding.
 - .2 Provide full penetration welds. Use welding sockets for joints 50 mm or under, conforming to ANSI B16.11.
 - .3 Preheat to 10°C in accordance with ANSI B31.1.

3.4 INSPECTION AND TESTS - GENERAL REQUIREMENTS

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

3.5 SPECIALIST EXAMINATIONS AND TESTS

- .1 General:
 - .1 Perform examinations and tests by specialist qualified to CSA W178.1 and CSA W178.2 and approved by Departmental Representative.

- .2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of Authority Having Jurisdiction.
- .3 Inspect and test 20% of welds in accordance with "Inspection and Test Plan" by non-destructive visual examination and full gamma ray radiographic (hereinafter referred to as "radiography") tests.
- .2 Hydrostatically test welds to ANSI/ASME B31.1. Comply with Section 21 05 01 - Common Work Results for Mechanical.
- .3 Visual examinations: include entire circumference of weld externally and wherever possible internally.
- .4 Failure of visual examinations:
 - .1 Upon failure of welds by visual examination, perform additional testing as directed by Departmental Representative.
- .5 Full radiographic tests for HTHW piping systems.
 - .1 Radiograph over full circumference up to 20% of welds for HTHW piping systems and up to 10% of welds for chilled water piping systems, selected at random by Departmental Representative from welds which would be most difficult to repair in event of failure after system is operational.
 - .2 Radiographic film:
 - .1 Identify each radiographic film with date, location, name of welder, and submit to Departmental Representative. Replace film if rejected because of poor quality.
 - .3 Interpretation of radiographic films:
 - .1 By qualified radiographer.
 - .4 Failure of radiographic tests:
 - .1 Extend tests to welds by welder responsible when those welds fails tests.

3.6 DEFECTS CAUSING REJECTION

- .1 As described in ANSI/ASME B31.1 and ANSI/ASME Boiler and Pressure Vessels Code.
- .2 In addition, chilled water systems, HTHW:
 - .1 Undercutting greater than 0.8 mm adjacent to cover bead on outside of pipe.
 - .2 Undercutting greater than 0.8 mm adjacent to root bead on inside of pipe.
 - .3 Undercutting greater than 0.8 mm at combination of internal surface and external surface.
 - .4 Incomplete penetration and incomplete fusion greater than total length of 38 mm in 1500 mm length of weld depth of such defects being greater than 0.8 mm.
 - .5 Repair cracks and defects in excess of 0.8 mm in depth.
 - .6 Repair defects whose depth cannot be determined accurately on basis of visual examination or radiographic tests.
- .3 Failure to meet radiographic requirements.

- .4 Welding performed by unqualified personnel.
- .5 Welds not reasonably uniform in appearance.
- .6 Evidence of peening.
- .7 Cracks.
- .8 Oxidation of welds.
- .9 Lack of fusion.
- .10 Presence of porosity, slag inclusion or overlaps.
- .11 Undercutting adjacent to completed welds or evidence of undercutting by grinding.
- .12 Burnthrough.

3.7 REPAIR OF WELDS WHICH FAILED TESTS

- .1 Replace welds of poor or doubtful quality.
- .2 Re-inspect and re-test repaired or re-worked welds at Contractor's expense.

PART 1 GENERAL1.1 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B1.20.1-2013, Pipe Threads, General Purpose (Inch).
 - .2 ASME B16.18-2012, Cast Copper Alloy Solder Joint Pressure Fittings.
- .2 ASTM International
 - .1 ASTM A276-13a, Standard Specification for Stainless Steel Bars and Shapes.
 - .2 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .3 ASTM B283/B283M-12, Standard Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
 - .4 ASTM B505/B505M-12a, Standard Specification for Copper Alloy Continuous Castings.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - .1 MSS SP-25-2008, 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, Includes Errata (8-23-2010).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and data sheets for equipment and systems and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 81 01 - Hazardous Materials.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
 - .2 Submit data for valves specified in this Section.

1.3 CLOSEOUT SUBMITTALS

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

1.4 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials/Spare Parts:
 - .1 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.
 - .2 Tools:
 - .1 Furnish special tools for maintenance of systems and equipment.
 - .2 Include following:
 - .1 Lubricant gun for expansion joints.

1.5 DELIVERY, STORAGE AND HANDLING

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

PART 2 PRODUCTS

2.1 MATERIALS

- .1 Valves:
 - .1 Except for specialty valves, to be single manufacturer.
 - .2 Products to have CRN registration numbers.
- .2 End Connections:
 - .1 Connection into adjacent piping/tubing:
 - .1 Steel pipe systems: screwed ends to ASME B1.20.1.
 - .2 Copper tube systems: solder ends to ASME B16.18.

- .3 Lockshield Keys:
 - .1 Where lockshield valves are specified, provide 10 keys of each size: malleable iron cadmium plated.

- .4 Gate Valves:
 - .1 Requirements common to gate valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: union with hexagonal shoulders.
 - .3 Connections: screwed with hexagonal shoulders.
 - .4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - .5 Packing: non-asbestos.
 - .6 Handwheel: non-ferrous.
 - .7 Handwheel Nut: bronze to ASTM B62.
 - .2 NPS 2 and under, non-rising stem, solid wedge disc, Class 125
 - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
 - .2 Operator: Handwheel.
 - .3 NPS 2 and under, non-rising stem, solid wedge disc, Class 150:
 - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
 - .2 Operator: handwheel.
 - .4 NPS 2 and under, rising stem, split wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Disc: split wedge, bronze to ASTM B283/B283M, loosely secured to stem.
 - .3 Operator: handwheel.
 - .5 NPS 2 and under, rising stem, solid wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Operator: handwheel.
 - .6 NPS 2 and under, rising stem, solid wedge disc, Class 150:
 - .1 Body: with long disc guides, union bonnet.
 - .2 Operator: handwheel.

- .5 Butterfly Valves:
 - .1 NPS 2 1/2 through NPS 6, 2068 kPa with grooved ends.
 - .1 Body: cast bronze, with copper-tube dimensioned grooved ends.
 - .2 Disc: elastomer coated ductile iron with integrally cast stem.
 - .3 Operator: lever or handwheel.

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.

3.2 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse and recycling.

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Instructions.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B31.1-2012, Power Piping.
- .2 ASTM International
 - .1 ASTM A125-96(2013), Standard Specification for Steel Springs, Helical, Heat-Treated.
 - .2 ASTM A307-12, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
 - .3 ASTM A563-07a, Standard Specification for Carbon and Alloy Steel Nuts.
- .3 Factory Mutual (FM)
- .4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP-58-2009, Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
- .5 Underwriter's Laboratories of Canada (ULC)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and data sheets for hangers and supports and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
 - .2 Submit shop drawings for:
 - .1 Bases, hangers and supports.
 - .2 Connections to equipment and structure.
 - .3 Structural assemblies.

- .4 Certificates:
 - .1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Manufacturers' Instructions:
 - .1 Provide manufacturer's installation instructions.
 - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

1.4 CLOSEOUT SUBMITTALS

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

1.5 DELIVERY, STORAGE AND HANDLING

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

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

- .1 Design Requirements:
 - .1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
 - .2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS 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 conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.
 - .5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP-58.
- .2 Performance Requirements:
 - .1 Design supports, platforms, catwalks, hangers to withstand seismic events.

2.2 GENERAL

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

2.3 PIPE HANGERS

- .1 Finishes:
 - .1 Pipe hangers and supports: galvanized after manufacture.
 - .2 Ensure steel hangers in contact with copper piping are epoxy coated.
- .2 Upper attachment structural: suspension from lower flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
 - .1 Rod: 9 mm UL listed.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed to MSS SP-58.
- .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-58.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed.
- .4 Upper attachment to concrete:
 - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
 - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed to MSS SP-58.
- .5 Shop and field-fabricated assemblies:
 - .1 Steel brackets.
 - .2 Sway braces for seismic restraint systems.
- .6 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.
- .7 Pipe attachments: material to MSS SP-58:
 - .1 Attachments for steel piping: carbon steel galvanized.
 - .2 Attachments for copper piping: copper plated black steel.

- .3 Use insulation shields for hot pipework.
- .4 Oversize pipe hangers and supports.

- .8 Adjustable clevis: material to MSS SP-58 UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
 - .1 Ensure "U" has hole in bottom for rivetting to insulation shields.

- .9 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP-58.

- .10 U-bolts: carbon steel to MSS SP-58 with 2 nuts at each end to ASTM A563.
 - .1 Finishes for steel pipework: galvanized.
 - .2 Finishes for copper, glass, brass or aluminum pipework: galvanized, with epoxy coated.

- .11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP-58.

2.4 INSULATION PROTECTION SHIELDS

- .1 Insulated cold piping:
 - .1 64 kg/m³ density insulation plus insulation protection shield to: MSS SP-58 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-58.

2.5 CONSTANT SUPPORT SPRING HANGERS

- .1 Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report (CMTR).

- .2 Load adjustability: 10% minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.

- .3 Provide upper and lower factory set travel stops.

- .4 Provide load adjustment scale for field adjustments.

- .5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.

- .6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.6 VARIABLE SUPPORT SPRING HANGERS

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

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install in accordance with:
 - .1 Manufacturer's instructions and recommendations.
- .2 Clevis plates:
 - .1 Attach to concrete with 4 minimum concrete inserts, one at each corner.
- .3 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
- .4 Use approved constant support type hangers where:
 - .1 Vertical movement of pipework is 13 mm or more,
 - .2 Transfer of load to adjacent hangers or connected equipment is not permitted.
- .5 Use variable support spring hangers where:
 - .1 Transfer of load to adjacent piping or to connected equipment is not critical.
 - .2 Variation in supporting effect does not exceed 25 % of total load.

3.3 HANGER SPACING

- .1 Plumbing piping: to Canadian Plumbing Code, Provincial Code and Authority Having Jurisdiction.
- .2 Gas and fuel oil piping: up to NPS 1/2: every 1.8 m.
- .3 Copper piping: up to NPS 1/2: every 1.5 m.
- .4 Flexible joint roll groove pipe: in accordance with table below for steel, but not less than one hanger at joints. Table listings for straight runs without concentrated loads and where full linear movement is not required.
- .5 Within 300 mm of each elbow.

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

- .6 Pipework greater than NPS 12: to MSS SP-58.

3.4 HANGER INSTALLATION

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

3.5 HORIZONTAL MOVEMENT

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

3.6 FINAL ADJUSTMENT

- .1 Adjust hangers and supports:
 - .1 Ensure that rod is vertical under operating conditions.
 - .2 Equalize loads.
- .2 Adjustable clevis:
 - .1 Tighten hanger load nut securely to ensure proper hanger performance.
 - .2 Tighten upper nut after adjustment.
- .3 C-clamps:
 - .1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.
- .4 Beam clamps:
 - .1 Hammer jaw firmly against underside of beam.

3.7 FIELD QUALITY CONTROL

- .1 Site Tests: conduct following tests in accordance with and submit report as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
 - .1 Chilled water piping and expansion joints.
 - .2 High temperature hot water piping.

3.8 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.

PART 1 GENERAL

1.1 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-24.3-92, Identification of Piping Systems.

1.2 ACTION AND INFORMATIONAL 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.

1.3 QUALITY ASSURANCE

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

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling.
 - .2 Dispose of unused paint coating material at official hazardous material collections site approved by Departmental Representative.
 - .3 Do not dispose of unused paint coating material into sewer system, into streams, lakes, onto ground or in locations where it will pose health or environmental hazard.

PART 2 PRODUCTS

2.1 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 EXISTING IDENTIFICATION SYSTEMS

- .1 Apply existing identification system to new work.
- .2 Before starting work, obtain written approval of identification system from Departmental Representative.

2.3 IDENTIFICATION OF PIPING SYSTEMS

- .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.
- .2 Pictograms:
 - .1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.
- .3 Legend:
 - .1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.
- .4 Arrows showing direction of flow:
 - .1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.
 - .2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.
 - .3 Use double-headed arrows where flow is reversible.
- .5 Extent of background colour marking:
 - .1 To full circumference of pipe or insulation.
 - .2 Length to accommodate pictogram, full length of legend and arrows.
- .6 Materials for background colour marking, legend, arrows:
 - .1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.

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

.7 Colours and Legends:

.1 Where not listed, obtain direction from Departmental Representative.

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

Background colour:	Legend, arrows:
Yellow	BLACK
Green	WHITE

.3 Background colour marking and legends for piping systems:

Contents	Background colour marking	Legend
Chilled water supply	Green	CH. WTR. SUPPLY
Chilled water return	Green	CH. WTR. RETURN
High temp HW Htg. supply	Yellow	HTHW HTG. SUPPLY++
High temp HW Htg. return	Yellow	HTHW HTG. RETURN++

2.4 VALVES, CONTROLLERS

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

2.5 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 except as specified otherwise.

- .2 Identify systems, equipment to conform to PWGSC Project Management Support Services (PMSS).

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: Secure tags with non-ferrous chains or closed "S" hooks.

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 GENERAL1.1 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE 90.1-2010 (SI), Energy Standard for Buildings Except Low-Rise Residential Buildings (ANSI/ASHRAE/IES), Errata (July 9, 2013)/Addenda a thru ds/IC 90.1-2010-02 to 18.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM B209M-10, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
 - .2 ASTM C335/C335M-10e1, Standard Test Method for Steady-State Heat Transfer Properties of Pipe Insulation.
 - .3 ASTM C411-11, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449-07(2013), Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C533-13, Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
 - .6 ASTM C547-12, Standard Specification for Mineral Fiber Pipe Insulation.
 - .7 ASTM C795-08(2013), Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .8 ASTM C921-10, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .2 CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts
- .4 Department of Justice Canada (Jus)
 - .1 Canadian Environmental Assessment Act (CEAA), 2012.
 - .2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
 - .3 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .6 Manufacturer's Trade Associations
 - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).

- .7 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-10, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701-11, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - .3 CAN/ULC-S702-09-AM1, Standard for Mineral Fibre Thermal Insulation for Buildings, Includes Amendment 1 (January 2012).
 - .4 CAN/ULC-S702.2-10, Standard for Mineral Fibre Thermal Insulation for Buildings, Part 2: Installation.

1.2 DEFINITIONS

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

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
- .4 Samples:
 - .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on 12 mm plywood board. Affix label beneath sample indicating service.

- .5 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

1.4 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Installer: specialist in performing work of this Section, and have successful experience in this size and type of project, qualified to standards of TIAC.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
 - .3 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Storage and Protection:
 - .1 Protect from weather, construction traffic.
 - .2 Protect against damage.
 - .3 Store at temperatures and conditions required by manufacturer.
- .3 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling.
 - .2 Place excess or unused insulation and insulation accessory materials in designated containers.
 - .3 Divert unused metal materials from landfill to metal recycling facility approved by Departmental Representative.
 - .4 Dispose of unused adhesive material at official hazardous material collections site approved by Departmental Representative.

PART 2 PRODUCTS2.1 FIRE AND SMOKE RATING

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

2.2 INSULATION

- .1 Mineral fibre specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335/C335M.
- .3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702 and ASTM C547.
 - .2 Maximum "k" factor: to CAN/ULC-S702.
- .4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702 and ASTM C547.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC-S702 and ASTM C547.

2.3 INSULATION SECUREMENT

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

2.4 CEMENT

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

2.5 VAPOUR RETARDER LAP ADHESIVE

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

2.6 INDOOR VAPOUR RETARDER FINISH

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

2.7 OUTDOOR VAPOUR RETARDER FINISH

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

2.8 JACKETS

- .1 Canvas:
 - .1 220 and 120 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
 - .2 Lagging adhesive: compatible with insulation.

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PRE-INSTALLATION REQUIREMENT

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

3.3 INSTALLATION

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturer's instructions and this specification.

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

3.4 PRE-FABRICATED, INSULATION AND ENCLOSURES

- .1 Application: at expansion joints, valves, flanges and unions.
- .2 Design continuous (uninterrupted) insulation with continuous vapour barrier.
- .3 Insulation:
 - .1 Insulation, fastenings and finishes: same as system.
 - .2 Jacket: high temperature fabric.

3.5 PIPING INSULATION SCHEDULES

- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 TIAC Code: A-1.
 - .1 Securements: SS bands at 300 mm on centre.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code 1501-H.
- .3 TIAC Code: A-3.
 - .1 Securements: SS wire bands at 300 mm on centre.
 - .2 Seals: VR lap seal adhesive, VR lagging adhesive.
 - .3 Installation: TIAC Code: 1501-C.
- .4 Thickness of insulation as listed in following table.
 - .1 Run-outs to individual units and equipment not exceeding 4000 mm long.
 - .2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	Temp degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)					
			Run out 25	to 1 38	1 ¼ to 2 38	2 ½ to 4 38	5 to 6 38	8 & over 38
Hot Water Heating	60 or above	A-1	25	38	38	38	38	38
Hot water Heating	up to 59	A-1	25	25	25	25	38	38
Chilled Water	4 - 13	A-3	25	25	25	25	38	38
Chilled Water	below 4	A-3	25	25	38	38	38	38

- .5 Finishes:
- .1 Exposed indoors: canvas.
 - .2 Exposed in mechanical rooms: canvas.
 - .3 Concealed, indoors: canvas on valves, fittings. No further finish.
 - .4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.
 - .5 Installation: to appropriate TIAC code CRF/1 through CPF/5.

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 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Instructions.
- .2 Section 01 35 29.06 - Health and Safety Requirements.
- .3 Section 21 05 01 - Common Work Results for Mechanical.
- .4 Section 23 05 05 - Installation of Pipework.
- .5 Section 23 05 17 - Pipe Welding.
- .6 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
- .7 Section 23 05 53.01 - Mechanical Identification.

1.2 REFERENCES

- .1 American Iron and Steel Institute (AISI)
- .2 American Society of Mechanical Engineers (ASME)
 - .1 ASME B1.20.1-2013, Pipe Threads, General Purpose (Inch).
 - .2 ASME B31.1-2012, Power Piping.
- .3 ASTM International
 - .1 ASTM A53/A53M-12, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - .2 ASTM A105/A105M-13, Standard Specification for Carbon Steel Forgings for Piping Applications.
 - .3 ASTM A106/A106M-13, Standard Specification for Seamless Carbon Steel Pipe for High Temperature Service.
 - .4 ASTM A181/A181M-13, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
 - .5 ASTM A193/A193M-12b, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
 - .6 ASTM A194/A194M-13, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
 - .7 ASTM A216/A216M-12, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
 - .8 ASTM A234/A234M-13, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

- .9 ASTM A307-12, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
- .10 ASTM A536-84(2009), Standard Specification for Ductile Iron Castings.
- .11 ASTM B61-08(2013), Standard Specification for Steam or Valve Bronze Castings.

- .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-14.5-M88, Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.

- .5 CSA International
 - .1 CSA B51-09, Boiler, Pressure Vessel and Pressure Piping Code. Includes Update No. 1 (2009).
 - .2 CSA B242-05 (R2011), Groove- and Shoulder-Type Mechanical Pipe Couplings.

- .6 Department of Justice Canada (Jus)
 - .1 Canadian Environmental Assessment Act (CEAA), 2012.
 - .2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.

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

- .8 Public Works and Government Services Canada (PWGSC)
 - .1 Real Property Branch / Professional and Technical Services / Architecture and Engineering Resources / Mechanical and Maintenance Engineering / Utilities Engineering (RPB/PTS/AER/MME/Utilities Engineering).
 - .2 Real Property Branch / Property and Facilities Management / Operational Support Services / Utilities Management Services (RPB/PFM/OSS/Utilities Management Services).

- .9 Transport Canada (TC)
 - .1 Transportation of Dangerous Goods Act, 1992, c. 34 (TDGA).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and data sheets for equipment and systems and include product characteristics, performance criteria, physical size, finish and limitations.
 - .1 Provide two copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide Project Record Documents in accordance with Section 01 78 00 - Closeout Submittals and 21 05 01 - Common Work Results for Mechanical.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Provide maintenance data as specified in Section 01 78 00 - Closeout Submittals.
- .2 Extra Materials/Spare Parts:
 - .1 Furnish following spare parts:
 - .1 Valve seats: one for each size.
 - .2 O-Rings: provide two for each type and size supplied.
 - .3 Valve handles: two of each size.
 - .4 Flange gaskets: one for every ten flanged joints, and one for every size. Minimum one.
 - .3 Tools:
 - .1 Furnish special tools for maintenance of systems and equipment.
 - .2 Include following:
 - .1 Lubricant gun for expansion joints.

1.6 QUALITY ASSURANCE

- .1 Regulatory Requirements: ensure Work is performed in compliance with all applicable Provincial/Territorial regulations.
- .2 Inspections:
 - .1 Inspect new piping prior to Departmental Representative and Authority Having Jurisdiction. Where Province has approved drawings, TSSA certified boiler inspector to inspect installation.
 - .2 Contractor to contact TSSA for requirements for inspection and testing of system modifications, design changes or repairs done in house.
 - .3 Costs for inspection to be covered by Contractor.
- .3 Supply grooved joint couplings, fittings, valves, grooving tools and specialties from a single manufacturer. Use date stamped castings for coupling housings, fittings, valve bodies, for quality assurance and traceability.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
 - .2 Be responsible for shipping, delivery, unloading, storage of material.
 - .3 Handle and store in manner to ensure that materials and coatings are not damaged.

- .3 Packaging Waste Management: remove for reuse of pallets, crates, padding, and packaging materials.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION/CENTRAL SYSTEM DESIGN REQUIREMENTS

- .1 High temperature hot water (HTHW) and high pressure chilled water building system design requirements to be established by RPB/PTS/AER/MME/ Utilities Engineering to ensure building system design is compatible with central plant design.

CHW	Design Pressure	1.035 MPa
	Design Temp	5.5 °C
HTHW	Design Pressure	1.379 MPa
	Design Temp	150 °C

2.2 GENERAL

- .1 Valves to be repackable under full line pressure while fully open.

2.3 HIGH PRESSURE (OVER 860 kPa AND UP TO 1725 kPa) CHILLED WATER

- .1 Piping:
- .1 To ASTM A53/A53M, Grade B.
 - .2 NPS 1/2 to 1-1/2: Schedule 80, seamless, screwed or plain ends.
 - .3 NPS 2 to 10: Schedule 40, ERW or Seamless, bevel ends.
 - .4 NPS 12 and over: 9.6 mm wall thickness ERW or seamless.
- .2 Fittings:
- .1 NPS 1/2 to 1-1/2: Class 3000, 20 MPa, forged steel socket weld ends, to ASTM A105/A105M.
 - .2 NPS 2-12: Schedule 40, bevel ends, to ASTM A234/A234M, Grade WPB.
 - .3 NPS 14 and over: 9.6 mm wall thickness, bevel ends, to ASTM A234/A234M, Grade WPB.
 - .4 NPS 2 - 6, Grooved Ends: ASTM A536 ductile iron, Grade 65-45-12; ASTM A234, Grade WPB; and ASTM A53, Grade B factory fabricated steel.
- .3 Couplings, caps, plugs:
- .1 NPS 1/2 to 1-1/2: Class 3000, 20 MPa, socket weld ends, to ASTM.
 - .2 NPS 2 to 6: roll grooved: rigid coupling designed with angle bolt pads to provide rigid joint to CSA B242 and system support and hanging in accordance with ASME B31.1 and B31.9. EPDM gasket, rated to +121 degrees C.
- .4 Nipples for drains, vents, pressure gauges, similar items:
- .1 NPS 1/2 to 1-1/2: Schedule 80, screwed, to ASTM A53/A53M, Grade A.

- .5 Unions:
 - .1 NPS 1/2 to 1-1/2: Class 3000, 20 MPa, screwed ends, forged steel, steel-to-steel ground joints, to ASTM A105/A105M.

- .6 Flanges:
 - .1 Class 150:
 - .1 NPS 1/2 to 1-1/2: full faced, screwed to ASTM A105/A105M.
 - .2 NPS 2 and over: full faced, weld neck, bored to suit pipe, to ASTM A105/A105M.
 - .2 Class 250:
 - .1 NPS 1/2 to 1-1/2: full faced, weld neck, bored to match pipe, to ASTM A105/A105M.
 - .2 NPS 2 and over: full faced, weld neck, bored to suit pipe, to ASTM A105/A105M.

- .7 Studs, bolts and nuts:
 - .1 Stud bolts, carbon steel, semi-finished with heavy hex nuts, to ASTM A307, Grade B.

- .8 Gaskets:
 - .1 Spiral wound 304 stainless steel rated for pressure and temperature of system.

- .9 Gate valves:
 - .1 NPS 1/2 to 1-1/2: Class 800, forged steel body, socket weld ends, forged steel bolted bonnet and yoke, two-piece self-aligning forged steel gland-flange with stainless steel bolts, stainless steel gland, deep stuffing box, fully guided solid stainless steel wedge disc, renewable Stellite seats. Rising stem.
 - .2 NPS 2 and over: Class 300, raised face flanged ends, cast steel body, OS&Y, flexible disc.

2.4 HIGH PRESSURE (OVER 860 kPa AND UP TO 1725 kPa) HIGH TEMPERATURE HOT WATER (UP TO 215 DEGREES C)

- .1 Piping:
 - .1 To ASTM A106/A106M, Grade B.
 - .2 NPS 1/2 to 1-1/2: Schedule 80, seamless.
 - .3 NPS 2 to 12: Schedule 40, Seamless, bevel ends.

- .2 Fittings:
 - .1 NPS 1/2 to 1-1/2: Class 3000, forged steel socket weld ends, to ASTM A181/A181M, Class 70.
 - .2 NPS 2 to 10: Schedule 40, seamless, bevel ends, to ASTM A234/A234M.
 - .3 NPS 12 and over: 10 mm wall thickness, seamless bevel ends, to ASTM A234/A234M.

- .3 Couplings:
 - .1 NPS 1/2 to 1-1/2: Class 3000, socket weld ends, to ASTM A181/A181M, Class 70.

- .4 Caps, plugs for drains, similar items:
 - .1 NPS 1/2 to 3/4: Class 3000, socket weld, to ASTM A181/A181M, Class 70.
- .5 Nipples for drains, vents, pressure gauges, similar items:
 - .1 NPS 1/2 to 1-1/2: Schedule 80, screwed ends, to ASTM A106/A106M, Grade A.
- .6 Unions:
 - .1 NPS 1/2 to 1-1/2: Class 3000, socket weld ends, forged steel, steel-to-steel ground joints, to ASTM A181/A181M, Class 70.
- .7 Flanges:
 - .1 NPS 1/2 to 1-1/2: Class 300, weld neck, bored to match pipe, to ASTM A105/A105M.
 - .2 NPS 2 and over: Class 300, raised face weld neck, bored to suit pipe, to ASTM A181/A181M.
- .8 Studs, bolts and nuts:
 - .1 Alloy steel studs and bolts, to ASTM A193/A193M, Grade B7, with semi-finished heavy hex head nuts, to ASTM A194/A194M, Grade 2H.
- .9 Gaskets:
 - .1 Steel flex 1.6 mm thick, rated for pressure and pressure of system.

2.5 ANCHORS, GUIDES, SLIDES

- .1 Anchors:
 - .1 Provide as indicated.
- .2 Alignment guides:
 - .1 Provide as indicated.
 - .2 To accommodate specified thickness of insulation.
 - .3 Vapour barriers on chilled water mains: Jackets to remain uninterrupted.
- .3 Pipe slides:
 - .1 For longitudinal and lateral movement as indicated with carbon steel base with filled PTFE pad and 1 mm thick Type 304 stainless steel slide plate covering full face of saddle and tack-welding along sides of saddle.
 - .2 Provide approved graphite silicone lubricant between metal-to-metal surfaces and bearings as recommended by manufacturer.

2.6 EXPANSION JOINTS - BELLOWS TYPE

- .1 Externally pressurized bellows, maintenance free, factory tested to 1-1/2 times maximum working pressure. Furnish test certificates.

- .2 Operating conditions: refer to schedule for details.
 - .1 Pressure classification: 1035 kPa.
- .3 To match distribution piping.
- .4 Construction:
 - .1 Bellows: multiple bellows, bellows shall be fully enclosed externally pressurized type, hydraulically formed, single ply austenitic stainless steel for specified fluid, pressure and temperature, water treatment and pipeline cleaning procedures.

2.7 BASES, HANGERS AND SUPPORTS

- .1 Conform to Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment supplemented as specified herein.
- .2 Provide to details as indicated.
- .3 Submit shop drawings for approval before fabrication.
- .4 Percussion type inserts not permitted.
- .5 Power driven fasteners not permitted.

2.8 FABRICATION

- .1 Do work in accordance with ASME B31.1.
- .2 Joints:
 - .1 Accessible locations: screwed, flanged or welded to match piping specification.
 - .2 Elsewhere: welded throughout, except at flanged components.
 - .3 Grooved joints on applicable systems in lieu of welded, flanged, or screwed joints and components.
- .3 Screwed joints:
 - .1 To ASME B1.20.1.
 - .2 Provide clean machine-cut threads.
 - .3 Use PTFE tape or lead-free pipe dope or paste on male threads.
- .4 Branch connections:
 - .1 Use butt or socket-weld fittings.
 - .2 Mains NPS 2-1/2 and smaller: use weldolets, threadolets, or 2 Mpa half couplings as reinforcements.
 - .3 Mains NPS 3 and larger: welded branch connections can be used.
 - .4 In grooved systems: tees and reducing tees can be used.

PART 3 EXECUTION

3.1 PREPARATION

- .1 Lay out work in accordance with lines and grades as indicated.
- .2 Verify lines, levels, dimensions as indicated against established benchmarks. Report discrepancies to Departmental Representative and obtain written instruction.
- .3 When required by Departmental Representative, provide drawings showing relative locations of various services.

3.2 WELDING

- .1 Perform welding in accordance with Section 23 05 17 - Pipe Welding supplemented as specified herein.
- .2 Notwithstanding the requirements of referenced section, the following shall apply:
 - .1 Welding to be in accordance with ASME B31.1.
 - .2 Welding to be executed by certified pipe welders.
 - .3 Pipe fitting to be executed by certified pipe fitters.

3.3 INSTALLATION

- .1 Installation to be performed by certified steam fitters.
- .2 Install pipework in accordance with Section 23 05 05 - Installation of Pipework, as specified herein.
- .3 Clearances:
 - .1 Maintain clearance around systems, equipment and components and between pipes and structures for O&M as directed by manufacturer's recommendations:
 - .1 Observation of operation, inspection, servicing, maintenance.
 - .2 Disassembly, removal of equipment and components without interrupting operation of other system, equipment, components.
 - .2 Except where indicated, install to permit separate thermal insulation of pipes.
- .4 Flanges: use suitable graphite lubricant on bolts and nuts.
- .5 Provide for pipe movement as indicated and in accordance with expansion joint manufacturer's installation instructions.
- .6 Branch take-offs:
 - .1 Use welding tees.
 - .2 Where reducing tees of proper size are unavailable, use available tees with

reducers. Tees with increasers not acceptable.

.3 Weldolets may be used at drip legs only provided ratio of outlet size to pipe size is 0.5 or smaller.

- .7 Cap open ends of piping during installation. Remove foreign material from inside piping.
- .8 Grade nominally horizontal piping in direction of flow as indicated at 0.4% slope to high point for air removal and to low point for condensate drainage.
- .9 Flanges: tighten bolts evenly with torque wrench.
- .10 Revisions to location of piping require written approval of Departmental Representative.
- .11 Connections to equipment:
 - .1 Use flanged valves for isolation and ease of maintenance and assembly.
 - .2 Use double swing joints and swing joints when equipment mounted on vibration isolation and when piping subject to movement.
- .12 Expansion Joints:
 - .1 Install to manufacturer's recommendations.
- .13 Anchors and Guides:
 - .1 Locate anchors and guides as indicated and in accordance with manufacturer's recommendations.
 - .2 Align piping at expansion joints and guides to avoid damage by movement of piping against fixed structures.

3.4 COLD SPRINGING

- .1 Except where cold springing is indicated or specified, do not force pipes into position.
- .2 Cold springing and pre-compression requirements to be based upon ambient temperature during installation of 30 degrees C and maximum operating temperature.
- .3 Cold springing of expansion joints: to recommendation of manufacturer and in presence of Departmental Representative and Manufacturer's Representative.
- .4 Pre-compress expansion joints in accordance with manufacturer's recommendations.

3.5 PIPE SUPPORTS

- .1 In accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment, supplemented as specified herein.

- .2 Install to manufacturer's recommendations.
- .3 Expansion joints:
 - .1 Provide supports as indicated, to manufacturer's recommendations as required to maintain venting and drainage.

3.6 VALVES

- .1 Install isolating valves at branch take-offs, at pieces of equipment and elsewhere as indicated.
- .2 Install in accordance with manufacturer's recommendations.
- .3 Install in accessible locations.
- .4 Depending upon piping configuration and ease of operation, on horizontal pipes install with stem horizontal or above.
- .5 Valves to be accessible for maintenance without removing adjacent piping.

3.7 FIELD QUALITY CONTROL

- .1 Inspections:
 - .1 Leave joints in piping systems uncovered until tests are completed and system inspected by Departmental Representative.
 - .2 Radiographic inspections:
 - .1 Notwithstanding inspection specified in Section 23 05 17 - Pipe Welding, carry out radiograph inspections of 10% of welds on HTHW piping to ASME B31.1.
 - .2 If joints on 10% radiographic test fail, radiograph joints performed by welder whose joint failed.
 - .3 Radiograph repaired joints to ASME B31.1.
 - .4 Perform Wet and Dry magnetic particle tests on welded slip-on flanges.
 - .5 Submit results of radiographs, together with copy of welder's licence and description of procedures used, to inspector of insurance company under contract to PWGSC.
 - .3 Departmental Representative and Authority Having Jurisdiction to inspect new piping for compliance with approved drawings and specifications.
 - .4 Obtain from Departmental Representative requirements for inspection and testing of system modifications, design changes and repairs performed in-house.
 - .5 Pay costs for inspections.

3.8 FLUSHING AND CLEANING

- .1 Cleaning Solutions.

- .2 Timing:
 - .1 Systems to be operational with safety devices functional, before cleaning is carried out.
- .3 Conditions at time of cleaning:
 - .1 Systems to be free from construction debris, dirt and other foreign material.
 - .2 Control valves to be operational, fully open to ensure that terminal units can be cleaned properly.
- .4 Cleaning procedures:
 - .1 Vacuum out inside of piping 305 mm prior to installing new piping and welding new piping in place.
- .5 Waste Management: separate waste materials for reuse and recycling.

3.9 SYSTEM START-UP - GENERAL

- .1 Provide 3 days written notice to Departmental Representative of requirement to have plant personnel start-up systems. Plant personnel will refill and start system.
- .2 Timing: after:
 - .1 Joints radiographed as specified.
 - .2 Painting of supports, steelwork to be completed before heat is applied to system.
- .3 Provide continuous supervision during start-up.

3.10 SYSTEM START-UP HYDRONIC SYSTEMS

- .1 Adjust pipe supports, hangers, springs as necessary.
- .2 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
- .3 During start-up, check operation of expansion loops, joints, anchors and guides.
- .4 Re-tighten bolts, using torque wrench. Repeat several times during commissioning.

3.11 IDENTIFICATION

- .1 In accordance with Section 23 05 53.01 - Mechanical Identification, supplemented as specified herein.
- .2 In addition, identify piping at building entries.