

PART 1 - GENERAL

- 1.1 RELATED REQUIREMENTS .1 Section 01 33 00 - Submittal Procedures.
.2 Section 01 61 00 - Common Product Requirements.
.3 Section 01 74 11 - Cleaning.
.4 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
.5 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
- 1.2 REFERENCES .1 Canadian General Standards Board (CGSB)
.1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- 1.3 ACTION AND INFORMATIONAL SUBMITTALS .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- 1.4 DELIVERY, STORAGE AND HANDLING .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
.2 Delivery and Acceptance Requirements:
.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 in accordance with Section 01 74 21 - Construction/ Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

- 2.1 NOT USED .1 Not used.
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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.
- 3.3 CLEARANCES .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer.
.2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer or as indicated (whichever is greater) without interrupting operation of other system, equipment, 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 Drain valves: NPS 3/4 ball valves unless indicated otherwise, with hose end male thread, cap and chain.
- 3.5 AIR VENTS .1 Install manual air vents to at high points in piping systems.
.2 Install isolating valve at each automatic air valve.
.3 Install drain piping to approved location and terminate where discharge is visible.
- 3.6 DIELECTRIC 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.
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3.7 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 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .6 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .7 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .8 Group piping wherever possible and as indicated.
- .9 Ream pipes, remove scale and other foreign material before assembly.
- .10 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .11 Provide for thermal expansion as indicated.
- .12 Valves:
 - .1 Install in accessible locations.
 - .2 Install with stems above horizontal position unless indicated.
 - .3 Valves accessible for maintenance without removing adjacent piping.
 - .4 Install butterfly valve on chilled and condenser water supply and return as indicated.
 - .5 Install butterfly valves between new weld neck flanges to ensure full compression of liner. Modify existing pipe for new valves and flanges.
 - .6 Use chain operators on valves NPS 2-1/2 and larger where installed more than 2400 mm above floor in Mechanical Rooms.

3.8 SLEEVES

- .1 General: install where pipes pass through concrete structures assemblies and as indicated.
- .2 Material: schedule 40 black steel pipe.
- .3 Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.
- .4 Sizes: 25 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 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.

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- 3.9 FLUSHING OUT OF PIPING SYSTEMS
- .1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
 - .2 Preparatory to acceptance, clean and refurbish equipment and leave in operating conditions.
 - .3 Provide test results upon completion and retain written report on status after complete.
- 3.10 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK
- .1 Advise Departmental Representative 48 hours minimum prior to performance of pressure tests.
 - .2 Pipework: test to 1-1/2 times normal operating pressure to a maximum of the piping systems working pressure including devices (i.e. valves, fittings, accessories).
 - .3 Maintain specified test pressure without loss for 8 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.
- 3.11 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.
 - .4 Ensure daily clean-up of existing areas.
 - .5 Coordinate with the Departmental Representative for chilled water and condenser water shutdown. Allow for after hour work to remove existing and install new valves and piping.
- 3.12 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 in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 1 - GENERAL

- 1.1 REFERENCES .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
- .1 ANSI/ASME B31.1-2010, Power Piping.
 - .2 ANSI/ASME B31.3-2010, Process Piping.
 - .3 ANSI/ASME B31.5-2010, Refrigerant Piping and Heat Transfer Components
 - .4 ANSI/ASME Boiler and Pressure Vessel Code-2010:
 - .1 BPVC 2010 Section I: Power Boilers.
 - .2 BPVC 2010 Section V: Nondestructive Examination.
 - .3 BPVC 2010 Section IX: Welding and Brazing Qualifications.
- .2 American National Standards Institute/American Water Works Association (ANSI/AWWA)
- .1 ANSI/AWWA C206-11, Field Welding of Steel Water Pipe.
- .3 Canadian Standards Association (CSA International)
- .1 CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding.
 - .2 CSA B51-09, Boiler, Pressure Vessel and Pressure Piping Code.
 - .3 CSA-W117.2-06, Safety in Welding, Cutting and Allied Processes.
 - .4 CSA W178.1-08, Certification of Welding Inspection Organizations.
 - .5 CSA W178.2-08, Certification of Welding Inspectors.
- 1.2 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.
- 1.3 INSPECTOR QUALIFICATIONS .1 Inspectors qualified to CSA W178.2.
- 1.4 WELDING PROCEDURES .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 WELDING CONSUMABLES .1 Certified to ASME SFA specifications.

2.2 ELECTRODES .1 Electrodes: in accordance with CSA W48 Series.

PART 3 - EXECUTION

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

3.2 QUALITY OF WORK .1 Welding: in accordance with ANSI/ASME B31.1, ANSI/ASME B31.3, ANSI/ASME B31.5, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to ASME BPVC, Section IX.

3.3 INSTALLATION REQUIREMENTS .1 Identify each weld with welder's identification symbol.

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 pipe joint fit-up and preparation, and welding of circumferential pipe welds after each pass deposited 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 in accordance with CSA W178.1 and CSA W178.2 and approved by Departmental Representative.
.2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.
.3 Inspect and test 100% of pipe welds in accordance with "Inspection and Test Plan" by non-destructive visual examination and by the NDE methods below.

3.5 SPECIALIST
EXAMINATIONS AND
TESTS
(Cont'd)

- .2 The required NDE will be done on weld joints on all chilled water and condenser water piping welds.
 - .1 NDE will be as follows.
 - .1 Piping Welds: All welds in piping will be visually inspected during pipe joint fit-up, and preparation and welding of circumferential pipe welds. Visual welding inspection shall be performed after each pass deposited. All chilled water and condenser water piping welds (100%) will be examined by radiographic test.
 - .2 The acceptance criteria for radiographic particle test and PT is ASME Section V.
 - .3 Hydrostatically test all other piping welds to requirements of ANSI/ASME B31.1.
 - .4 Visual examinations: include entire circumference of weld externally and wherever possible internally.
 - .5 Failure of visual examinations:
 - .1 Upon failure of any weld by visual examination, perform additional testing as directed by Departmental Representative of a total of up to 20% of all welds, selected at random by the Departmental Representative by radiographic particle tests.

3.6 REPAIR OF WELDS
WHICH FAILED TESTS

- .1 Re-inspect and re-test repaired or re-worked welds at Contractor's expense as described in ANSI/ASME B31.1 and ASME BPVC.

PART 1 - GENERAL

- 1.1 RELATED REQUIREMENTS
- .1 Section 01 33 00 - Submittal Procedures.
 - .2 Section 01 61 00 - Common Product Requirements.
 - .3 Section 01 74 11 - Cleaning.
 - .4 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .5 Section 01 78 00 - Closeout Submittals.
- 1.2 REFERENCES
- .1 American Society of Mechanical Engineers (ASME)
 - .1 ANSI/ASME B16.34-2009, Valves Flanged, Threaded and Welding End
 - .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A216/A216M-08, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
 - .2 ASTM A351/A351M-10, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
 - .3 ASTM A564/A564M-10, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
 - .4 ASTM B16/B16M-10, Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines.
 - .5 ASTM B62-09, Specification for Composition Bronze or Ounce Metal Castings.
 - .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - .1 MSS SP-61-2009, Pressure Testing of Valves.
 - .2 MSS SP-68-2011, High Pressure Butterfly Valves with Offset Design.
- 1.3 ACTION AND INFORMATIONAL SUBMITTALS
- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheets for valves and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit data for valves specified in this section.
- 1.4 CLOSEOUT SUBMITTALS
- .1 Submit maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- 1.5 DELIVERY, STORAGE AND HANDLING
- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and 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.
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- 1.5 DELIVERY, STORAGE AND HANDLING (Cont'd) .3 Packaging Waste Management: remove for reuse and return by manufacturer 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 All valves of the same type to be from one manufacturer.
.2 All valves to have CRN registration numbers.
- 2.2 BUTTERFLY VALVES - Class 150 .1 Sizes: NPS 2 and over.
.2 Style: Lug body for end of line service in either direction.
.3 Pressure rating: Class 150.
.4 Bolting: ASME Class 150 steel flanges.
.5 Operators: Worm gear operator.
.6 Valves shall be High Performance Butterfly type with offset seat in conformance with MSS SP-68. Valve body shall be Class 150 in conformance with ANSI/ASME B16.34. Valve seat shall be rated for bubble tight shut-off up to the full body rating (1,965 kPa at 38 degrees C) of the valve with either downstream flange removed.
.7 Valves shall have internal stop to prevent disc over-travel.
.8 Valves shall have retained top and bottom low friction bearings.
.9 Valve shall be equipped with stainless steel nameplate indicating:
.1 Valve make
.2 Valve model
.3 Valve serial number
.4 CRN number
.5 Bi-directional, end-of-line cold water pressure rating
.10 Construction:
.1 Body: ASTM A216 Gr. WCB Cast steel
.2 Disc: ASTM A351 Gr. CF8M
.3 Shaft: ASTM A564 type 630 H1150
.4 All other materials selected by manufacturer for the specified performance rating.
- 2.3 BUTTERFLY VALVES - Class 300 - CHILLED WATER SYSTEM .1 Sizes: NPS 2 and over.
.2 Style: Lug body for end of line service in either direction.
.3 Pressure rating: Class 300.
.4 Bolting: ASME Class 300 steel flanges.
.5 Operators: Worm gear operator.
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- 2.3 BUTTERFLY VALVES - Class 300 - CHILLED WATER SYSTEM (Cont'd)
- .6 Valves shall be High Performance Butterfly type with offset seat in conformance with MSS SP-68. Valve body shall be Class 300 in conformance with ANSI/ASME B16.34. Valve seat shall be rated for bubble tight shut-off up to the full body rating (5,100 kPa at 38 degrees C) of the valve with either downstream flange removed.
 - .7 Valves shall have internal stop to prevent disc over-travel.
 - .8 Valves shall have retained top and bottom low friction bearings.
 - .9 Valve shall be equipped with stainless steel nameplate indicating:
 - .1 Valve make
 - .2 Valve model
 - .3 Valve serial number
 - .4 CRN number
 - .5 Bi-directional, end-of-line cold water pressure rating
 - .10 Construction:
 - .1 Body: ASTM A216 Gr. WCB Cast steel
 - .2 Disc: ASTM A351 Gr. CF8M
 - .3 Shaft: ASTM A564 type 630 H1150
 - .4 All other materials selected by manufacturer for the specified performance rating.
- 2.4 BALL VALVES
- .1 NPS 4 and under:
 - .1 Body and cap: cast high tensile bronze to ASTM B62 or brass to ASTM B16/B16M C36000.
 - .2 Stem: tamperproof ball drive.
 - .3 Stem packing nut: external to body.
 - .4 Ball and seat: replaceable chrome plated brass solid full port ball and teflon seats.
 - .5 Stem seal: TFE with external packing nut.
 - .6 Operator: removable lever handle.
 - .7 Provide Class 150 valve for condenser water and Class 300 for chilled water systems.

PART 3 - EXECUTION

- 3.1 PREPARATION
- .1 Valve and mating flange preparation.
 - .1 Inspect adjacent pipeline, remove rust, scale, welding slag, other foreign material.
 - .2 Ensure that valve seats and pipe flange faces are free of dirt or surface irregularities which may disrupt flange seating and cause external leakage.
 - .3 Install butterfly valves with disc in almost closed position.
 - .4 Inspect valve disc seating surfaces and waterway and eliminate dirt or foreign material.
- 3.2 INSTALLATION OF VALVES
- .1 Install in accordance with manufacturer's instructions.
 - .2 Do not use gaskets between pipe flanges and valves unless instructed otherwise by valve manufacturer.
 - .3 Verify suitability of valve for application by inspection of identification tag.
 - .4 Mount actuator on to valve prior to installation.

3.2 INSTALLATION OF VALVES
(Cont'd)

- .5 Handle valve with care so as to prevent damage to disc and seat faces.
- .6 Valves in horizontal pipe lines should be installed with stem in horizontal position to minimize liner and seal wear.
- .7 Ensure that valves are centered between bolts before bolts are tightened and then opened and closed to ensure unobstructed disc movement. If interference occurs due, for example to pipe wall thickness, taper bore adjacent piping to remove interference.

3.3 TESTING, INSPECTION AND CERTIFICATION

- .1 Valve shall be certified in writing by the manufacturer as been tested in conformance to hydrostatic shell and seat tests of ANSI/ASME B16.34 and MSS SP-61 and shall state that its shutoff rating for cold water service is up to 1,965 kPa for Class 150 and 5,100 KPa for Class 300 with either downstream flange removed.

3.4 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Clean installed products in accordance to manufacturer's recommendation.
- .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 SUMMARY .1 Section Includes:
.1 Hangers and supports for mechanical piping.
- .2 Related Sections:
.1 Section 01 33 00 - Submittal Procedures.
.2 Section 01 35 29.06 - Health and Safety Requirements.
.3 Section 01 61 00 - Common Product Requirements.
.4 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 B31.1-2010, Power Piping.
- .2 ASTM International
.1 ASTM A563-07a, Standard Specification for Carbon and Alloy Steel Nuts.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
.1 Material Safety Data Sheets (MSDS).
- .4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
.1 ANSI/MSS SP-58-2009, Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
- .5 Underwriter's Laboratories of Canada (ULC)
- 1.3 SYSTEM DESCRIPTION .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 MSS SP-58, ANSI/ASME B31.1.
- .3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.
- .4 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.
- 1.4 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 Ontario, Canada.
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- 1.4 SUBMITTALS (Cont'd) .3 Submit shop drawings and product data for following items:
.1 Hangers.
- .4 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
.2 Instructions: submit manufacturer's installation instructions.
.1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.
- 1.5 QUALITY ASSURANCE .1 Health and Safety:
.1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- 1.6 DELIVERY, STORAGE, AND HANDLING .1 Packing, shipping, handling and unloading:
.1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
.1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/ Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

- 2.1 GENERAL .1 Fabricate hangers, supports and sway braces in accordance with ANSI/ANSI B31.1 and MSS SP-58.
- 2.2 PIPE HANGERS .1 Finishes:
.1 Pipe hangers and supports: galvanized after manufacture.
.2 Use electro-plating galvanizing process.
.3 Ensure steel hangers in contact with copper piping are epoxy coated.
- .2 Upper attachment structural: suspension from lower flange of I-Beam:
.1 Cold piping NPS 2-1/2 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 2-1/2 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.
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- 2.2 PIPE HANGERS (Cont'd)
- .4 Upper attachment to concrete:(Cont'd)
 - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed to MSS SP-58.
 - .5 Shop and field-fabricated assemblies:
 - .1 Trapeze hanger assemblies.
 - .2 Steel brackets.
 - .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.
 - .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 A 563.
 - .1 Finishes for steel pipework: black galvanized.
 - .2 Finishes for copper, glass, brass or aluminum pipework: galvanized, with formed portion plastic coated epoxy coated.
 - .11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP 58.

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 Provide steel saddle for insulated pipe to protect insulation.

3.3 HANGER SPACING .1

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	

.2 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:

.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.

PART 1 - GENERAL

- 1.1 RELATED REQUIREMENTS
- .1 Section 01 33 00 - Submittal Procedures.
 - .2 Section 01 35 29.06 - Health and Safety Requirements.
 - .3 Section 01 61 00 - Common Product Requirements.
 - .4 Section 01 74 11 - Cleaning.
 - .5 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .6 Section 26 05 00 - Electrical General Requirements.
- 1.2 REFERENCES
- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- 1.3 ACTION AND INFORMATIONAL SUBMITTALS
- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 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.
 - .3 Instructions: submit manufacturer's installation instructions.
- 1.4 QUALITY ASSURANCE
- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- 1.5 DELIVERY, STORAGE, AND HANDLING
- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
 - .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
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PART 2 - PRODUCTS

**2.1 PIPE TRACING
HEATING CABLES**

- .1 General:
 - .1 Furnish and install a complete UL Listed and CSA Certified system of heating cables, components, and controls to prevent pipes from freezing.
 - .2 Products:
 - .1 The self-regulating heating cable shall consist of two (2) 16 AWG nickel-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heating cable to be cut to length in the field. The heating cable shall be covered by a radiation-crosslinked, modified polyolefin dielectric jacket. To provide a ground path and to enhance the heating cable's ruggedness, the heating cable shall have a braid of tinned copper and an outer jacket of modified polyolefin as required per section 427-23 of the NEC-1996. For installation on plastic piping, the heating cable shall be applied using aluminum tape (AT-180).
 - .2 In order to conserve energy and to prevent overheating, the heating cable shall have a self-regulating factor of at least 90%. The self-regulating factor is defined as the percentage reduction, without thermostatic control, of the heating cable output going from 4.4°C pipe temperature operation to 65°C pipe temperature operation.
 - .3 The heating cable shall operate on line voltages of 208 volts without the use of transformers.
 - .4 The heating cable for metal pipe freeze protection shall be sized according to the table below. The required heating cable output rating is in watts per foot at 65°C. (Heating cable selection based on 25 mm fibreglass insulation on metal piping.)

<u>Pipe Size (inches)</u>	<u>Minimum Ambient Temperature -29°C</u>
3 or less	5 watts
4	5 watts
6	8 watts
8	2 strips - 5 watts
10	2 strips - 8 watts
 - .5 Heating-cable circuit shall be protected by a ground-fault device for equipment protection. This requirement is in accordance with section 427-22 of the NEC-1996.
- .3 Components:
 - .1 All heating-cable components shall be UL Listed and CSA Certified, for use as part of the system to provide pipe freeze protection. Component enclosures shall be rated NEMA 4X to prevent water ingress and corrosion. Installation shall not require the installing contractor to cut into the heating-cable core to expose the bus wires. Connection systems that require the installing contractor to strip the bus wires, or that use crimps or terminal blocks, shall not be acceptable. All components that make an electrical connection shall be re-enterable for servicing. No component shall use silicone to seal the electrical connections. An exception will be made in areas where a conduit transition is required.
- .4 System Control:
 - .1 Thermostatic Control - Ambient Sensing: The system shall be controlled by an ambient sensing thermostat set at 4.4°C (adjustable) and through a contractor to receive an on/off signal from the Building Automation System. Div. 25 to provide status and control of heat trace 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 INSTALLATION .1 System must be installed per manufacturer's recommendations.
- .2 Apply the heating cable linearly on the pipe after piping has been successfully pressure-tested. Secure the heating cable to piping with cable ties or fibreglass tape.
- .3 Apply "Electric Traced" labels to the outside of the thermal insulation.
- .4 Distribute and fasten cable evenly on pipe using pipe strap or tape at maximum spacing 0.5 m. Ensure that heating cables do not touch or cross each other at any point. Run only cold leads in conduit and ensure sensing bulb does not touch cable. Ground shield to building ground. Coordinate cable installation with insulation application. Loop additional cable at fittings, valves, and flanges.
- .5 Make power and control connections.
- 3.3 FIELD QUALITY CONTROL .1 Perform tests in accordance with Section 26 05 00 - Electrical General Requirements.
- .2 After insulation and before and after installing the thermal insulation, subject heating cable to testing using a 2500 Vdc Megger. Minimum insulation resistance shall be 20 megohms or greater.
- .3 Where resistance of 50 megohms or less is measured, stop work and advise Departmental Representative.
- 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 REQUIREMENTS
- .1 Section 01 33 00 - Submittal Procedures.
 - .2 Section 01 35 29.06 - Health and Safety Requirements.
 - .3 Section 01 61 00 - Common Product Requirements.
 - .4 Section 01 74 11 - Cleaning.
 - .5 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- 1.2 REFERENCES
- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
 - .2 National Building Code of Canada.
- 1.3 ACTION AND INFORMATIONAL SUBMITTALS
- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 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.
 - .2 Provide separate shop drawings for each isolated system complete with performance and product data.
 - .3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.
 - .3 Manufacturer's Field Reports: manufacturer's field reports specified.
- 1.4 QUALITY ASSURANCE
- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
-

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

PART 2 - PRODUCTS

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

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

- 2.3 HANGERS
- .1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30 degrees arc without metal to metal contact.
 - .2 Type H1 - stable spring, elastomeric element, cup with moulded isolation bushing which passes through hanger box.
 - .3 Performance: to suit application.

- 2.4 SEISMIC CONTROL MEASURES
- .1 General:
 - .1 Provide seismic restraints for all new work required.
 - .2 Seismic control systems to work in every direction.
 - .3 Fasteners and attachment points to resist same maximum load as seismic restraint.
 - .4 Drilled or power driven anchors and fasteners not permitted.
 - .5 No equipment, equipment supports or mounts to fail before failure of structure.
 - .6 Supports of cast iron or threaded pipe not permitted.
 - .7 Seismic control measures not to interfere with integrity of firestopping.
 - .2 Piping systems:
 - .1 Piping systems: hangers longer than 300 mm; brace at each hanger.
 - .2 Compatible with requirements for anchoring and guiding of piping systems.
 - .3 Bracing methods:
 - .1 Approved by Departmental Representative.
 - .2 Structural angles or channels.

- 2.4 SEISMIC CONTROL MEASURES (Cont'd) .3 Bracing methods:(Cont'd)
- .3 Cable restraint system incorporating grommets, shackles and other hardware to ensure alignment of restraints and to avoid bending of cables at connection points. Incorporate neoprene into cable connections to reduce shock loads.

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 Seismic control measures to meet requirements of NBC.
- .2 Install vibration isolation equipment in accordance with manufacturers instructions and adjust mountings to level equipment.
- .3 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.
- .4 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm minimum static deflection as follows:
- .1 Up to NPS4: first 3 points of support. NPS5 to NPS8: first 4 points of support. NPS10 and Over: first 6 points of support.
- .2 First point of support: static deflection of twice deflection of isolated equipment, but not more than 50 mm.
- .5 Where isolation is bolted to floor use vibration isolation rubber washers.
- .6 Block and shim level bases so that ductwork and piping connections can be made to rigid system at operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.
- 3.3 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 SUMMARY .1 Section Includes:
.1 Materials and requirements for the identification of piping systems, duct work, valves and controllers, including the installation and location of identification systems.
- .2 Related Requirements
.1 Section 01 33 00 - Submittal Procedures.
.2 Section 01 35 29.06 - Health and Safety Requirements.
.3 Section 01 61 00 - Common Product Requirements.
.4 Section 01 74 11 - Cleaning.
.5 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 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.
- .2 Samples:
.1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
.2 Samples to include nameplates, labels, tags, lists of proposed legends.
- 1.4 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.
- 1.5 DELIVERY, STORAGE, AND HANDLING .1 Packing, shipping, handling and unloading:
.1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
.1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
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PART 2 - PRODUCTS

- 2.1 EXISTING IDENTIFICATION SYSTEMS .1 Apply existing identification system to new work.
- 2.2 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.
- 2.3 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.
- 2.4 LANGUAGE .1 Identification in English and French.
.2 Use one nameplate and label for both languages.

PART 3 - EXECUTION

- 3.1 MANUFACTURER'S INSTRUCTIONS .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.
- 3.2 TIMING .1 Provide identification only after insulating and painting.
- 3.3 INSTALLATION .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
.2 Identify systems, equipment to conform to PWGSC PMSS.
- 3.4 LOCATION OF IDENTIFICATION ON PIPING SYSTEMS .1 On long straight runs in open areas in chiller plant: 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 On both sides of visual obstruction or where run is difficult to follow.
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3.4 LOCATION OF IDENTIFICATION ON PIPING SYSTEMS (Cont'd)

- .4 On both sides of separations such as walls, floors, partitions.
- .5 At beginning and end points of each run and at each piece of equipment in run.
- .6 At point immediately upstream of major manually operated or automatically controlled valves. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .7 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 controller: Secure tags with non-ferrous chains or closed "S" hooks.
- .2 Install one copy of flow diagrams, valve schedules mounted 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 RELATED REQUIREMENTS .1 Section 01 33 00 - Submittal Procedures.
- 1.2 REFERENCES .1 American Society for Testing and Materials International (ASTM)
.1 ASTM B209-10, Specification for Aluminum and Aluminum Alloy Sheet and Plate.
.2 ASTM C335/C335M-10e1, Standard Test Method for Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.
.3 ASTM C449-07, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
.4 ASTM C547-11e1, Mineral Fiber Pipe Insulation.
.2 Canadian General Standards Board (CGSB)
.1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
.3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
.1 Material Safety Data Sheets (MSDS).
.4 Manufacturer's Trade Associations
.1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).
.5 Underwriters' Laboratories of Canada (ULC)
.1 CAN/ULC S102-10, Surface Burning Characteristics of Building Materials and Assemblies.
.2 CAN/ULC S702-09, Thermal Insulation, Mineral Fibre, for Buildings
- 1.3 DEFINITIONS .1 For purposes of this section:
.1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.
.2 "EXPOSED" - will mean "not concealed" as specified.
.2 TIAC ss:
.1 CRF: Code Rectangular Finish.
.2 CPF: Code Piping Finish.
- 1.4 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.
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PART 2 - PRODUCTS

- 2.1 FIRE AND SMOKE RATING .1 In accordance with CAN/ULC S102.
.1 Maximum flame spread rating: 25.
.2 Maximum smoke developed rating: 50.
- 2.2 INSULATION .1 Mineral fibre specified includes glass fibre, rock wool, slag wool.
.2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
.3 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
.1 Mineral fibre: to CAN/ULC S702 & ASTM C547.
.2 Jacket: to CGSB 51-GP-52Ma.
.3 Maximum "k" factor: to CAN/ULC S702 & ASTM C547.
- 2.3 INSULATION SECUREMENT .1 Tape: self-adhesive, aluminum, 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 JACKETS .1 PVC:
.1 Ontario Building Code compliant for 25/50 flame spread and smoke developed.
.2 Minimum thickness 0.015 mil.
.3 Colour white unless otherwise specified.
.4 Non yellowing UV stabilized.
.5 Minimum service temperatures: -20°C.
.6 Maximum service temperature: 65°C.
.7 Moisture vapour transmission: 0.02 perm.
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- 2.7 JACKETS (Cont'd)
- .1 PVC:(Cont'd)
 - .8 Fastenings:
 - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.
 - .3 Pressure sensitive vinyl tape of matching colour.
 - .2 Aluminum:
 - .1 To ASTM B209.
 - .2 Thickness: 0.50 mm sheet.
 - .3 Finish: embossed.
 - .4 Joining: Longitudinal and circumferential slip joints with 50 mm laps.
 - .5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
 - .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

PART 3 - EXECUTION

- 3.1 MANUFACTURER'S INSTRUCTIONS
- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.
- 3.2 PRE-INSTALLATION REQUIREMENT
- .1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.
 - .2 Surfaces clean, dry, free from foreign material.
- 3.3 INSTALLATION
- .1 Install in accordance with TIAC National Standards.
 - .2 Apply materials in accordance with manufacturers instructions and this specification.
 - .3 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.
 - .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Install hangers, supports outside vapour retarder jacket.
 - .5 Supports, Hangers:
 - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.
- 3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES
- .1 Application: at valves, flanges, meters, sensors and unions at equipment.
 - .2 Design: to permit periodic removal and replacement without damage to adjacent insulation.

3.4 REMOVABLE,
PRE-FABRICATED,
INSULATION AND
ENCLOSURES
(Cont'd)

- .3 Insulation:
.1 Insulation, fastenings and finishes: same as system.
.2 Jacket: aluminum.

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 evaporator water boxes and end sheets, nozzles, valves, flanges and fittings unless otherwise specified. Provide 38 mm thick insulation for evaporator water boxes.
.2 TIAC Code: A-3.
.1 Securements: SS bands at 300 mm on centre.
.2 Seals: VR lap seal adhesive, VR lagging adhesive.
.3 Installation: TIAC Code: 1501-C.
.3 Thickness of insulation as listed in following table.

Applic a-tion	Temp degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)					
			Run out	to 1 25	1-1/4 to 2 38	2-1/2 to 4 38	5 to 6 38	8 & over 38
Chilled water with vapour barrier interior	4-13	A-3	25	25	38	38	38	38
Condenser water with vapour barrier exterior	10-35	A-3	38	38	38	38	50	50

- .4 Finishes:
.1 Exposed indoors: PVC.
.2 Exposed exterior: Aluminum.
.3 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.
.4 Finish attachments: SS bands, at 150 mm on centre. Seals: wing closed.
.5 Installation: to appropriate TIAC code CRF/1 through CPF/5.

PART 1 - GENERAL

- 1.1 RELATED REQUIREMENTS .1 Section 01 33 00 - Submittal Procedures.
.2 Section 01 35 29.06 - Health and Safety Requirements.
.3 Section 01 61 00 - Common Product Requirements. Section 01 74 11 - Cleaning.
.4 Section 01 74 21 - Construction/ Demolition Waste Management and Disposal.
.5 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
.6 Section 23 21 13.02 - Hydronic Systems: Steel.
- 1.2 REFERENCES .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
.1 Material Safety Data Sheets (MSDS).
- 1.3 ACTION AND INFORMATIONAL SUBMITTALS .1 Product Data:
.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- 1.4 QUALITY ASSURANCE .1 Health and Safety:
.1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- 1.5 DELIVERY, STORAGE, AND HANDLING .1 Packing, shipping, handling and unloading:
.1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
.2 Waste Management and Disposal:
.1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/ Demolition Waste Management and Disposal.
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PART 2 - PRODUCTS

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

PART 3 - EXECUTION

- 3.1 MANUFACTURER'S INSTRUCTIONS
- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.
- 3.2 CLEANING HYDRONIC SYSTEMS
- .1 Timing: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.
 - .2 Cleaning Agency:
 - .1 Retain qualified water treatment specialist to perform system cleaning.
 - .3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.
 - .4 Cleaning procedures:
 - .1 Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:
 - .1 Cleaning procedures, flow rates, elapsed time.
 - .2 Chemicals and concentrations used.
 - .3 Inhibitors and concentrations.
 - .4 Specific requirements for completion of work.
 - .5 Special precautions for protecting piping system materials and components.
 - .6 Complete analysis of water used to ensure water will not damage systems or equipment.
 - .5 Conditions at time of cleaning of systems:
 - .1 Systems: free from construction debris, dirt and other foreign material.
 - .2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.
 - .3 Strainers: clean prior to initial fill.
 - .4 Install temporary filters on pumps not equipped with permanent filters.
 - .5 Install pressure gauges on strainers to detect plugging.
 - .6 Report on Completion of Cleaning:
 - .1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.
 - .7 Hydronic Systems:
 - .1 Fill system with water, ensure air is vented from system.
 - .2 Use water metre to record volume of water in system to +/- 0.5%.
 - .3 Add chemicals under direct supervision of chemical treatment supplier.
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3.2 CLEANING
HYDRONIC SYSTEMS
(Cont'd)

- .7 Hydronic Systems:(Cont'd)
- .4 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.
 - .5 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.
 - .6 Add chemical solution to system.
 - .7 Establish circulation, raise temperature slowly to 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 adding to sodium sulphite (test for residual sulphite).

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 Repeat with water at design temperature.
 - .7 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.
 - .8 Bring system up to design temperature and pressure slowly over a 24 hour period.
 - .9 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .10 Adjust pipe supports, hangers, springs as necessary.
 - .11 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
 - .12 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.
 - .13 Check operation of drain valves.
 - .14 Adjust valve stem packings as systems settle down.
 - .15 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 SUMMARY .1 Section Includes.
- .1 Materials and installation for steel piping, valves and fittings for hydronic systems in building services piping.
- .2 Related Requirements
- .1 Section 01 35 29.06 - Health and Safety Requirements.
 - .2 Section 01 74 21 - Construction/ Demolition Waste Management and Disposal.
 - .3 Section 02 41 19 - Selective Demolition.
 - .4 Section 01 91 16 - Exterior Paint.
 - .5 Section 21 05 01 - Common Work Results for Mechanical.
 - .6 Section 23 05 05 - Installation of Pipework.
 - .7 Section 23 05 23.05 - Butterfly Valves.
 - .8 Section 23 05 53.01 - Mechanical Identification.
 - .9 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
- 1.2 REFERENCES .1 American Society of Mechanical Engineers (ASME).
- .1 ANSI/ASME B16.1-2010, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - .2 ANSI/ASME B16.3-2011, Malleable Iron Threaded Fittings: Classes 150 and 300.
 - .3 ANSI/ASME B16.5-2009, Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
 - .4 ANSI/ASME B16.9-2007, Factory-Made Wrought Buttwelding Fittings.
 - .5 ANSI/ASME B18.2.1-2010, Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
 - .6 ANSI/ASME B18.2.2-2010, Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
- .2 American Society for Testing and Materials International, (ASTM).
- .1 ASTM A47/A47M-99(2009), Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M-10, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
 - .3 ASTM A105/ASTM 105M-11, Standard Specification for Carbon Steel Forgings for Piping Applications.
 - .4 ASTM A139/A139M-04(2010), Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over).
- .3 American Water Works Association (AWWA).
- .1 ANSI/AWWA C111/A21.11-07, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .4 Manufacturer's Standardization of the Valve and Fittings Industry (MSS).
- .1 MSS-SP-71-2011, Cast Iron Swing Check Valves Flanged and Threaded Ends.
- 1.3 QUALITY ASSURANCE .1 Health and Safety.
- .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.4 DELIVERY,
STORAGE AND
HANDLING

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

PART 2 - PRODUCTS

2.1 PIPE

- .1 Steel pipe: to ASTM A53/A53M & ASTM A139/A139M, welded, Grade B carbon steel, as follows:
 - .1 NPS 2-1/2 to 10, Schedule 40.
 - .2 NPS 12, Std.
- .2 Provide openings & wells for new accessories including thermometers, pressure gauges, BAS sensors, drain/test connections, etc.
- .3 Provide pipe identification with flow arrows for all new condenser and chilled water piping in accordance with Section 23 05 53.01 - Mechanical Identification.
- .4 Prime and paint all new uninsulated condenser piping in accordance with Section 01 91 16 - Exterior Paint. Colour to match existing.

2.2 PIPE JOINTS

- .1 Condenser and chilled water piping: welded, flanged mechanical couplings.
- .2 Flanges: NPS 2 to 8: Schedule 40 and NPS 10 and over: Standard. Class 150 for condenser water piping and Class 300 for chiller water piping, full faced, weld neck, bored to suit pipe, to: ASTM A105/ASTM 105M.
- .3 Flange gaskets: to ANSI/AWWA C111/A21.11 (black neoprene gaskets).
- .4 Pipe thread: taper.
- .5 Bolts and nuts: to ANSI/ASME B18.2.1 and ANSI/ASME B18.2.2 (Grade 8 studs and nuts).

2.3 FITTINGS AND
ACCESSORIES

- .1 Pipe flanges and flanged fittings:
 - .1 Cast iron: to ANSI/ASME B16.1.
 - .2 Steel: to ANSI/ASME B16.5.
- .2 Butt-welding fittings: steel, to ANSI/ASME B16.9.
- .3 Unions: malleable iron, to ASTM A47/A47M and ANSI/ASME B16.3.
- .4 Steel pipe gaskets, fanges and flanged fittings: to ANSI/ASME B16.5.

2.3 FITTINGS AND
ACCESSORIES
(Cont'd)

- .5 Couplings, caps, plugs:
 - .1 NPS 1/2 to 1-1/2: Class 3000, 20 MPa, socket weld ends, to ASTM.
- .6 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.

2.4 VALVES

- .1 Connections:
 - .1 NPS 2 and smaller: Screwed ends.
 - .2 NPS 2-1/2 and larger: Flanged ends.
- .2 Refer to Section 23 05 23 - Valves.

PART 3 - EXECUTION

3.1 PIPING
INSTALLATION

- .1 Install pipework in accordance with Section 23 05 05 - Installation of Pipe Work. Chilled water system to be Class 300 and condenser water system to be Class 150.

3.2 FLUSHING AND
CLEANING

- .1 As per Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

3.3 TESTING

- .1 Test system in accordance with Section 23 05 05 - Installation of Pipe Work.

PART 1 - GENERAL

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| <u>1.1 RELATED REQUIREMENTS</u> | .1 | Section 01 33 00 - Submittal Procedures. |
| | .2 | Section 01 61 00 - Common Product Requirements. |
| | .3 | Section 01 74 11 - Cleaning. |
| | .4 | Section 01 74 21 - Construction/Demolition Waste Management and Disposal. |
| | .5 | Section 01 78 00 - Closeout Submittals. |
| | | |
| <u>1.2 REFERENCES</u> | .1 | Canadian Standards Association (CSA International). |
| | .2 | Underwriters Laboratories (UL). |
| | | |
| <u>1.3 ACTION AND INFORMATIONAL SUBMITTALS</u> | .1 | Provide submittals in accordance with Section 01 33 00 - Submittal Procedures. |
| | | |
| <u>1.4 CLOSEOUT SUBMITTALS</u> | .1 | Submit maintenance and operation data in accordance with Section 01 78 00 - Closeout Submittals. |
| | | |
| <u>1.5 DELIVERY, STORAGE AND HANDLING</u> | .1 | Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements. |
| | .2 | Deliver materials to site in original factory packaging, labelled with manufacturer's name, address. |
| | .3 | Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal. |
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PART 2 - PRODUCTS

- 2.1 BASIN HEATERS .1 Provide eight 14 kW 575V/3 ϕ /60Hz immersion heaters (two per cell) to maintain condenser water temperature at 4.4°C (40°F) when outside temperature is -29°C (-20°F). Immersion heaters to be UL and CSA rated, copper heating elements and 50 mm diameter connection.
- .2 Immersion heaters to include heater connection plates, basin heater control panel (one per cell), parts assembly hardware and sealer kit and immersion thermostat and level control switch.
- .3 Basin heater control panel to be UL and CSA rated complete with a single probe to sense both water temperature and water level, disconnecting contactors, 24V control circuit transformer, NEMA 4 enclosure. Control panel to contain contacts for interlocking immersion heaters to condenser pumps.
- .4 Immersion thermostat and level control switch to operate heaters on low temperature when basin is filled. Provide wiring as per manufacturer's instructions.

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 GENERAL .1 Maintain adequate clearance to permit service and maintenance.
- .2 Should deviations beyond allowable clearances arise, request and follow Departmental Representative's directive.
- .3 Check shop drawings for conformance of tappings for ancillaries and for equipment operating weights.
- 3.3 BASIN HEATERS .1 Install immersion heaters, control panels and accessories as per manufacturer's instructions.
- .2 Interlock immersion heaters to condenser pumps to de-energize heaters when pumps are running.
- 3.4 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 in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.