

PART 1 - GENERAL

1.1 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .2 Canadian Standards Association (CSA International)
 - .1 CSA B139 Series-15, Installation Code for Oil Burning Equipment.
- .3 Green Seal Environmental Standards (GSES)
 - .1 Standard GS-11-2008, 2nd Edition, Environmental Standard for Paints and Coatings.
- .4 National Fire Code of Canada (NFCC 2005)
- .5 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
 - .1 SCAQMD Rule 1113-A2007, Architectural Coatings.
 - .2 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

1.3 DELIVERY, STORAGE AND HANDLING

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

- .1 Paint: zinc-rich to CAN/CGSB-1.181.
 - .1 Primers Paints Coating: in accordance with manufacturer's recommendations for surface conditions.
 - .2 Primer: maximum VOC limit 250 g/L to Standard GS-11 to SCAQMD Rule 1113.
 - .3 Paints: maximum VOC limit 150 g/L to Standard GS-11 to SCAQMD Rule 1113.
- .2 Fire Stopping: in accordance with Section 07 84 00 - Fire Stopping.

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 Screwed fittings jointed with Teflon tape.
- .2 Protect openings against entry of foreign material.
- .3 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .4 Assemble piping using fittings manufactured to ANSI standards.
- .5 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.
 - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .6 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.

- .7 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- .8 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .9 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .10 Group piping wherever possible and as indicated.
- .11 Ream pipes, remove scale and other foreign material before assembly.
- .12 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .13 Provide for thermal expansion as indicated.
- .14 Valves:
 - .1 Install in accessible locations.
 - .2 Remove interior parts before soldering.
 - .3 Install with stems above horizontal position unless indicated.
 - .4 Valves accessible for maintenance without removing adjacent piping.
 - .5 Install globe valves in bypass around control valves.
 - .6 Use ball valves at branch take-offs for isolating purposes except where specified.
 - .7 Install ball valves on chilled water and related condenser water systems only.
- .15 Check Valves:
 - .1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and as indicated.
 - .2 Install swing check valves in horizontal lines on discharge of pumps and as indicated.

3.8 SLEEVES

- .1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and as indicated.
- .2 Material: schedule 40 black steel pipe.
- .3 Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.
- .4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Installation:
 - .1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished
 - .2 Other floors: terminate 25 mm above finished floor.
 - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to surface. CAN/CGSB-1.181.

- .6 Sealing:
 - .1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.
 - .2 Elsewhere:
 - .1 Provide space for firestopping.
 - .2 Maintain fire rating integrity.
 - .3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.
 - .4 Ensure no contact between copper pipe or tube and sleeve.

3.9 ESCUTCHEONS

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

3.10 PREPARATION FOR FIRE STOPPING

- .1 Install firestopping within annular space between pipes, ducts, insulation and adjacent fire separation in accordance with Section 07 84 00 - Fire Stopping.
- .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 fires topping material or installation.
- .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barriers.

3.11 FLUSHING OUT OF PIPING SYSTEMS

- .1 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 11 - Cleaning supplemented as specified in relevant mechanical sections.
- .2 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.12 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

- .1 Advise 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.

3.13 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.

3.14 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 SUMMARY

- .1 Section Includes:
 - .1 Electrical motors, drives and guards for mechanical equipment and systems.
 - .2 Supplier and installer responsibility indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.
 - .3 Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 50 V which are related to control systems specified in Division 22 and 23. Refer to Division 26 for quality of materials and workmanship.
- .2 Related Requirements
 - .1 Section 01 33 00 - Submittal Procedures.
 - .2 Section 01 45 00 - Quality Control.
 - .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 01 78 00 - Closeout Submittals.

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 90.1-2016, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved; Continuous Maintenance Standard).
- .2 Electrical Equipment Manufacturers' Association Council (EEMAC)
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .4 National Electrical Manufacturers Association (NEMA)
 - .1 NEMA MG 1-2016, Motors and Generators.

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 copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario.
- .3 Quality Control: in accordance with Section 01 45 00 - Quality Control.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.
- .4 Closeout Submittals
 - .1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 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 in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 GENERAL

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

2.2 MOTORS

- .1 Provide motors for mechanical equipment as specified.
- .2 Motors 11.2 kW (15 HP) and larger: EEMAC Class B/F, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 45°C/60°C over ambient of 30°C, 3 phase, 600 V, c/w integral thermistor protection, unless otherwise specified or indicated. Provide shaft grounding kits for each motor.

- .3 Motors to be compatible for VFD and shall be premium efficiency, inverter duty type to NEMA MG 1 Part 31 and shall have as a minimum EEMAC Class F insulation. There shall be no restrictions on the cable length between the VFD and the motor. Inverter ready motors shall not be acceptable.

2.3 BELT DRIVES

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

2.4 DRIVE GUARDS

- .1 Provide guards for unprotected drives.
- .2 Guards for belt drives;
 - .1 Expanded metal screen welded to steel frame.
 - .2 Minimum 1.2 mm thick sheet metal tops and bottoms.
 - .3 38 mm dia holes on both shaft centres for insertion of tachometer.
 - .4 Removable for servicing.
- .3 Provide means to permit lubrication and use of test instruments with guards in place.
- .4 Install belt guards to allow movement of motors for adjusting belt tension. -

- .5 Guard for flexible coupling:
 - .1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.
 - .2 Securely fasten in place.
 - .3 Removable for servicing.

- .6 Unprotected fan inlets or outlets:
 - .1 Wire or expanded metal screen, galvanized, 19 mm mesh.
 - .2 Net free area of guard: not less than 80% of fan openings.
 - .3 Securely fasten in place.
 - .4 Removable for servicing.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

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

3.3 FIELD QUALITY CONTROL

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

3.4 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.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B31.1-2016, Power Piping.
 - .2 ASME B31.3-2016, Process Piping.
 - .3 ASME Boiler and Pressure Vessel Code-2017:
 - .1 ASME BPVC-I-2017, Power Boilers.
 - .2 ASME BPVC-V-2017, Nondestructive Examination.
 - .3 ASME BPVC-IX-2017, Welding and Brazing Qualifications.
- .2 American Water Works Association (AWWA)
 - .1 AWWA C206-17, Field Welding of Steel Water Pipe.
- .3 American Welding Society (AWS)
 - .1 AWS C1.1M/C1.1-2000 (R2012), Recommended Practices for Resistance Welding.
- .4 Canadian Standards Association (CSA International)
 - .3 CSA B51-14, Boiler, Pressure Vessel and Pressure Piping Code.
 - .1 CSA W47.2-11 (R2015), Certification of Companies for Fusion Welding of Aluminum.
 - .2 CSA W48-14, Filler Metals and Allied Materials for Metal Arc Welding.
 - .3 CSA-W117.2-12, Safety in Welding, Cutting and Allied Processes.
 - .4 CSA W178.1-14, Certification of Welding Inspection Organizations.
 - .5 CSA W178.2-14, Certification of Welding Inspectors.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

1.3 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Welders:
 - .1 Welding qualifications in accordance with CSA B51.
 - .2 Use qualified and licensed welders possessing certificate for each procedure performed from authority having jurisdiction.
 - .3 Submit welder's qualifications to 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.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 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 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 ASME B31.1, B31.3, ASME BPVC-I and IX and AWWA C206, using procedures conforming to AWS C1.1, and special procedures specified elsewhere in Division 15 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.

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 ASME BPVC-V, CSA B51 and requirements of authority having jurisdiction.
 - .3 Inspect and test 10% of welds in accordance with "Inspection and Test Plan" by non-destructive visual examination and magnetic particle (hereinafter referred to as "particle") tests and spot full gamma ray radiographic (hereinafter referred to as "radiography") tests.
- .2 Hydrostatically test welds to ASME B31.1.
- .3 Visual examinations: include entire circumference of weld externally and wherever possible internally.
- .4 Failure of visual examinations:
 - .1 Upon failure of welds by visual examination, perform additional testing as directed by Departmental Representative of total of up to 10% of welds, selected at random by Departmental Representative by radiographic particle tests.

- .5 Full radiographic tests for piping systems.
 - .1 Spot radiography:
 - .1 Conduct spot radiographic tests of up to 10% of welds, 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 ASME B31.1 and ASME Boiler and Pressure Vessels Code.
- .2 In addition, chilled water systems below 1034 kPa:
 - .1 Undercutting greater than 0.8 mm adjacent to cover bead on outside of pipe.
 - .2 Undercutting greater than 0.8 mm adjacent to root bead on inside of pipe.
 - .3 Undercutting greater than 0.8 mm at combination of internal surface and external surface.
 - .4 Incomplete penetration and incomplete fusion greater than total length of 38 mm in 1500 mm length of weld depth of such defects being greater than 0.8 mm.
 - .5 Repair cracks and defects in excess of 0.8 mm in depth.
 - .6 Repair defects whose depth cannot be determined accurately on basis of visual examination or radiographic tests.

3.7 REPAIR OF WELDS WHICH FAILED TESTS

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

3.8 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 53.01 - Mechanical Identification.

1.2 REFERENCES

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

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for thermometers and pressure gauges 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.
- .4 Certificates:
 - .1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Test and Evaluation Reports:
 - .1 Submit certified test reports for thermometers and pressure gauges from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.

1.4 DELIVERY, STORAGE AND HANDLING

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

- .3 Storage and Handling Requirements:
 - .1 Store thermometers and pressure gauges off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect thermometers and pressure gauges from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan Waste Reduction Workplan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 GENERAL

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

2.2 DIRECT READING THERMOMETERS

- .1 Industrial, variable angle type, mercury-free, liquid filled, 125 mm scale length: to CAN/CGSB-14.4 & ASME B40.200.
 - .1 Resistance to shock and vibration.

2.3 THERMOMETER WELLS

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

2.4 PRESSURE GAUGES

- .1 112 mm, dial type: to ASME B40.100, Grade 2A, stainless steel bourdon tube having 0.5% accuracy full scale unless otherwise specified.
- .2 Provide:
 - .1 Siphon for steam service.
 - .2 Snubber for pulsating operation.
 - .3 Diaphragm assembly for corrosive service.
 - .4 Gasketed pressure relief back with solid front.
 - .5 Bronze stop cock.
 - .6 Oil filled for high vibration applications.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 GENERAL

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

3.3 THERMOMETERS

- .1 Install in wells on piping. Include heat conductive material inside well.
- .2 Install in locations as indicated and on inlet and outlet of:
 - .1 Heat exchangers.
 - .2 Water heating and cooling coils.
- .3 Install wells as indicated only for balancing purposes.
- .4 Use extensions where thermometers are installed through insulation.

3.4 PRESSURE GAUGES

- .1 Install in locations as follows:
 - .1 Suction and discharge of pumps.
 - .2 Upstream and downstream of PRV's.
 - .3 Upstream and downstream of control valves.
 - .4 Inlet and outlet of coils.
 - .5 Inlet and outlet of liquid side of heat exchangers.
 - .6 In other locations as indicated.
- .2 Install gauge cocks for balancing purposes, elsewhere as indicated.
- .3 Use extensions where pressure gauges are installed through insulation.

3.5 NAMEPLATES

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

3.6 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

3.7 PROTECTION

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

PART 1 - GENERAL

1.1 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.18-2012, Cast Copper Alloy Solder Joint Pressure Fittings.
- .2 ASTM International
 - .1 ASTM B62-17, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .2 ASTM B505/B505M-14, Standard Specification for Copper-Base Alloy Continuous Castings.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - .1 MSS-SP-80-2013, Bronze Gate Globe, Angle and Check Valves.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 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 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 DELIVERY, STORAGE AND HANDLING

- .1 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 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 speciality valves, to be single manufacturer.
 - .2 Products to have CRN registration numbers.

- .2 End Connections:
 - .1 Connection into adjacent piping/tubing:
 - .1 Copper tube systems: solder ends to ASME B16.18.

- .3 Globe Valves:
 - .1 Requirements common to globe valves, Class 300 unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: union with hexagonal shoulders.
 - .3 Connections: screwed with hexagonal shoulders.
 - .4 Pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - .5 Stuffing box: threaded to bonnet with gland follower, packing nut, high grade non-asbestos packing.
 - .6 Handwheel: non-ferrous.
 - .7 Handwheel Nut: bronze to ASTM B62.
 - .2 NPS 2 and under, composition disc, Class 300:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc in easily removable disc holder, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
 - .3 Operator: handwheel.

- .4 Ball Valves:
 - .1 NPS 4 and under:
 - .1 Body and cap: cast high tensile bronze to ASTM B62.
 - .2 Pressure rating: 2760-kPa CWP, Class 300 minimum.
 - .3 Connections: solder ends to ASME.
 - .4 Stem: tamperproof ball drive.
 - .5 Stem packing nut: external to body.
 - .6 Ball and seat: replaceable stainless steel solid ball and Teflon seats.
 - .7 Stem seal: TFE with external packing nut.
 - .8 Operator: removable lever handle.

PART 3 - EXECUTION

3.1 INSTALLATION

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

END OF SECTION

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 ASME B16.34-2013 Valves Flanged, Threaded and Welding End
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A193/A193M-16, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
 - .2 ASTM A194/A194M-17, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
 - .3 ASTM A216/A216M-16, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
 - .4 ASTM B16/B16M-10(2015), Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines.
 - .5 ASTM B62-17, Specification for Composition Bronze or Ounce Metal Castings.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - .1 MSS SP-61-2013, Pressure Testing of Valves.

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.
- .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 CHECK VALVES

- .1 NPS 2½ and over, cast steel:
 - .1 Body and multiple-bolted cap: cast steel to ASTM A216/A216M WCB.
 - .2 Cap studs: to ASTM A193/A193M Type B7.
 - .3 Cap nuts: to ASTM A194/A194M Type 2H.
 - .4 Body/cap joint: male-female face with corrugated metallic gasket.
 - .5 Disc: heat treated corrosion and heat resistant 13% chromium steel.
 - .6 Seat rings: heat treated corrosion and heat resistant 13% chromium steel, slipped in, seal welded, ground to match disc.
 - .7 Provide Class 300 valve.

2.3 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 300 valve for chilled water.

2.4 CIRCUIT BALANCING VALVES (CBV)

- .1 General:
 - .1 Y style globe valve, designed to provide precise flow measurement and control, with valved ports for connection to differential pressure meter. Provide Class 150 for condenser and chilled water and Class 300 for heating water system.
- .2 Accuracy:
 - .1 Readout to be within plus or minus 2% of actual flow at design flow rate.
- .3 Pressure die-cast dezincification resistant copper alloy construction, Teflon disc, screw-in bonnet.
 - .1 Flow control: At least four 4 full turns of handwheel with digital handwheel and tamperproof concealed mechanical memory.
- .4 Insulation:
 - .1 Use prefabricated shipping packaging of 5.4 R polyurethane as insulation.
- .5 Drain connection:
 - .1 NPS 3/4 valved and capped, suitable for hose socket.
 - .2 Incorporated into valve body or provided as separate item.
- .6 Size:
 - .1 Valve to be sized for a minimum pressure drop of 6 kPa (2 ft.) at design flow at mid range. Provide pipe reducers as required.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION OF VALVES

- .1 Install in accordance with manufacturer's instructions.
- .2 Do not use gaskets between pipe flanges and valves unless instructed otherwise by valve manufacturer.
- .3 Verify suitability of valve for application by inspection of identification tag.
- .4 Mount actuator on to valve prior to installation.
- .5 Handle valve with care so as to prevent damage to disc and seat faces.
- .6 Valves in horizontal pipe lines should be installed with stem in horizontal position to minimize liner and seal wear.
- .7 Ensure that valves are centred 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.
- .8 Handwheel with chain operators are to be installed on all valves more than 3 meters above floor.
- .9 Remove internal parts before soldering or brazing.
- .10 Install all valves such that adequate clearance is provided to allow for obstruction free operation.
- .11 Install valves at all branch take-offs and to isolate each piece of equipment, and as indicated.
- .12 For all threaded valves provide one screwed union beside each valve to allow easy replacement of valve.

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 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 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.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 49.01 - Seismic Restraint Systems (SRS) - Type P2 Buildings.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B31.1-2016, Power Piping.
- .2 ASTM International
 - .1 ASTM A125-96(2013)e1, Standard Specification for Steel Springs, Helical, Heat-Treated.
 - .2 ASTM A307-14e1, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .3 ASTM A563-15, 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 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 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 as specified in Section 23 05 49.01 - Seismic Restraint Systems (SRS) - Type P2 Buildings.

2.2 GENERAL

- .1 Fabricate hangers, supports and sway braces in accordance with MSS SP 58. ANSI B31.1 and
- .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: painted with zinc-rich paint after manufacture.
 - .2 Use electro-plating galvanizing process .
 - .3 Ensure steel hangers in contact with copper piping are copper plated or epoxy coated.
- .2 Upper attachment structural: suspension from lower flange of I-Beam:
 - .1 Cold piping 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 & FM approved 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 & FM approved 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 & FM approved.
- .4 Upper attachment to concrete:
 - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
 - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed & FM approved to MSS SP 58.
- .5 Hanger rods: threaded rod material to MSS SP 58:
 - .1 Ensure that hanger rods are subject to tensile loading only.
 - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
 - .3 Do not use 22 mm or 28 mm rod.

- .6 Pipe attachments: material to MSS SP 58:
 - .1 Attachments for steel piping: carbon steel.
 - .2 Attachments for copper piping: copper plated black steel.
 - .3 Use insulation shields for hot pipework.
 - .4 Oversize pipe hangers and supports.
- .7 Adjustable clevis: material to MSS SP 58 UL listed & FM approved, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
 - .1 Ensure "U" has hole in bottom for riveting to insulation shields.
- .8 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP 58.
- .9 U-bolts: carbon steel to MSS SP 58 with 2 nuts at each end to ASTM A563.
 - .1 Finishes for steel pipework: black.
 - .2 Finishes for copper, glass, brass or aluminum pipework: black, with formed epoxy coated.
- .10 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP 58.

2.4 RISER CLAMPS

- .1 Steel or cast iron pipe: black carbon steel to MSS SP 58, type 42, UL listed & FM approved.
- .2 Copper pipe: carbon steel copper plated to MSS SP 58, type 42.
- .3 Bolts: to ASTM A307.
- .4 Nuts: to ASTM A563.

2.5 INSULATION PROTECTION SHIELDS

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

2.6 CONSTANT SUPPORT SPRING HANGERS

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

- .2 Load adjustability: 10% minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.
- .3 Provide upper and lower factory set travel stops.
- .4 Provide load adjustment scale for field adjustments.
- .5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.
- .6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.7 VARIABLE SUPPORT SPRING HANGERS

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

2.8 EQUIPMENT SUPPORTS

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

2.9 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install in accordance with:
 - .1 Manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
 - .1 Install on piping systems at pumps, boilers, chillers, cooling towers, and as indicated.
- .3 Clamps on riser piping:
 - .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
 - .2 Bolt-tightening torques to industry standards.
 - .3 Steel pipes: install below coupling or shear lugs welded to pipe.
 - .4 Cast iron pipes: install below joint.
- .4 Clevis plates:
 - .1 Attach to concrete with 4 minimum concrete inserts, one at each corner.
- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
- .6 Use approved constant support type hangers where:
 - .1 Vertical movement of pipework is 13 mm or more,
 - .2 Transfer of load to adjacent hangers or connected equipment is not permitted.
- .7 Use variable support spring hangers where:
 - .1 Transfer of load to adjacent piping or to connected equipment is not critical.
 - .2 Variation in supporting effect does not exceed 25 % of total load.

3.3 HANGER SPACING

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

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

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

3.8 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 RELATED REQUIREMENTS

- .1 Section 21 05 01 - Common Work Results for Mechanical.
- .2 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

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 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 system shop drawings complete with performance and product data.
 - .3 Provide detailed drawings of seismic control measures for equipment and piping.
 - .3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

1.4 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 21 05 01 - Common Work Results for Mechanical.

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 ELASTOMERIC PADS

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

2.3 ELASTOMERIC MOUNTS

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

2.4 SPRINGS

- .1 Design stable springs: ratio of lateral to axial stiffness is equal to or greater than 1.2 times 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 100% relative humidity installations.
- .4 Colour code springs.

2.5 SPRING MOUNT

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

2.6 HANGERS

- .1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30 degrees arc without metal to metal contact.
- .2 Type H1 - neoprene - in-shear, moulded with rod isolation bushing which passes through hanger box.
- .3 Type H2 - stable spring, elastomeric washer, cup with moulded isolation bushing which passes through hanger box.
- .4 Type H3 - stable spring, elastomeric element, cup with moulded isolation bushing which passes through hanger box.
- .5 Type H4 - stable spring, elastomeric element with precompression washer and nut with deflection indicator.

2.7 HORIZONTAL THRUST RESTRAINT

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

2.8 STRUCTURAL BASES

- .1 Type B1 - Prefabricated steel base: integrally welded on sizes up to 2400 mm on smallest dimension, split for field welding on sizes over 2400 mm on smallest dimension and reinforced for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; pre-drilled holes to receive equipment anchor bolts; and complete with adjustable built-in motor slide rail where indicated.
- .2 Type B2 - Steel rail base: structural steel, positioned for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; and pre-drilled holes to receive equipment anchor bolts.
- .3 Bases to clear housekeeping pads by 25 mm minimum.

2.9 INERTIA BASE

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

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install vibration isolation equipment in accordance with manufacturers instructions and adjust mountings to level equipment.
- .2 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.
- .3 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm minimum static deflection as follows:
 - .1 Up to NPS4: first 3 points of support. NPS 5 to NPS 8: first 4 points of support. NPS 10 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.
- .4 Where isolation is bolted to floor use vibration isolation rubber washers.
- .5 Block and shim level bases so that ductwork and piping connections can be made to rigid system at operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

3.3 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract Documents. periodic site to review installation, scheduled as follows:
 - .2 Manufacturer's Field Services: consisting of product use recommendations and visits
 - .1 After delivery and storage of Products.
 - .2 After preparatory work is complete but before installation commences.
 - .3 Twice during the installation, at 25% and 60% completion stages.
 - .4 Upon completion of installation.
 - .3 Submit manufacturer's reports to Departmental Representative within 3 days of manufacturer representative's review.
 - .4 Make adjustments and corrections in accordance with written report.
- .2 Inspection and Certification:
 - .1 Experienced and competent sound and vibration testing professional engineer to take vibration measurement for HVAC systems after start up and TAB of systems to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

3.4 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.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Seismic restraint systems for statically supported and vibration isolated equipment and systems; including all mechanical equipment, both vibration isolated and statically supported.
- .2 Related Requirements
 - .1 Section 21 13 13 - Wet Pipe Sprinkler Systems.

1.2 REFERENCES

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .2 National Research Council Canada (NRCC)
 - .1 NRCC NBCC-2015, National Building Code of Canada 2015.

1.3 DEFINITIONS

- .1 Priority Two (P2) Buildings: buildings in which life safety is of paramount concern. It is not necessary that P2 buildings remain operative during or after earthquake activity.
- .2 SRS: acronym for Seismic Restraint System.

1.4 DESCRIPTION

- .1 SRS fully integrated into, and compatible with:
 - .1 Noise and vibration controls specified elsewhere.
 - .2 Structural, mechanical, electrical design of project.
- .2 Systems, equipment not required to be operational during and after seismic event.
- .3 During seismic event, SRS to prevent systems and equipment from causing personal injury and from moving from normal position.
- .4 Designed by Professional Engineer specializing in design of SRS and registered in Province of Ontario.

1.5 ACTION AND INFORMATIONAL 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.
- .3 Submit design data including:
 - .1 Full details of design criteria.
 - .2 Design calculations (including restraint loads resulting from seismic forces in accordance with National Building Code, detailed work sheets, tables).
 - .3 Separate shop drawings for each SRS and devices for each system, equipment.
 - .4 Identification of location of devices.
 - .5 Schedules of types of SRS equipment and devices.
 - .6 Details of fasteners and attachments to structure, anchorage loadings, attachment methods.
 - .7 Installation procedures and instructions.
 - .8 Design calculations including restraint loads to NBC and Supplement.
 - .9 Detailed work sheets, tables Simplified, Detailed work sheets, tables. Simplified, conservative assumptions may be acceptable.
- .4 Submit additional copy of shop drawings and product data to Structural Engineer for review of connection points to building structure.
- .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 installation supplier's instructions.
- .6 Closeout Submittals:
 - .1 Provide maintenance data including monitoring requirements for incorporation into manuals specified in Section 01 78 00 - Closeout Submittals.

1.6 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.01 - Health and Safety Requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

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

PART 2 - PRODUCTS

2.1 SRS MANUFACTURER

- .1 SRS from one manufacturer regularly engaged in SRS production.

2.2 GENERAL

- .1 SRS to provide gentle and steady cushioning action and avoid high impact loads.
- .2 SRS to restrain seismic forces in every direction.
- .3 Fasteners and attachment points to resist same load as seismic restraints.
- .4 SRS of Piping systems compatible with:
 - .1 Expansion, anchoring and guiding requirements.
 - .2 Equipment vibration isolation and equipment SRS.
- .5 SRS utilizing cast iron, threaded pipe, other brittle materials not permitted.
- .6 Attachments to RC structure:
 - .1 Use high strength mechanical expansion anchors.
 - .2 Drilled or power driven anchors not permitted.
- .7 Wet pipe sprinkler systems: refer to Section 21 13 13 - Wet Pipe Sprinkler Systems.
- .8 Seismic control measures not to interfere with integrity of firestopping.

2.3 SRS FOR STATIC EQUIPMENT, SYSTEMS

- .1 Floor-mounted equipment, systems:
 - .1 Anchor equipment to equipment supports.
 - .2 Anchor equipment supports to structure.
 - .3 Use size of bolts scheduled in approved shop drawings.

- .2 Suspended equipment, systems:
 - .1 Use one or combination of following methods:
 - .1 Install tight to structure.
 - .2 Cross-brace in every direction.
 - .3 Brace back to structure.
 - .4 Slack cable restraint system.
 - .2 SCS to prevent sway in horizontal plane, "rocking" in vertical plane, sliding and buckling in axial direction.
 - .3 Hanger rods to withstand compressive loading and buckling.

2.4 SRS FOR VIBRATION ISOLATED EQUIPMENT

- .1 Floor mounted equipment, systems:
 - .1 Use one or combination of following methods:
 - .1 Vibration isolators with built-in snubbers.
 - .2 Vibration isolators and separate snubbers.
 - .3 Built-up snubber system approved by Departmental Representative, consisting of structural elements and elastomeric layer.
 - .2 SRS to resist complete isolator unloading.
 - .3 SRS not to jeopardize noise and vibration isolation systems. Provide 4-8 mm clearance between seismic restraint snubbers and equipment during normal operation of equipment and systems.
 - .4 Cushioning action: gentle and steady by utilizing elastomeric material or other means in order to avoid high impact loads.

- .2 Suspended equipment, systems:
 - .1 Use one or combination of following methods:
 - .1 Slack cable restraint system.
 - .2 Brace back to structure via vibration isolators and snubbers.

2.5 SLACK CABLE RESTRAINT SYSTEM (SCS)

- .1 Use elastomer materials or similar to avoid high impact loads and provide gentle and steady cushioning action.

- .2 SCS to prevent sway in horizontal plane, "rocking" in vertical plane, sliding and buckling in axial direction.

- .3 Hanger rods to withstand compressive loading and buckling.

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 Attachment points and fasteners:
 - .1 To withstand same maximum load that seismic restraint is to resist and in every direction.
- .2 Slack Cable Systems (SCS):
 - .1 Connect to suspended equipment so that axial projection of wire passes through centre of gravity of equipment.
 - .2 Use appropriate grommets, shackles, other hardware to ensure alignment of avoid restraints and to bending of cables at connection points.
 - .3 Piping systems: provide transverse SCS at 10 m spacing maximum, longitudinal SCS at 20 m maximum or as limited by anchor/slack cable performance.
 - .4 Small pipes may be rigidly secured to larger pipes for restraint purposes, but not reverse.
 - .5 Orient restraint wires on ceiling hung equipment at approximately 90 degrees to each other (in plan), tie back to structure at maximum of 45 degrees to structure.
 - .6 Adjust restraint cables so that they are not visibly slack but permit vibration function isolation system to normally.
 - .7 Tighten cable to reduce slack to 40 mm under thumb pressure. Cable not to support weight during normal operation.
- .3 Install SRS at least 25 mm from equipment, systems, services.
- .4 Miscellaneous equipment not vibration-isolated:
 - .1 Bolt through house-keeping pad to structure.
- .5 Co-ordinate connections with other disciplines.
- .6 Vertical tanks:
 - .1 Anchor through house-keeping pad to structure.
 - .2 Provide steel bands above centre of gravity.
- .7 Horizontal tanks:
 - .1 Provide at least two straps with anchor bolts fastened to structure.

3.3 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract Documents.
 - .2 Manufacturer's Field Services: consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:
 - .1 After delivery and storage of Products.
 - .2 After preparatory work is complete but before installation commences.
 - .3 Twice during the installation, at 25% and 60% completion stages.
 - .4 Upon completion of installation.
 - .3 Submit manufacturer's reports to Departmental Representative within 3 days of manufacturer representative's review.
- .2 Inspection and Certification:
 - .1 SRS: inspected and certified by Seismic Engineer upon completion of installation.
 - .2 Provide written report to Departmental Representative with certificate of compliance.

3.4 CLEANING

- .1 Upon completion and verification of performance of installation, 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.
- .2 Canadian Standards Association (CSA)
 - .1 CSA B149.1-15, Natural Gas and Propane Installation Code.
- .3 National Fire Protection Association (NFPA)
 - .1 NFPA (Fire) 13, Standard for the Installation of Sprinkler Systems, 2016 Edition.
 - .2 NFPA (Fire) 14, Standard for the Installation of Standpipe and Hose Systems, 2016 Edition.

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.
- .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.

1.3 QUALITY ASSURANCE

- .1 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

1.4 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 material for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .2 Dispose of unused paint 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 SYSTEM NAMEPLATES

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

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

- .2 Use maximum of 25 letters/numbers per line.

2.3 EXISTING IDENTIFICATION SYSTEMS

- .1 Apply existing identification system to new work.
- .2 Where existing identification system does not cover for new work, use identification system specified this section.
- .3 Before starting work, obtain written approval of identification system from Departmental Representative.

2.4 PIPING SYSTEMS GOVERNED BY CODES

- .1 Identification:
 - .1 Natural gas: to CSA B149.1 authority having jurisdiction.
 - .2 Propane gas: to CSA B149.1 authority having jurisdiction.
 - .3 Sprinklers: to NFPA (Fire) 13.
 - .4 Standpipe and hose systems: to NFPA (Fire) 14.

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

.7 Colours and Legends:

- .1 Where not listed, obtain direction from Departmental Representative.
- .2 Colours for legends, arrows: to following table:

Background colour:	Legend, arrows:
Yellow	BLACK
Green	WHITE
Red	WHITE

.3 Background colour marking and legends for piping systems:

Contents	Background colour	Legend marking
Condenser water supply	Green	COND. WTR. SUPPLY
Condenser water return	Green	COND. WTR. RETURN
Chilled water supply	Green	CH. WTR. SUPPLY
Chilled water return	Green	CH. WTR. RETURN
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	HEATING RETURN
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Storm water	Green	STORM
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Fire protection water	Red	FIRE PROT. WTR
Sprinklers	Red	SPRINKLERS

2.6 IDENTIFICATION DUCTWORK SYSTEMS

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

2.7 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.

2.8 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.

2.9 LANGUAGE

- .1 Identification in English and French.
- .2 Use one nameplate and label for each language 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 painting specified Section 09 91 23 - Interior Painting has been completed.

3.3 INSTALLATION

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

3.4 NAMEPLATES

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

- .3 Protection:
 - .1 Do not paint, insulate or cover.

3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

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

3.6 VALVES, CONTROLLERS

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

3.7 CLEANING

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

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

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- .1 TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.
- .2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.

1.2 QUALIFICATIONS OF TAB PERSONNEL

- .1 Submit names of personnel to perform TAB to Departmental Representative within 15 days of award of contract.
- .2 Provide documentation confirming qualifications, successful experience.
- .3 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:
 - .1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.
 - .2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-1998.
 - .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing-2002.
- .4 Recommendations and suggested practices contained in the TAB Standard: mandatory.
- .5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.
- .6 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.
- .7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.
- .8 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.
 - .1 For systems or system components not covered in TAB Standard, use TAB by TAB procedures developed Specialist.
 - .2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.3 PURPOSE OF TAB

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

1.4 CO-ORDINATION

- .1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule to ensure completion before acceptance of project.
- .2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

1.5 PRE-TAB REVIEW

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

1.6 START-UP

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

1.7 OPERATION OF SYSTEMS DURING TAB

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

1.8 START OF TAB

- .1 Notify Departmental Representative 7 days prior to start of TAB.
- .2 Start TAB when building is essentially completed, including:
- .3 Installation of ceilings, doors, windows, other construction affecting TAB.
- .4 Application of weatherstripping, sealing, and caulking.
- .5 Pressure, leakage, other tests specified elsewhere Division 23.
- .6 Provisions for TAB installed and operational.
- .7 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
 - .1 Proper thermal overload protection in place for electrical equipment.
 - .2 Air systems:
 - .1 Filters in place, clean.
 - .2 Duct systems clean.
 - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
 - .4 Correct fan rotation.
 - .5 Fire, smoke, volume control dampers installed and open.
 - .6 Coil fins combed, clean.
 - .7 Access doors, installed, closed.
 - .8 Outlets installed, volume control dampers open.

1.9 APPLICATION TOLERANCES

- .1 Do TAB to following tolerances of design values:
 - .1 Other HVAC systems: plus 5%, minus 5%.

1.10 ACCURACY TOLERANCES

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

1.11 INSTRUMENTS

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

1.12 ACTION AND INFORMATIONAL SUBMITTALS

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

1.13 PRELIMINARY TAB REPORT

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

1.14 TAB REPORT

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

1.15 VERIFICATION

- .1 Reported results subject to verification by Departmental Representative.
- .2 Provide personnel and instrumentation to verify up to 30% of reported results.
- .3 Number and location of verified results as directed by Departmental Representative.
- .4 Pay costs to repeat TAB as required to satisfaction of Departmental Representative.

1.16 SETTINGS

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

1.17 COMPLETION OF TAB

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

1.18 AIR AND WATER SYSTEMS

- .1 Standard: TAB to most stringent of this section or TAB standards of AABC, NEBB, SMACNA & ASHRAE.
- .2 Do TAB of systems, equipment, components, controls specified Division 23.
- .3 Qualifications: personnel performing TAB current member in good standing of AABC or NEBB.
- .4 Quality assurance: perform TAB under direction of supervisor qualified to standards of AABC or NEBB.
- .5 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, air and water flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .6 Adjust airflow pattern at all adjustable flow diffusers. Coordinate with Departmental Representative.
- .7 Locations of equipment measurements: to include as appropriate:
 - .1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.
 - .2 At controllers, controlled device.
- .8 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not used.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 Definitions:
 - .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services and equipment in and suspended ceilings non-accessible chases and furred-in spaces.
 - .2 "EXPOSED" - means "not concealed" as previously defined.
 - .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.
 - .2 TIAC Codes:
 - .1 CRD: Code Round Ductwork,
 - .2 CRF: Code Rectangular Finish.
- .2 Reference Standards:
 - .1 ASTM International Inc.
 - .1 ASTM C335/C335M-10e1, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
 - .2 ASTM C553-13, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .3 ASTM C612-14, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .2 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .3 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).
 - .4 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-10, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for duct insulation, and include product characteristics, performance criteria, physical size, finish and limitations.
 - .1 Description of equipment giving manufacturer's name, type, model, year and capacity.
 - .2 Details of operation, servicing and maintenance.
 - .3 Recommended spare parts list.

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

1.3 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Installer: specialist in performing work of this section, qualified to standards member of TIAC.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address and ULC markings.
- .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 FIRE AND SMOKE RATING

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

2.2 INSULATION

- .1 Mineral fibre: as specified 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 C-1: Rigid mineral fibre board to ASTM C612, with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).
- .4 TIAC Code C-2: Mineral fibre blanket to ASTM C553 faced with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).
 - .1 Mineral fibre: to ASTM C553.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to ASTM C553.

2.3 ACCESSORIES

- .1 Vapour retarder lap adhesive:
 - .1 Water based, fire retardant type, compatible with insulation.
- .2 Tape: self-adhesive, aluminum, plain reinforced, 50 mm wide minimum.
- .3 Contact adhesive: quick-setting.
- .4 Tie wire: 1.5 mm stainless steel.
- .5 Fasteners: 4 mm diameter pins with 35 mm diameter clips, length to suit thickness of insulation.

PART 3 - EXECUTION

3.1 APPLICATION

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

3.2 PRE- INSTALLATION REQUIREMENTS

- .1 Pressure test ductwork systems complete, witness and certify.
- .2 Ensure surfaces are clean, dry, free from foreign material.

3.3 INSTALLATION

- .1 Install in accordance with TIAC National Standards.

- .2 Apply materials in accordance with manufacturers instructions and as indicated.
- .3 Use 2 layers with staggered joints when required nominal thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Ensure hangers, and supports are outside vapour retarder jacket.
- .5 Hangers and supports:
 - .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .6 Fasteners: install at 300 mm on centre in horizontal and vertical directions, minimum 2 rows each side.

3.4 DUCTWORK INSULATION SCHEDULE

- .1 Insulation types and thicknesses: conform to following table:

	TIAC Code	Vapour Retarder	Thickness (mm)
Rectangular cold and dual temperature supply air ducts	C-1	yes	50
Round cold and dual temperature supply air ducts	C-2	yes	50
Acoustically lined ducts	none		

3.5 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 Society for Testing and Materials International (ASTM)
 - .1 ASTM B209M-14, 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 Horizontal Pipe Insulation.
 - .3 ASTM C449-07(2013), Standard Specification for Mineral Insulating and Finishing Fiber-Hydraulic-Setting Thermal Cement.
 - .4 ASTM C547-15, Mineral Fiber Pipe Insulation.
 - .5 ASTM C921-10(2015), Standard Practice for Determining the Properties of Jacketing Materials for Thermal 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.
 - .2 CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts.
- .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-S102-07, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S702-14, Thermal Insulation, Mineral Fibre, for Buildings

1.2 DEFINITIONS

- .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services in suspended ceilings and chases non-accessible 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 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:
- .2 Installer: specialist in performing work of this Section, and have at least 3 years successful experience in this size and type of project, qualified to standards of TIAC.
- .3 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 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 in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .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 - PRODUCTS

2.1 FIRE AND SMOKE RATING

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

2.2 INSULATION

- .1 Mineral fibre specified includes glass fibre, rock wool, slag wool.

- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.

- .3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702 & 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 & ASTM C547.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC-S702 & ASTM C547.

- .5 TIAC Code C-2: mineral fibre blanket faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
 - .1 Mineral fibre: to CAN/ULC-S702 & ASTM C547.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC-S702 & ASTM C547.

- .6 TIAC Code A-6: flexible unicellular tubular elastomer.
 - .1 Insulation: with vapour retarder jacket.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Certified by manufacturer: free of potential stress corrosion cracking corrodants.

2.3 INSULATION SECUREMENT

- .1 Tape: self-adhesive, aluminum, plain reinforced, 50 mm wide minimum.
- .2 Contact adhesive: quick setting.
- .3 Canvas adhesive: washable.
- .4 Tie wire: 1.5 mm diameter stainless steel.
- .5 Bands: stainless steel, 19mm 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 Polyvinyl Chloride (PVC):
 - .1 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.
 - .2 Colours: to match adjacent finish paint by Departmental Representative.
 - .3 Minimum service temperatures: -20 degrees C.
 - .4 Maximum service temperature: 65 degrees C.
 - .5 Moisture vapour transmission: 0.02 perm.
 - .6 Thickness: mm.
 - .7 Fastenings:
 - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.
 - .3 Pressure sensitive vinyl tape of matching colour.

- .8 Special requirements:
 - .1 Outdoor: UV rated material at least 0.5 mm thick.
- .2 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.
- .3 Aluminum:
 - .1 To ASTM B209.
 - .2 Thickness: 0.50 mm sheet.
 - .3 Finish: stucco 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 where saddles and shoes insulation saddles have not been provided.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

- .1 Application: at expansion joints, valves, primary flow measuring elements flanges and unions at equipment.
- .2 Design: to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.
- .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 valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 TIAC Code: A-1.
 - .1 Securements: Tape 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: Tape at 300 mm on centre.
 - .2 Seals: VR lap seal adhesive, VR lagging adhesive.
 - .3 Installation: TIAC Code: 1501-C.
- .4 TIAC Code: A-6.
 - .1 Seals: lap seal adhesive, lagging adhesive.
- .5 TIAC Code: C-2 with vapour retarder jacket.
 - .1 Seals: lap seal adhesive, lagging adhesive.
 - .2 Installation: TIAC Code: 1501-C.

- .6 TIAC Code: A-2.
 - .1 Insulation securements:.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code: 1501-H.
- .7 Thickness of insulation as listed in following table.
 - .1 Run-outs to individual units and equipment not exceeding 4000 mm long.
 - .2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Applica- tion	Temp °C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)						
			Run ou	to 1	1-1/4 to 2	2-1/2 to 4	5 to 6	8 & over	
Hot Water Heating	60-94	A-1	25	38	38	38	38	38	
Hot Water Heating	up to 59	A-1	25	25	25	25	38	38	
Domestic HWS		A-1	25	25	25	38	38	38	
Chilled Water	4-13	A-3	25	25	25	25	25	25	
Chilled Water Pump Casing		A-3	25	25	25	25	25	25	
Condenser Water Indoors			—	—	—	—	—	—	
Cooling Coil cond. drain		C-2	25	25	25	25	25	25	

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

3.7 CLEANING

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

END OF SECTION

PART 1 - GENERAL

1.1 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.

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.
 - .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 sulphate (test for residual sulphate).

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 new and 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 of noise movement, absence 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 REFERENCES

- .1 Underwriters Laboratories (UL)
 - .1 UL 719, Nonmetallic-Sheathed Cables.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for water detection & alarm system and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect electric and electronic control systems from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials.

PART 2 - PRODUCTS

2.1 WATER LEAK DETECTION SYSTEM

- .1 Provide a complete water leak detection system including ULC approved controls designed for the areas listed below. Submit system design & system drawings to Departmental Representative for approval.

- .2 Water Sensing Cables and Water Point Sensors:
 - .1 Departmental Representative in collaboration with manufacturer shall specify the installation of water detection cables and point sensors in the following areas:
 - .1 Computer Room
 - .2 Under Raised Floors
 - .3 As shown on drawings.
- .3 Water Sensing Cable:
 - .1 The water sensing cable shall be a four (4) wire design, with two (2) sensing wires, one (1) alarm wire and one (1) continuity wire embedded in a fluoropolymer carrier rod which can sense the presence of water at any point along its length and shall not detect hydrocarbons. The sensing cable design shall have the ability to provide continuous verification of sensing circuit integrity. The sensing wires shall be jacketed with a conductive fluoropolymer and shall be constructed with no metal parts exposed to the environment for corrosion resistance. Sensing cable shall be quick drying and reset within 15 seconds of removal from free water; sensing cable that is braided in construction is not acceptable. No more than one foot of tap water, in contact with a sensing cable at a depth of 1/16 inch, shall be required to cause an alarm at the electronic alarm module. The water sensing cable shall be UL Listed and rated Type CL2P for plenum use. The sensing cable shall have a tensile breaking strength of 160 pounds and an abrasion resistance of >65 cycles per UL 719. The sensing cable shall be vibrant yellow for easy identification within floor voids, drip trays and general service areas. Water sensing cable shall be pre-terminated and modular for quick connection to cables and leak detection components. Soldering or the use of wire nut shall not be a permitted method to join leak detection cable. The sensing cable system shall feature modular branching connectors in order to introduce tee splices into the layout. System shall be laid out in a grid pattern, provide proposed layout for approval.
- .4 Sensor Interface Modules:
 - .1 Contractor shall furnish and install for each leak detection circuit a sensor Interface Module.
 - .2 The sensor interface module shall continuously monitor the sensor cable for continuity faults. The loss of continuity in any of the wires shall result in an alarm condition.
 - .3 The number and location of the Sensor Interface Module shall be indicated on the system drawing. Modules shall include network interface card for connection to existing IT loop, as instructed by Departmental Representative.
- .5 System Control Panel:
 - .1 Contractor shall furnish & install packaged wall mounted control panel for full monitoring of complete water sensing system.
 - .2 Panel shall be packaged, ULC listed, baked enamel finish, LED display, with user interface keypad or touch screen interface.
 - .3 Panel shall include network interface card for connection to existing IT loop, as instructed by Departmental Representative.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- .1 All leak detection system components shall be installed in accordance with the manufacturer's installation instructions, NEC, and local code requirements.
- .2 The sensing cable shall be installed after all piping, air conditioning, raised flooring, and other mechanical work has been completed, and prior to installation of other data or power distribution cabling. The sub floor sensing cable path shall remain clear of water, oil, solder, flux, dirt or other materials that may soil the sensing cable. Prepare floor surface for cable installation, install hold down clips for sensing cable, route and fix the sensor cable, route and fix any interconnect accessories such as jumper cable, point probes, branch connectors, leader cables and end terminations.
- .3 The sensing cable shall be installed beneath the raised flooring and around the perimeter of all rooms, a maximum of three feet from the outside wall. Route the sensing cable a minimum distance of three feet beyond the perimeter of all A/C units. The sensing cable should be kept clear of any sharp edges, floor pedestals and uninsulated ground conductors. In addition, lay the cable in a serpentine pattern, on 4-8 foot minimum centres, to protect interior surface areas where water sources are found, such as A/C unit, CPU piping, floor drains, chillers, etc. The sensing cable should be installed under the centre of floor tiles to facilitate access to, and visual location of, leaks. Sensing cable shall be secured to the sub floor with hold-down clips at approximately six-foot intervals and at every change in direction.
- .4 The sensor cable shall be on the bottom layer of all cabling in contact with the slab floor and positioned such that it will be in the path of any water leaking from chilled water supply and return lines, valves and fittings in the chilled water system, leaks from condensate tray overflows in air handlers, and similar source of water in the sub-floor and surrounding wall spaces.
- .5 The installer shall be responsible for providing a clean and functional system. The installer shall be responsible for installation of the sensing cable, functional testing, and mapping of the system. Contractor shall supply supervision and training to the end user for the leak detection system.

- .6 graphic display map, prepared from "as- built" drawings, shall be furnished upon completion. The map shall indicate the location of the sensing cables, landmarks such as equipment, A/C units, walls, floor drains, change of cable direction, and cable distance readings. The map shall be mounted next to the alarm and locating module.

3.3 TESTS

- .1 The system shall be tested in accordance with the manufacturer's recommendations and industry standards.

3.4 COMMISSIONING

- .1 The system shall be commissioned upon completion of the installation by personnel authorized by the manufacturer in accordance with manufacturer's instructions. At this time demonstration and basic operation shall be provided to the Departmental Representative.
- .2 At the time of commissioning the system, the system supplier shall provide the Departmental Representative with the name of an authorized manufacturer's Service Contractor who can provide preventive maintenance and service contracts for the leak detection system at least once a year, inclusive of removing debris from sensing cables, ensuring the interconnection and integrity of the electronic components in accordance with the manufacturer's recommendations.

3.5 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 21 05 01 - Common Work Results for Mechanical.
- .2 Section 23 05 23.01 - Valves - Bronze.

1.2 REFERENCE STANDARDS

- .1 ASME
 - .1 ASME B16.4-2016, Gray-Iron Threaded Fittings Classes 125 and 250.
 - .2 ASME B16.15-2013, Cast Copper Alloy Threaded Fittings Classes 125 and 250.
 - .3 ASME B16.18-2012, Cast Copper Alloy, Solder Joint Pressure Fittings.
 - .4 ASME B16.22-2013, Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings.
- .2 ASTM International
 - .1 ASTM B32-08 (R2014), Standard Specification for Solder Metal.
 - .2 ASTM B88M-16, Standard Specification for Seamless Copper Water Tube Metric.
- .3 American Welding Society (AWS)
 - .1 AWS A5.8/A5.8M-2011, AMD1 Specification Filler Metals for Brazing and Braze Welding.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for hydronic systems 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 Ontario, Canada.
 - .2 Indicate on manufacturers catalogue literature the following: valves.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.4 CLOSEOUT SUBMITTALS

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

- .2 Operation and Maintenance Data: submit operation and maintenance data for hydronic systems for incorporation into manual.
- .3 Submit electronic copies of operation and maintenance manual.

1.5 QUALITY ASSURANCE

- .1 Regulatory Requirements: ensure Work is performed in compliance with applicable Provincial /Territorial regulations.

1.6 DELIVERY, STORAGE AND HANDLING

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

PART 2 - PRODUCTS

2.1 TUBING

- .1 Type B hard drawn copper tubing: to ASTM B88M.

2.2 FITTINGS

- .1 Cast bronze threaded fittings: to ASME B16.15.
- .2 Wrought copper and copper alloy solder joint pressure fittings: to ASME B16.22.
- .3 Cast iron threaded fittings: to ASME B16.4.
- .4 Cast copper alloy solder joint pressure fittings: to ASME B16.18.

2.3 FLANGES

- .1 Brass or bronze: threaded.

- .2 Cast iron: threaded.
- .3 Orifice flanges: slip-on, raised face, 2100 kPa.

2.4 JOINTS

- .1 Solder, tin-antimony, 95:5: to ASTM B32.
- .2 Silver solder BCUP: to AWS A5.8.
- .3 Brazing: as indicated.

2.5 VALVES

- .1 Connections:
 - .1 NPS 2 and smaller: ends for soldering.
 - .2 NPS 2-1/2 and larger: flanged ends.
- .2 Balancing, for TAB:
 - .1 Sizes: calibrated balancing valves, as specified.
 - .2 NPS 2 and under:
 - .1 Mechanical rooms: globe, with plug disc as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 Elsewhere: globe, with plug disc as specified Section 23 05 23.01 - Valves - Bronze.
- .3 Drain valves: Ball, Class 300, as specified Section 23 05 23.01 - Valves - Bronze.
- .4 Ball valves:
 - .1 NPS 4 and under: as specified Section 23 05 23.01 - Valves - Bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 PIPING INSTALLATION

- .1 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.
- .2 Install concealed pipes close to building structure to keep furring space to minimum. Install to conserve headroom and space. Run exposed piping parallel to walls. Group piping where ever practical.
- .3 Slope piping in direction of drainage and for positive venting.
- .4 Use eccentric reducers at pipe size change installed to provide positive drainage or positive venting.
- .5 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.
- .6 Assemble piping using fittings manufactured to ANSI standards.

3.4 VALVE INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Install butterfly valves on chilled water and condenser water lines only.
- .3 Install ball or butterfly valves at branch take-offs and to isolate each piece of equipment, and as indicated.
- .4 Install globe valves for balancing and in by-pass around control valves as indicated.
- .5 Install chain operators on valves NPS 2-1/2 and over where installed more than 2400 mm above floor in Mechanical Equipment Rooms.

3.5 CIRCUIT BALANCING VALVES

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

3.6 FLUSHING AND CLEANING

- .1 Flush and clean in presence of Departmental Representative.
- .2 Flush after pressure test for a minimum of 4 hours.
- .3 Fill with solution of water and non-foaming, phosphate-free detergent 3% solution by weight. Circulate for minimum of 8 hours.
- .4 Refill system with clean water. Circulate for at least 4 hours. Clean out strainer screens/baskets regularly. Then drain.
- .5 Refill system with clean water. Circulate for at least 2 hours. Clean out strainer screens/baskets regularly. Then drain.
- .6 Drainage to include drain valves, dirt pockets, strainers, low points in system.
- .7 Re-install strainer screens/baskets only after obtaining Departmental Representative's approval.

3.7 FILLING OF SYSTEM

- .1 Refill system with clean water adding water treatment as specified.

3.8 FIELD QUALITY CONTROL

- .1 Testing:
 - .1 Test system in accordance with Section 21 05 01 - Common Work Results for Mechanical.
- .2 Balancing:
 - .1 Balance water systems to within plus or minus 5% of design output.

3.9 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 21 05 01 - Common Work Results for Mechanical.
- .2 Section 23 05 05 - Installation of Pipe Work.
- .3 Section 23 05 23.01 - Valves - Bronze.
- .4 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .5 Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.1-2015, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - .2 ASME B16.3-2016, Malleable Iron Threaded Fittings: Classes 150 and 300.
 - .3 ASME B16.5-2017, Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard.
 - .4 ASME B16.9-2012, Factory-Made Wrought Butt welding Fittings.
 - .5 ASME B18.2.1-2012, Square Hex, Heavy Hex and Askew Head Bolts and Hex, Hex Heavy Hex, Flange. Loaded Head and Lag Screws (Inch Series).
 - .6 ASME B18.2.2-2015, Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
- .2 ASTM International
 - .1 ASTM A47/A47M-99(2014), Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M-12, Standard Specification for Pipe, Steel, Black and Coated Hot-Dipped, Zinc Welded and Seamless.
 - .3 ASTM E202-12, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.
- .3 American Water Works Association (AWWA)
 - .1 AWWA C111/A21.11-17, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .4 CSA International
 - .1 CSA W48-14, Filler Metals and Allied Materials for Metal Arc Welding.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for hydronic systems 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 Indicate on drawings:
 - .1 Components and accessories.

1.4 CLOSEOUT SUBMITTALS

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

1.5 DELIVERY, STORAGE AND HANDLING

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

PART 2 - PRODUCTS

2.1 PIPE

- .1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:
 - .1 To NPS 6: Schedule 40.
 - .2 NPS 8 and over, Schedule 30.

- .3 NPS 12 and over, 10 mm wall thickness.

2.2 PIPE JOINTS

- .1 NPS 2 and under: screwed fittings with PTFE tape or lead-free pipe dope.
- .2 NPS 2-1/2 and over: welding fittings and flanges to CSA W48.
- .3 Flanges: plain or raised face, slip-on weld neck to AWWA C111/ A21.11.
- .4 Orifice flanges: slip-on raised face, 2100 kPa.
- .5 Flange gaskets: to AWWA C111/ A21.11.
- .6 Pipe thread: taper.
- .7 Bolts and nuts: to ASME B18.2.1 and ASME B18.2.2.

2.3 FITTINGS

- .1 Screwed fittings: malleable iron, to ASME B16.3, Class 300.
- .2 Pipe flanges and flanged fittings:
 - .1 Cast iron: to ASME B16.1, Class 300.
 - .2 Steel: to ASME B16.5.
- .3 Butt-welding fittings: steel, to ASME B16.9.
- .4 Unions: malleable iron, to ASTM A47/A47M and ASME B16.3.

2.4 VALVES

- .1 Connections:
 - .1 NPS 2 and smaller: screwed ends.
 - .2 NPS 2-1/2 and larger: flanged ends.

- .2 Balancing, for TAB:
 - .1 Sizes: calibrated balancing valves, as specified this section.
 - .2 NPS 2 and under:
 - .1 Mechanical Rooms: globe, with plug disc as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 Elsewhere: globe, with plug disc as specified Section 23 05 23.01 - Valves - Bronze.
- .3 Drain valves: Ball, Class 300, as specified Section 23 05 23.01 - Valves - Bronze.
- .4 Ball valves:
 - .1 NPS 4 and under: as specified Section 23 05 23.01 - Valves - Bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PIPING INSTALLATION

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

3.3 CIRCUIT BALANCING VALVES

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

3.4 CLEANING, FLUSHING AND START-UP

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

3.5 TESTING

- .1 Test system in accordance with Section 21 05 01 - Common Work Results for Mechanical.
- .2 For glycol systems, retest with ethylene propylene glycol to ASTM E 202, inhibited, for use in building system after cleaning. Repair leaking joints, fittings or valves.

3.6 BALANCING

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

3.7 CLEANING

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

3.8 PROTECTION

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

PART 1 - GENERAL

1.1 REFERENCES

- .1 ASME
 - .1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII-2015.
- .2 ASTM International
 - .1 ASTM A47/A47M-99(2014), Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A278/A278M-01(2015), Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (350 degrees C).
 - .3 ASTM A536-84(20014), Standard Specification for Ductile Iron Castings.
 - .4 ASTM B62-17, Standard Specification for Composition Bronze or Ounce Metal Castings.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for expansion tanks, air vents, separators, valves, and strainers and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for hydronic specialties for incorporation into manual.
- .3 Submit 3 copies of operation and maintenance manual.

1.4 DELIVERY, STORAGE AND HANDLING

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

- .3 Storage and Handling Requirements:
 - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect hydronic specialties from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

PART 2 - PRODUCTS

2.1 AUTOMATIC AIR VENT

- .1 Standard float vent: brass body and NPS 1/8 connection and rated at 690 kPa working pressure.
- .2 Industrial float vent: cast iron body and NPS 1/2 connection and rated at 860 kPa working pressure.
- .3 Float: solid material suitable for 115 degrees C working temperature.

2.2 AIR SEPARATOR - IN-LINE

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

2.3 COMBINATION SEPARATORS/ STRAINERS

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

2.4 COMBINATION LOW PRESSURE RELIEF AND REDUCING VALVE

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

2.5 PIPE LINE STRAINER

- .1 NPS 1/2 to 2: bronze body to ASTM B62, screwed connections, Y pattern.

- .2 NPS 2 1/2 to 12: cast steel body to ASTM A 278/A 278M, Class 30or , cast iron body to ASTM A278/A278M, Class 30 flanged connections.
- .3 NPS 2 to 12: T type with ductile iron body to ASTM A536 malleable iron body to ASTM A47M, grooved ends.
- .4 Blowdown connection: NPS 1.
- .5 Screen: stainless steel with 1.19 mm perforations.
- .6 Working pressure: 860 kPa.

2.6 SUCTION DIFFUSER

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 APPLICATION

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

3.3 GENERAL

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

3.4 STRAINERS

- .1 Install in horizontal or down flow lines.
- .2 Ensure clearance for removal of basket.
- .3 Install ahead of each pump.
- .4 Install ahead of each automatic control valve larger than NPS 1 and as indicated.

3.5 AIR VENTS

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

3.6 PRESSURE SAFETY RELIEF VALVES

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

3.7 SUCTION DIFFUSERS

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

3.8 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposa.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
- .2 ASTM International
 - .1 ASTM A653/A653M-15e1, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA 008-2008, IAQ Guideline for Occupied Buildings Under Construction, 2nd Edition.
 - .2 SMACNA 016-2012, HVAC Air Duct Leakage Test Manual, 2nd Edition.
 - .3 SMACNA 1966, HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for metal ducts and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
- .4 Test and Evaluation Reports:
 - .1 Certification of Ratings:
 - .1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

1.3 DELIVERY, STORAGE AND HANDLING

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

- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect metal ducts from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

PART 2 - PRODUCTS

2.1 SEAL CLASSIFICATION

- .1 Classification as follows:

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

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

2.2 SEALANT

- .1 Sustainability Characteristics:
 - .1 Adhesives and sealants: in accordance with Section 07 92 00 - Joint Sealants.
- .2 Sealant: oil resistant, water borne, polymer type flame resistant duct sealant. Temperature range of minus 30 degrees C to plus 93 degrees C.

2.3 TAPE

- .1 Tape: polyvinyl treated, open weave fibreglass tape, 50 mm wide.

2.4 DUCT LEAKAGE

- .1 In accordance with SMACNA 016.

2.5 FITTINGS

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

2.6 FIRE STOPPING

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

2.7 GALVANIZED STEEL

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 GENERAL

- .1 Do work in accordance with ASHRAE & SMACNA as indicated.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods.
 - .1 Insulate strap hangers 100 mm beyond insulated duct. Ensure diffuser is fully seated.
- .3 Support risers in accordance with ASHRAE & SMACNA.
- .4 Install breakaway joints in ductwork on sides of fire separation.
- .5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.

3.3 HANGERS

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

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

3.4 SEALING AND TAPING

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

3.5 CLEANING

- .1 Progress Cleaning:
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

PART 1 - GENERAL

1.1 REFERENCES

- .1 National Fire Protection Association (NFPA)
 - .1 NFPA (Fire) 90A, Standard for the Installation of Air Conditioning and Ventilating Systems, 2015 Edition.
- .2 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC S112-10, Standard Test Method of Fire Test of Fire Damper Assemblies.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for fire and smoke dampers and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate the following:
 - .1 Fire dampers.
 - .2 Operators.
 - .3 Fusible links.
 - .4 Design details of break-away joints.
- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.3 CLOSEOUT SUBMITTALS

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

1.4 MAINTENANCE MATERIAL SUBMITTALS

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

1.5 DELIVERY, STORAGE AND HANDLING

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

PART 2 - PRODUCTS

2.1 FIRE DAMPERS

- .1 Fire dampers: arrangement Type A, listed and bear label of ULC, meet requirements of provincial fire authority, Fire Commissioner of Canada, NFPA (Fire) 90A & authorities having jurisdiction. Fire damper assemblies fire tested in accordance with CAN/ULC-S112.
- .2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
 - .1 Fire dampers: 1-1/2 hour fire rated dynamic type unless otherwise indicated.
- .3 Top hinged: offset single damper, round or square; multi-blade hinged or interlocking type; guillotine type; sized to maintain full duct cross section as indicated.
- .4 Fusible link actuated, having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow, or systems that do not shut off on fire alarm.
- .5 40 x 40 x 3 mm retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.
- .6 Equip fire dampers with steel sleeve or frame installed disruption ductwork or impair damper operation.
- .7 Equip sleeves or frames with perimeter mounting angles attached on both sides of wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce ceiling to conform with ULC.
- .8 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area.
- .9 Dampers shall be installed so that the centreline of the damper depth or thickness is located in the centreline of the wall, partition or floor slab depth or thickness.

- .10 Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- .1 Install in accordance with NFPA 90A and in accordance with conditions of ULC listing.
- .2 Maintain integrity of fire separation.
- .3 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.
- .4 Install access door adjacent to each damper.
- .5 Co-ordinate with installer of fire stopping.
- .6 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible.
- .7 Install break-away joints of approved design on each side of fire separation.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

PART 1 - GENERAL

1.1 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for diffusers, registers and grilles and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate following:
 - .1 Capacity.
 - .2 Throw and terminal velocity.
 - .3 Noise criteria.
 - .4 Pressure drop.
 - .5 Neck velocity.

1.2 MAINTENANCE MATERIAL SUBMITTALS

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

1.3 DELIVERY, STORAGE AND HANDLING

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

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- .1 Performance Requirements:

- .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

2.2 GENERAL

- .1 Frames:
 - .1 Full perimeter gaskets.
 - .2 Plaster frames where set into plaster or gypsum board and as specified.
 - .3 Concealed fasteners.
- .2 Concealed manual volume control damper operators.
- .3 Colour: standard.

2.3 MANUFACTURED UNITS

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

2.4 RETURN AND EXHAUST GRILLES AND REGISTERS

- .1 Type RG1: aluminum, 13 x 13 mm egg crate type face bars, size as indicated on drawings, with drywall frame in drywall areas. Finish: White.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- .1 Install in accordance with manufacturers instructions.
- .2 Install with cadmium plated screws in countersunk holes where fastenings are visible.

3.3 CLEANING

- .1 Progress Cleaning:
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

- .1 ASTM International
 - .1 ASTM C547-15, Specification for Mineral Fiber Pipe Insulation.
- .2 CSA International
 - .1 CSA B52-13, Mechanical Refrigeration Code.
 - .2 CAN/CSA C656-14, Performance Standard for Single Package Central Air-Conditioners and Heat Pumps.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for air conditioning components and accessories and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Ontario, Canada.
 - .2 Indicate on drawings:
 - .1 Major components and accessories including sound power levels of units.
 - .2 Type of refrigerant used.

1.3 CLOSEOUT SUBMITTALS

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

1.4 DELIVERY, STORAGE AND HANDLING

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

- .3 Storage and Handling Requirements:
 - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect air conditioning components from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

1.5 WARRANTY

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

PART 2 - PRODUCTS

2.1 DESCRIPTION

- .1 Integrated package: to CAN/CSA C656.
- .2 System type:
 - .1 Air flow arrangement: down-flow and ducted type as shown.
 - .2 Cooling: direct expansion and chilled water (dual cooled).
 - .3 Condensing: City water cooled.
- .3 Cooling and dehumidifying capacity, with fan heat extracted: based on computer room environment of 22 degrees C dry bulb and 50% R.H. (plus or minus 1 degree C and 5% R.H.), with minimum supply air temperature of 14 degrees C and minimum control dead-band of 3% R.H. separating humidification and dehumidification.
- .4 Unit controls not to permit dehumidification and humidification to occur simultaneously.
- .5 Unit capacity: as indicated on drawing schedule.
- .6 Fan capacity to provide for dry coil operation at 22 degrees C and 50% R.H..

2.2 CABINET

- .1 Free standing, welded steel, unit construction, corrosion protected, 20 mm thick acoustic insulation, factory baked on external finish aesthetically compatible with typical computer and peripheral cabinets. Colour as selected from manufacturer's standard range by Departmental Representative.
- .2 Cabinet to house: compressors, cooling coil, reheat coil, fans, filters, humidifier, unit environmental control system, motor starters or contactors and electrical disconnect switch.
- .3 Include adequate access to components for servicing.

- .4 Corrosion protected welded structural steel floor stand with adjustable feet and locking device on corners, vibration isolators and compatible with raised floor system.
- .5 For AC units 5 & 6, they are to be shipped in multiple pieces to allow moving them into place. Units to be re-assembled on site and fully re-commissioned.

2.3 DISCHARGE PLENUM

- .1 Welded steel, unit construction, corrosion protected, 20 mm thick acoustic insulation, constructed to assure proper air distribution to space under raised floor.

2.4 RETURN PLENUM AND FILTER HOUSING

- .1 Welded steel, unit construction, corrosion protected, 20 mm thick acoustic insulation, factory baked on external finish aesthetically compatible with typical computer and peripheral cabinets with inlet on top as indicated.
 - .1 Colour: to match unit cabinet.

2.5 FANS

- .1 DWDI centrifugal, statically and dynamically balanced, V-belt drive, with self-aligning, permanently lubricated, 100,000 hours minimum life ball or roller bearings.
- .2 If V-belt driven include 2 belt adjustable pitch pulleys with belts sized for 200% minimum of motor capacity.

2.6 FAN MOTORS

- .1 Drip-proof permanently lubricated bearings for continuous duty, 40 degrees C maximum rise and variable pitch sheaves on belt driven systems.

2.7 COMPRESSORS

- .1 Semi hermetic type, minimum 2 required, with:
 - .1 Vibration isolators.
 - .2 Adjustable high and low pressure switches.
 - .3 Anti-slug device.
 - .4 Motor overload and over temperature protection pump down controls.
 - .5 Crank case heater.
 - .6 Compressor lead/lag switch.
 - .7 Refrigerant service valves.
 - .8 Capacity controls.

2.8 COOLING COIL

- .1 Aluminum fins, mechanically bonded to copper tubes, tested to 1.7 MPa, maximum face velocity 2.8 m/s, with stainless steel insulated condensate tray and drain connections.
- .2 Direct expansion: with separate refrigerant circuit for each compressor.
- .3 Cooling coil condensate drain pans: designed to avoid standing water, easily cleaned or removable for cleaning.
 - .1 Drain connection with deep seal trap complete with trap seal primer.
- .4 Chilled water capacity: as indicated on drawing schedule.

2.9 REHEAT COIL

- .1 Electric: CSA or ULC approved, 575 Volts 3 phase 60 Hz, stainless steel or copper fin-tubular construction. Two stages minimum.
 - .1 Capacity: as indicated.
 - .2 SCR control.
- .2 Coils: located down-stream of cooling coil.

2.10 FILTERS

- .1 Prefilters: 25 mm flat, disposable type: MERV 8.
- .2 Final filters: pleated type: MERV 14.
- .3 Mounting: in corrosion resistant racks with service access.

2.11 HUMIDIFIER

- .1 Steam generator type: plastic disposable reservoir-boiler, latticed electrode heating elements complete with steam distributor.
- .2 Capacity: as indicated.
- .3 Location downstream of cooling coil with water level control, overflow and drain, strainer and automatic flush, CSA or ULC approved.

2.12 REFRIGERANT PIPING, VALVES, FITTINGS AND ACCESSORIES WITHIN UNIT

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

2.13 ENVIRONMENTAL CONTROLS

- .1 Solid state electronic control system.
- .2 Front mounted operating panel with visual display.
- .3 Panel to include following:
 - .1 Manual operation and adjustment:
 - .1 On-Off air conditioning system control.
 - .2 Room temperature set point, indicator and sensitivity adjustment controller.
 - .3 Room humidity set point, indicator and sensitivity adjustment controller.
 - .4 Alarm silencing switch for each alarm point.
 - .5 Compressor lead-lag selection switch.
 - .6 Alarm circuits test switch.
 - .2 Operational: Visual and Audible Alarm:
 - .1 Loss of air flow.
 - .2 Loss of liquid flow.
 - .3 High room temperature.
 - .4 Low room temperature.
 - .5 High humidity.
 - .6 Low humidity.
 - .7 High head pressure No.1 compressor.
 - .8 High head pressure No.2 compressor
 - .3 Operational: Visual display:
 - .1 Cooling each stage.
 - .2 Reheat stage 1 and 2.
 - .3 Humidification
 - .4 Dehumidification.
 - .5 Change filter.
- .4 Control system to include network card for full operation & monitoring of all AC units through existing IT network. Network cards to utilize standard IP protocol. IP address & network connection by Departmental Representative.

- .5 Unit control system to extend to all units for full lead lag operation and to water detection system. Both units 5 & 6 are to be interlocked in order to not operate simultaneously.
- .6 Unit control system to automatically transfer units from chilled water to DX cooling upon loss of chilled water flow, chilled water is primary cooling mode.
- .7 Unit control system to disable reheat and humidifier when unit is operating in DX cooling mode. Also, unit to lock out reheat when unit is in humidification and vice versa. Unit nameplate full load amperage to reflect these physical lock outs.

2.14 REFRIGERANT CHARGE

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 GENERAL

- .1 Install as indicated, to manufacturer's recommendations, and to EPS 1/RA/2.
- .2 Manufacturer to certify installation.
- .3 Run drain line from cooling coil condensate drain pan to terminate over nearest floor drain.
- .4 Extend required network cables between AC units as required for full communication between all units.

3.3 EQUIPMENT PREPARATION

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

3.4 FIELD QUALITY CONTROL

- .1 Commissioning:
 - .1 Manufacturer to:
 - .1 Certify installation.
 - .2 Start up and commission installation.
 - .3 Carry out on-site performance verification tests.
 - .4 Demonstrate operation and maintenance.
 - .5 Include for 2 hour operation demonstration & training session with Departmental Representative.
 - .2 For units 5 & 6, manufacturer to provide full operation testing at start-up to ensure units have been assembled properly, as would have been completed at the factory.
 - .3 Provide Departmental Representative at least 24 hours notice prior to inspections, tests, and demonstrations. Submit written report of inspections and test results.

3.5 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

3.6 PROTECTION

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