

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 B139-04, 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.

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.
 - .3 Paints: maximum VOC limit 150 g/L to Standard GS-11.
- .2 Sealants: in accordance with Section 07 92 00 - Joint Sealants.
 - .1 Sealants: maximum VOC limit to GSES GS-36.
- .3 Sealants: maximum VOC limit to GSES GS-36.
- .4 Adhesives: maximum VOC limit to GSES GS-36.
- .5 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 CSA B139.
- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer and CSA B139 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: DN 20mm gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

3.5 AIR VENTS

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

3.6 DIELECTRIC COUPLINGS

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

- .4 Over DN 50mm: isolating flanges.

3.7 PIPEWORK INSTALLATION

- .1 Install pipe work to CSA B139.
- .2 Screwed fittings joined with Teflon tape.
- .3 Protect openings against entry of foreign material.
- .4 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .5 Assemble piping using fittings manufactured to ANSI standards.
- .6 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.
 - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .7 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .8 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- .9 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .10 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .11 Group piping wherever possible.
- .12 Ream pipes, remove scale and other foreign material before assembly.
- .13 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .14 Provide for thermal expansion as required.
- .15 Valves:
 - .1 Install in accessible locations.
 - .2 Remove interior parts before soldering.
 - .3 Install with stems above horizontal position unless indicated.
 - .4 Valves accessible for maintenance without removing adjacent piping.
 - .5 Use ball or butterfly valves at branch take-offs for isolating purposes except where specified.
 - .6 Install butterfly valves between weld neck flanges to ensure full compression of liner.
 - .7 Use chain operators on valves DN 65mm and larger where installed more than 2400 mm above floor in Mechanical Rooms.

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 surface.
 - .2 Other floors: terminate 25 mm above finished floor.
 - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
- .6 Sealing:
 - .1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.
 - .2 Elsewhere:
 - .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 304 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 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 Department Representative 96 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 Department Representative.
- .6 Pay costs for repairs or replacement, retesting, and making good. Department Representative to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after approval and certification of tests by Department Representative.

3.13 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
 - .1 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 B31.1-07, Power Piping.
- .2 31BASTM International
 - .1 ASTM A125-1996(2007), Standard Specification for Steel Springs, Helical, Heat-Treated.
 - .2 ASTM A307-07b, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .3 ASTM A563-07a, Standard Specification for Carbon and Alloy Steel Nuts.
- .3 Factory Mutual (FM)
- .4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP58-2002, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - .2 MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.
 - .3 MSS SP89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .5 Underwriter's Laboratories of Canada (ULC)

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and data sheets for hangers and supports and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit shop drawings for:
 - .1 Bases, hangers and supports.
 - .2 Connections to equipment and structure.
 - .3 Structural assemblies.
- .3 Certificates:
 - .1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Manufacturers' Instructions:
 - .1 Provide manufacturer's installation instructions.

1.3 CLOSEOUT SUBMITTALS

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

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

Part 2 Products

2.1 SYSTEM DESCRIPTION

- .1 Design Requirements:
 - .1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
 - .2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP58.
 - .3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.
 - .4 Design hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.
 - .5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP58.

2.2 GENERAL

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

2.3 PIPE HANGERS

- .1 Finishes:
 - .1 Pipe hangers and supports: galvanized after manufacture.
 - .2 Use hot dipped galvanizing process.
 - .3 Ensure steel hangers in contact with copper piping are copper plated.
- .2 Upper attachment structural: suspension from lower flange of I-Beam:
 - .1 Cold piping DN 50mm maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
 - .1 Rod: 13 mm FM approved.
 - .2 Cold piping DN 65mm or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed to MSS-SP58 and MSS-SP69.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:

- .1 Cold piping DN 50mm maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed to MSS SP69.
- .2 Cold piping DN 65mm or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed.
- .4 Upper attachment to concrete:
 - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
 - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed to MSS SP69.
- .5 Hanger rods: threaded rod material to MSS SP58:
 - .1 Ensure that hanger rods are subject to tensile loading only.
 - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
- .6 Pipe attachments: material to MSS SP58:
 - .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 SP69 UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
 - .1 Ensure "U" has hole in bottom for rivetting to insulation shields.
- .8 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.
- .9 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.
 - .1 Finishes for steel pipework: black.
 - .2 Finishes for copper, glass, brass or aluminum pipework: galvanized, with formed portion plastic coated.
- .10 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

2.4 RISER CLAMPS

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

2.5 INSULATION PROTECTION SHIELDS

- .1 Insulated cold piping:

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

2.6 CONSTANT SUPPORT SPRING HANGERS

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

2.7 VARIABLE SUPPORT SPRING HANGERS

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

2.8 EQUIPMENT SUPPORTS

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel. Submit calculations with shop drawings.

2.9 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

2.10 HOUSE-KEEPING PADS

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

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 86BClamps on riser piping:
 - .1 158BSupport independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
 - .2 159BBolt-tightening torques to industry standards.
 - .3 160BSteel pipes: install below coupling or shear lugs welded to pipe.
 - .4 161BCast 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 and authority having jurisdiction.
- .2 Copper piping: up to DN 13mm: every 1.5 m.

- .3 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.

- .4 Within 300 mm of each elbow.

Maximum Pipe Size : DN	Maximum Spacing Steel	Maximum Spacing Copper
up to 32mm	2.4 m	1.8 m
40mm	3.0 m	2.4 m
50mm	3.0 m	2.4 m
65mm	3.7 m	3.0 m
75mm	3.7 m	3.0 m
100mm	3.7 m	3.6 m
150mm	4.3 m	
200mm	4.3 m	
250mm	4.9 m	
300mm	4.9 m	

- .5 Pipework greater than DN 300mm: to MSS SP69.

3.4 HANGER INSTALLATION

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

3.5 HORIZONTAL MOVEMENT

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

3.6 FINAL ADJUSTMENT

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

- .1 Hammer jaw firmly against underside of beam.

3.7 CLEANING

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

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian Gas Association (CGA)
 - .1 CSA/CGA B149.1-05, Natural Gas and Propane Installation Code.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.
 - .2 CAN/CGSB-24.3-92, Identification of Piping Systems.
- .3 National Fire Protection Association (NFPA)
 - .1 NFPA 13-2002, Standard for the Installation of Sprinkler Systems.
 - .2 NFPA 14-2003, Standard for the Installation of Standpipe and Hose Systems.

1.2 SUBMITTALS

- .1 Product Data:
- .2 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Product data to include paint colour chips, other products specified in this section.
- .4 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 materials in accordance with manufacturer's written instructions.

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, matte finish, with square corners, letters accurately aligned and machine engraved into core.
- .3 Sizes:
 - .1 Conform to following table:

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

- .2 Use maximum of 25 letters/numbers per line.
- .4 Locations:
 - .1 Terminal cabinets, control panels: use size # 5.
 - .2 Equipment in Mechanical Rooms: use size # 9.
- .5 Identification for PWGSC Preventive Maintenance Support System (PMSS):
 - .1 Use arrangement of Main identifier, Source identifier, Destination identifier.
 - .2 Equipment in Mechanical Room:
 - .1 Main identifier: size #9.
 - .2 Source and Destination identifiers: size #6.
 - .3 Terminal cabinets, control panels: size #5.
 - .3 Equipment elsewhere: sizes as appropriate.

2.3 PIPING SYSTEMS GOVERNED BY CODES

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

2.4 IDENTIFICATION OF PIPING SYSTEMS

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

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

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

Contents	Background colour marking	Legend
** Add design temperature		
++ Add design temperature and pressure		
City water	Green	CITY WATER
Treated water	Green	TREATED WATER

Contents	Background colour marking	Legend
** Add design temperature		
++ Add design temperature and pressure		
Hot water heating supply (50% PG)	Yellow	HEATING SUPPLY
Hot water heating return (50% PG)	Yellow	HEATING RETURN
Cooling water supply (50% PG)	Yellow	COOLING SUPPLY
Cooling water return (50% PG)	Yellow	COOLING RETURN
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Refrigeration suction	Yellow	REF. SUCTION
Refrigeration liquid	Yellow	REF. LIQUID
Refrigeration hot gas	Yellow	REF. HOT GAS
Natural gas	Yellow (According to Codes)	

2.5 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.

2.6 VALVES, CONTROLLERS

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

2.7 CONTROLS COMPONENTS IDENTIFICATION

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

2.8 EQUIPMENT

- .1 Identify all equipment with specified tags as indicated on drawings.

2.9 LANGUAGE

- .1 Identification in English.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 TIMING

- .1 Provide identification only after painting specified 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 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 Department Representative. Provide one copy (reduced in size if required) in each operating and maintenance manual.
- .3 Number valves in each system consecutively by extending the valve numbering sequence from the existing numbers.

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 QUALIFICATIONS OF TAB PERSONNEL

- .1 Submit names of personnel to perform TAB to Department Representative within 90 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.
- .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 procedures developed by TAB 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), requirements and recommendations contained in these procedures and requirements are mandatory.

1.2 PURPOSE OF TAB

- .1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads
 - .1 TAB of all air systems
 - .2 TAB of all hydronic systems
 - .3 Testing of Fire and Smoke dampers.
 - .4 Coordinate work with all applicable sections.
- .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.

1.3 EXCEPTIONS

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

1.4 CO-ORDINATION

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

1.8 START OF TAB

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

1.9 APPLICATION TOLERANCES

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

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 Department 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 Department Representative.

1.12 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 Department 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 one copies of TAB Report to Department Representative for verification and approval, in English in electronic (PDF) format.

1.15 VERIFICATION

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

1.16 SETTINGS

- .1 After TAB is completed to satisfaction of Department 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 Department Representative.

1.18 AIR SYSTEMS

- .1 Standard: TAB to most stringent of TAB standards of AABC.
- .2 Do TAB of systems, equipment, components, controls specified Division 23.
- .3 Qualifications: personnel performing TAB current member in good standing of AABC.
- .4 Quality assurance: perform TAB under direction of supervisor qualified by AABC.

1.19 OTHER TAB REQUIREMENTS

- .1 General requirements applicable to work specified this paragraph:

- .1 Qualifications of TAB personnel: as for air systems specified this section.
- .2 Quality assurance: as for air systems specified this section.

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 SCOPE

- .1 Includes,
 - .1 Domestic water piping.
 - .2 Hydronic piping.
 - .3 Greenhouse process water piping (where indicated on greenhouse drawings or specifications).

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ASHRAE Standard 90.1-01, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM B209M-04, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate Metric.
 - .2 ASTM C335-04, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411-04, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C533-2004, Calcium Silicate Block and Pipe Thermal Insulation.
 - .6 ASTM C547-2003, Mineral Fiber Pipe Insulation.
 - .7 ASTM C795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .8 ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .2 CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts
- .4 Department of Justice Canada (Jus)
 - .1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
 - .2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
 - .3 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .6 Manufacturer's Trade Associations

- .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).
- .7 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-03, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701-01, Thermal Insulation, Polystyrene, Boards, and Pipe Covering.
 - .3 CAN/ULC-S702-1997, Thermal Insulation, Mineral Fibre, for Buildings
 - .4 CAN/ULC-S702.2-03, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

1.3 DEFINITIONS

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

1.4 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .3 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .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.

1.5 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.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Storage and Protection:
 - .1 Protect from weather, construction traffic.
 - .2 Protect against damage.
 - .3 Store at temperatures and conditions required by manufacturer.

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°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.
 - .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.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC-S702.
- .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.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC-S702.
- .6 TIAC Code A-6: flexible unicellular tubular elastomer.
 - .1 Insulation: with vapour retarder jacket.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC-S702.
 - .4 Certified by manufacturer: free of potential stress corrosion cracking corrodants.
- .7 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.

- .1 Insulation: to ASTM C533.
- .2 Maximum "k" factor: to CAN/ULC-S702.
- .3 Design to permit periodic removal and re-installation.

2.3 INSULATION SECUREMENT

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

2.4 CEMENT

- .1 Thermal insulating and finishing cement:
 - .1 Hydraulic setting on mineral wool, to ASTM C449/C449M.

2.5 VAPOUR RETARDER LAP ADHESIVE

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

2.6 INDOOR VAPOUR RETARDER FINISH

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

2.7 OUTDOOR VAPOUR RETARDER FINISH

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

2.8 JACKETS

- .1 Polyvinyl Chloride (PVC):
 - .1 One-piece moulded type to CAN/CGSB-51.53 with pre-formed shapes as required.
 - .2 Colours: to match adjacent finish paint.
 - .3 Minimum service temperatures: -20°C.
 - .4 Maximum service temperature: 65°C.
 - .5 Moisture vapour transmission: 0.02 perm.
 - .6 Fastenings:
 - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.
 - .3 Pressure sensitive vinyl tape of matching colour.
- .2 Canvas:

- .1 220 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: smooth.
 - .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.

2.9 WEATHERPROOF CAULKING FOR JACKETS INSTALLED OUTDOORS

- .1 Caulking to: Section 07 92 10 - Joint Sealing.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PRE-INSTALLATION REQUIREMENT

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

3.3 INSTALLATION

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

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

- .1 Application: at expansion joints, valves, 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: PVC.

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 Thickness of insulation as listed in following table.
 - .1 Run-outs to individual units and equipment not exceeding 4000 mm long.
 - .2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.


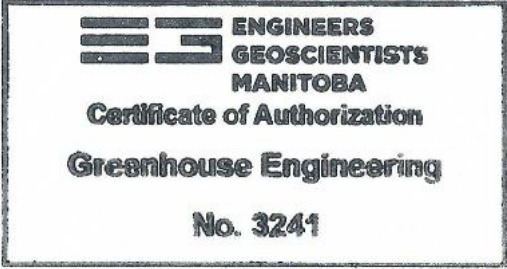
Application	Temp (°C)	TIAC code	Pipe sizes (DN) and insulation thickness (mm)					
			Run out	Upto 25mm	25mm to 32mm	38mm to 65mm	100mm to less than 150mm	200mm & over
Hot Water Heating	60 - 94	A-1	25	38	38	50	50	50
Hot Water Heating	up to 59	A-1	25	25	25	38	38	38
Domestic HWS and HWR		A-1	25	25	25	38	38	38
Domestic Tempered Water		A-1	25	25	25	38	38	38
Domestic CWS		A-3	15	15	15	25	25	25
Plumbing Vent		C-2	25	25	25	25	25	25

- .3 Finishes (Jacketing) shall match existing.

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

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Part 1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 13 34 13 – Greenhouse structure and specialties
- .2 Section 13 34 14 – Greenhouse computer control system
- .3 Division 22
- .4 Division 23
- .5 Section 26 13 01 – Greenhouse Electrical

1.2 SUBMITTALS

- .1 Submit required submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product data: Submit manufacturer's product data, installation instructions, use limitations and recommendations for each product and system used. Submit manufacturer's certifications stating that products and systems comply with requirements. List and describe features of control systems, performances and operating characteristics.
- .3 Manuals: Provide operation and maintenance manuals, in accordance with Section 01 78 00 – Closeout submittals. Emergency instructions, safety considerations, parts listings, exploded views, parts sources. Include list of all operating components and details.

1.3 SHOP DRAWINGS

- .1 Shop drawings: Submit coordinated shop drawings for fabrication and installation of the greenhouse mechanical work, including; plans, elevations, sections, detail sections of custom work, hardware, mounting heights, anchorage and support details, placement of all components supplied under this section. Show and provide details of support members or other support provision for heating systems, plumbing water lines, as well as all other overhead mechanical equipment furnished by this section.
- .2 Follow procedures and requirements as per section 01 33 00 – Submittal procedures.

1.4 REFERENCES

- .1 NBC 2010

- .2 ASTM C 534/C534M-14 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- .3 ASTM E 84 -15b Standard Test Method for Surface Burning Characteristics of Building Materials.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Protect materials during delivery, storage and handling to comply with manufacturers' directions and as required to prevent damage and deterioration, in accordance with Section 01 61 00 – Common Product Requirements. Store materials and equipment indoors, away from rain, snow and condensing conditions.

Part 2 PRODUCTS

2.1 MATERIALS AND COMPONENTS

- .1 Hydronic Hot Water Heating Systems
 - .1 Generalities
 - .1 Each of the greenhouse compartments is to be heated with a hot water system, consisting of perimeter radiation and overhead radiation, as shown on the drawings.
 - .2 The heating loops are to be independently controlled, by way of 3 way mixing valves and circulating pumps, located in the basement corridors.
 - .3 Two mixing valves and two pumps, with associated pipework, valves and equipment are to be installed for each greenhouse compartment.
 - .4 The greenhouse corridor is to be heated with a hot water system, consisting of overhead radiation, as shown on the drawings.
 - .5 The corridor will be controlled by a separate 3-way mixing valve and a separate circulating pump.
 - .6 Mains are to be connected to the existing greenhouse wing hot water supply, return and reverse return headers, where indicated on the drawings.
 - .7 Provide pumps and control valves per pump and valve schedule.
 - .2 Pipes:
 - .1 Pipe: Mains: Schedule 40 grooved steel pipe, painted with red oxide primer.
 - .2 Pipe: Greenhouse supply and returns, loops: Schedule 40 grooved steel pipe, painted with red oxide primer.
 - .3 Pipe insulation: Mains: 25mm fiberglass with aluminum jacket.
 - .4 Pipe insulation: overhead in greenhouses: bare, risers and exposed horizontal runs within 2200 mm AFF in the greenhouses, insulated with aluminum jacket.
 - .3 Finned pipes:
 - .1 Perimeter and overhead fin pipe: aluminum finned pipe, 32mm Schedule 40 aluminum pipe with 83mm x 83mm x 0.64mm aluminum fins at 6.22mm spacing centre to centre.
 - .2 Pipe to be grooved to accept the grooved coupling provided. Coupling to be grooved style cast aluminum with high temperature dielectric gasket rated for 51°C to 110°C.
 - .3 Coupling and external grooved fin system shall absorb expansion of heated aluminum.
 - .4 Supply complete with all aluminum hanger brackets.

- .4 Heating Cabinets:
 - .1 Perimeter fin pipe to be installed in perimeter heating cabinets as shown on the drawings.
 - .2 Cabinets to be made of flattened expanded aluminum sheet, pre-formed to the profile shown on drawings.
 - .3 Supply complete with all aluminum hanger support and brackets.
- .5 Pipe Supports:
 - .1 Overhead fin pipe to be suspended from the perimeter support angles, approximately 300mm below the gutter and 300mm to one side.
 - .2 Suspension shall be by galvanized steel offset brackets, stainless steel threaded rod and hangers by the manufacturer of the fin pipe.
 - .3 Care must be taken to avoid damaging the fin material.
 - .4 Care must be taken to avoid damage to the shade cloth during installation and during operation.
- .6 Pumps
 - .1 Pump with sealed rotor, pump and motor forming one unit and integral entity without sealing for the shaft and with only two gaskets for sealing.
 - .2 Pump motors must be 2 pole asynchronous, motors must be CSA approved 115 VAC single phase.
 - .3 Terminal enclosures are to be easily accessible and will have accessible cables. Insulation class F.
 - .4 The motors are to have thermal protection or an impedance protection device.
 - .5 Pumps in greenhouse compartments (2 pumps in each of 6 greenhouse compartments) and pump in greenhouse, capacity as per schedule
- .7 Control valves:
 - .1 Mixing valves: 3 way forged brass nickel plated body with NPT female pipe thread ports.
 - .2 Maximum leak through rate of 2%.
 - .3 Valve position to be adjustable manually with the valve actuator in place.
 - .4 Valve position to be reported by an indicator plate and a pointer.
 - .5 A flow-characterizing disc shall be installed in the inlet in the control port of the valves and provide linear flow response to position.
 - .6 The valve trim shall utilize a stainless steel ball and stem.
 - .7 Compartment mixing valves (2 mixing valves in each of 6 greenhouse compartments: capacity as per schedule.
 - .8 Corridor mixing valve: capacity as per schedule.
 - .9 Mixing valve actuators: 24VAC floating point actuator,
 - .1 6 Nm torque over 100 degree rotation.
 - .2 Running time: 90s minimum, 120s maximum.
 - .3 Control signal: 24VAC, 1.8VA.
 - .4 The actuating motor rotates its output shaft whenever 24VAC is applied either between the clockwise or counterclockwise terminals and the common terminal.
 - .5 Actuator to consist of a coupler, compatible with the 3 way mixing valve, anti-rotation bolts to fit the 3 way mixing valve, an actuating motor with terminal box and a hand wheel for manual override of valve position.
 - .10 Vent all high points in the system using automatic air vents.

- .11 Provide sediment valves at all low points in the system and isolation shut-off valves for all circuits.
- .12 Provide and install balancing valves for each heating circuit.
- .13 Isolate all copper pipes from dissimilar metals (dielectric joints).
- .8 Hot water unit heaters: Horizontal delivery, hot water unit heater.
 - .1 Unit must be CSA/UL approved, suitable for damp location.
 - .2 Fan assisted with copper/aluminum finned heat exchanger.
 - .3 Baked enamel painted steel casing.
 - .4 Make and model to match existing.
 - .5 Fan to be in aluminum and balanced, equipped with a galvanized steel fan guard, and horizontal air deflectors.
 - .6 Motor designed for continuous duty and can operate in a maximum ambient temperature of 40 °C.
 - .7 Motor to be 115 V, single phase, 60 Hz TEFC with thermal overload protection.
 - .8 Mounting Bracket: Provide appropriate mounting bracket and structural support within the corridor CO-2. All support hardware to be stainless steel.
- .9 Pump and control valve schedule:

Pump and Valve Schedule									
Zone	Valve Size	Loop Flow	Pump Head	Pump Power	Pump Voltage	Pump Model	Valve Model	Valve Kv	Actuator Voltage
	mm	m3/h	m Aqua	W	VAC				VAC
D7 Overhead	15	0.55	1	110	115	UPS 15-35 SFC	B312	2.6	24
D7 Perimeter	15	0.56	1	110	115	UPS 15-35 SFC	B312	2.6	24
D8 Overhead	15	0.55	1	110	115	UPS 15-35 SFC	B312	2.6	24
D8 Perimeter	15	0.56	1	110	115	UPS 15-35 SFC	B312	2.6	24
D9 Overhead	15	0.55	1	110	115	UPS 15-35 SFC	B312	2.6	24
D9 Perimeter	15	0.56	1	110	115	UPS 15-35 SFC	B312	2.6	24
D10 Overhead	15	0.55	1	110	115	UPS 15-35 SFC	B312	2.6	24
D10 Perimeter	15	0.56	1	110	115	UPS 15-35 SFC	B312	2.6	24
D11 Overhead	15	0.92	1.5	110	115	UPS 15-35 SFC	B313	4.1	24
D11 Perimeter	20	1.41	1.5	110	115	UPS 15-35 SFC	B318	6.4	24
D12 Overhead	15	0.92	1.5	110	115	UPS 15-35 SFC	B313	4.1	24
D12 Perimeter	20	1.41	1.5	110	115	UPS 15-35 SFC	B318	6.4	24
Corridor	20	1.6	1.2	110	115	UPS 15-35 SFC	B318	6.4	24
Unit Heater	15	7.6	N/A	N/A	N/A	N/A	B211	1.6	24

- .2 Domestic Cold Water Distribution
 - .1 Provide domestic cold water distribution, hose bibs connections and supplies to the evaporative cooling units, where shown on drawings.
 - .2 All hose bibs to be provided with vacuum breakers, 19mm FHT inlet x 19mm MHT outlet, to CAN/CSA-B64 Series-01 (R2007) and CAN/CSA B-64.2.1-01.
 - .3 Domestic cold water pipe: Type L copper, per drawings.
 - .4 Insulation: overhead piping in corridor and greenhouse compartments: 12 mm fiberglass insulation with aluminum jacket.
 - .5 Hose bib: ball valve, ¼ turn, with quick couplings.
 - .6 Isolation: Isolate all copper pipe from dissimilar metals.
 - .7 Hangers: supply and install all necessary hangers. All hanger components will be stainless steel, aluminum or hot dipped galvanized steel.
- .3 Tempered Water Distribution
 - .1 Provide tempered water lines and valves where shown on drawings.

- .2 All hose bibs to be provided with vacuum breakers, 19mm FHT inlet x 19mm MHT outlet, to CAN/CSA-B64 Series-01 (R2007) and CAN/CSA B-64.2.1-01.
- .3 Tempered water lines: Type L copper, per drawings.
- .4 Insulation: Not required for tempered water lines.
- .5 Hose bib: ball valve, ¼ turn, with quick couplings.
- .6 Isolation: Isolate all copper pipe from dissimilar metals.
- .7 Hangers: supply and install all necessary hangers. Hangers and components to be in stainless steel or hot dip galvanized steel.
- .4 RO piping:
 - .1 RO water stainless steel piping, 13mm in diameter as shown on drawings.
 - .2 Hangers: supply and install all necessary hangers. Hangers to be in stainless steel or hot dip galvanized steel.
 - .3 Valves: stainless steel full port ball valve, ¼ turn.
 - .4 Air adaptor for winterizing: all stainless steel construction.
- .5 Pipe penetrations:
 - .1 All pipe penetrations are in the compartments and must be fire-rated. Use proper sleeve protection to avoid galvanic corrosion with reinforcement bars
 - .2 All pipe penetrations must have appropriate sealing, as per paragraph 3.02.4 and 3.02.5 below.

Part 3 EXECUTION

3.1 PREPARATION

- .1 Examine areas and conditions where greenhouse mechanical work is to be installed. Notify general contractor in writing of conditions detrimental to proper and timely installation of work.
- .2 Coordinate and furnish hangers, supports, support brackets and pipe and duct penetrations.
- .3 Dissimilar metals: where aluminum surfaces come in contact with ferrous metals, concrete or other incompatible materials, keep aluminum surfaces from direct contact using appropriate barriers. Isolate all copper piping with dielectric joints.

3.2 ERECTION

- .1 Install pipework, ducts and mechanical components in accordance with manufacturers' written instructions and final approved shop drawings and erection drawings.
- .2 Follow building lines and install pipe level and plumb.
- .3 Provide temporary bracing and supports as required to ensure stability during installation.
- .4 Install closures, trim, caps, escutcheons and similar miscellaneous aluminum items and accessories as required for complete, weathertight and airtight installation.
- .5 Provide interference drawings for coordination, review and approval. These tasks must be performed and accepted prior to proceeding with the general work. This is to ensure that pipe runs, crossings, mixing groups, corridor cooler units, corridor heating pipes, corridor wall penetrations and coordination with electrical conduit runs is performed.
- .6 All work to be done keeping in mind that the finished product will be fully exposed to view.

3.3 INSTALLATION OF EQUIPMENT

- .1 General:
 - .1 Install equipment in accordance with manufacturers' installation instructions and recognized industry practices to insure intended function.
- .2 Piping:
 - .1 Make provision for thermal expansion.
 - .2 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.
- .3 Pumps:
 - .1 Install pumps per manufacturer's recommendations.
 - .2 Allow free access for maintenance
 - .3 Conduct tests and adjustments to achieve the required water flow.
 - .4 Provide a balancing report.
- .4 Control valves:
 - .1 Install control valves per manufacturer's recommendations.
 - .2 Allow free access for maintenance.
 - .3 Install actuator (motor) and linkage per manufacturer's recommendations.
 - .4 Pressure and temperature gauges must be readily visible and readable while standing on the corridor floor.
- .5 Automatic air vents:
 - .1 Install per manufacturer's recommendations
 - .2 Install air vents at highest points of water circuits.
- .6 Balancing valves:
 - .1 Install per manufacturer's recommendation.
 - .2 Water flow must be correctly adjusted to achieve appropriate water flow.
 - .3 Provide a balancing report.
- .7 Coordination is required for the installation of equipment and systems specified in other divisions or sections, particularly supply and return mains, electrical work and control system work.

3.4 ADJUSTING AND CLEANING

- .1 General: after mechanical work is complete, clean all surfaces removing dirt, grease and other substances from exposed surfaces.
- .2 All surfaces, equipment enclosures, shall be handed over in a clean condition, with all foreign materials, labels, stickers, contaminants marks or scuffs removed.
- .3 Factory and shipping labels shall be removed from all surfaces.
- .4 Repair all marred or scratched surfaces of factory finished equipment, using finish materials furnished by the manufacturer.
- .5 Cleaning to be performed as per requirements indicated in Divisions 01 and 23.

3.5 COORDINATION, COMMISSIONING, STARTUP AND INSTRUCTION

- .1 Provide commissioning services upon startup in accordance with section 01 91 00 – Commissioning (Cx), Commissioning Specifications (Cx) and Commissioning (Cx) Plan. This includes proving all equipment and all greenhouse systems.
 - .1 A detailed checklist shall be submitted with the Operation and maintenance manual.

- .2 Provide complete balancing report of all hydronic systems, as per requirements of Division 23 - Testing, Adjusting, and Balancing for HVAC.
- .3 A detailed checklist shall be submitted with the operation and maintenance manual.
- .4 Provide user instruction and instruction for maintenance personnel in all greenhouse mechanical components, equipment and systems and their integrated operation.

END OF SECTION