
Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Use of mechanical systems during construction.

1.2 USE OF SYSTEMS

- .1 Use of new permanent heating and ventilating systems for supplying temporary heat or ventilation is permitted only under following conditions and with the express written permission of Departmental Representative:
 - .1 Entire system is complete, pressure tested, cleaned, flushed out.
 - .2 Specified water treatment system has been commissioned, water treatment is being continuously monitored.
 - .3 Building has been closed in, areas to be heated/ventilated are clean and will not thereafter be subjected to dust-producing processes.
 - .4 There is no possibility of damage.
 - .5 Supply ventilation systems are protected by 80% filters, inspected daily, changed every week or more frequently as required.
 - .6 Return systems have approved filters over openings, inlets, outlets.
 - .7 Systems will be:
 - .1 Operated as per manufacturer's recommendations and instructions.
 - .2 Operated by Contractor.
 - .3 Monitored continuously by Contractor.
 - .8 Warranties and guarantees are not relaxed.
 - .9 Regular preventive and other manufacturers recommended maintenance routines are performed by Contractor at own expense and under supervision of Departmental Representative.
 - .10 Refurbish entire system before static completion; clean internally and externally, restore to "as- new" condition, replace filters in air systems.
- .2 Filters specified in this Section are over and above those specified in other Sections of this project.
- .3 Exhaust systems are not included in approvals for temporary heating ventilation.

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 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.

Part 2 Products**2.1 PIPE**

	<u>Service</u>	<u>Material</u>
.1	Steam to 1034 kPa vents.	Steel Schedule 80, black, 9.5 mm wall for sizes 300 mm and larger.
.2	Chilled water	Steel Schedule 40, black, 9.5 mm wall for sizes 300 mm and larger, Grooved for 50 mm and larger.
.3	Equipment drains and overflows	Steel Schedule 40, galvanized, PVC or PVC-XFR-15/50
.4	Sanitary drainage and vent above grade (not including return air plenum)	Type "M" or "DWV" copper. Cast iron, plastic PVC
.5	Sanitary drainage and vent above grade in ceiling return air plenum	Type "M" or "DWV" copper, cast iron, plastic PVC-XFR-15/50
.6	Domestic water unburied	Type "L" hard copper, PEX.
.7	Condensate, pumped condensate	Steel Schedule 80, black.
.8	Fire protection	Lightwall pipe, as approved by NFPA, Schedule 30. For sizes 200 mm and larger, pressfit pipe.
.9	Storm drainage inside building.	Cast iron, PVC, (CPVC in return air plenum)

2.2 FITTINGS

	<u>Service</u>	<u>Material</u>	<u>Joint</u>
.1	Chilled water	Malleable iron 1034 kPa banded Steel same thickness as pipe Wrought copper or cast bronze Pressfit fittings	Threaded Grooved mechanical
.2	Vents	Malleable iron 1034 kPa banded	Threaded
.3	Steam (to 1034 kPa)	Malleable iron	
.4	Condensate, pumped condensate	Banded Steel, same thickness as pipe	Welded
.5	Steam to 690 kPa	Malleable iron 1034 kPa banded, air tested for pipe sizes 50 mm and over. Steel same thickness as pipe for sizes 50 mm and over	Threaded Welded
.6	Equipment drains	Malleable iron 1034 kPa banded, galvanized. Steel, same thickness as pipe, galvanized. Malleable iron, grooved galvanized. Wrought copper or cast brass. PVC	Threaded Welded Grooved mechanical 95-5 solder, grooved mechanical Solvent weld or grooved mechanical
.7	Sanitary drainage and vent unburied (not including return air ceiling plenum.)	Wrought copper or cast brass. Cast iron. PVC C.S.A.	95-5 solder Hub & Spigot Gasket & Clamp Solvent weld or grooved mechanical
.8	Sanitary drainage and Vent unburied (in return air ceiling plenum)	Wrought copper or cast iron PVC-XFR-15/50	95-5 solder Hub & Spigot Solvent weld or grooved mechanical

.9	Sanitary drainage and vent buried under building	Wrought copper or cast brass. Cast iron. PVC	95-5 solder Hub & Spigot Gasket & Clamp or grooved mechanical Solvent weld or grooved mechanical
.10	Domestic water inside building	Wrought copper bronze or cast brass PEX	95-5 solder, grooved mechanical Mechanical joint
.11	Fire protection	Malleable iron or cast iron Malleable iron or steel grooved Steel, same thickness as pipe	Screwed or flanged Grooved mechanical
.12	Storm	Cast iron PVC	Hub & Spigot Gasket & Clamp Solvent weld, or grooved mechanical
.13	Use factory fabricated butt welded fittings for welded steel pipes.		
.14	Use long radius elbows for steel and cast iron water piping.		

Part 3 Execution

3.1 CONNECTIONS TO EQUIPMENT

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

3.2 CLEARANCES

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer.
- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer or as indicated (whichever is greater) without interrupting operation of other system, equipment, components.

3.3 DRAINS

- .1 Install piping with grade in direction of flow except as indicated.
- .2 Install drain valve complete with isolation at low points in piping systems, at equipment and at section isolating valves.
- .3 Pipe each drain valve discharge separately to nearest floor drain where indicated. 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.

3.4 AIR VENTS

- .1 Install manual air vents at high points in piping systems complete with isolation valve and u-bend copper tubing to allow discharge to bucket.
- .2 Install automatic air valve at each air separator and where indicated.
- .3 Install isolating valve at each automatic air valve.
- .4 Install drain piping to approved location and terminate where discharge is visible.

3.5 DIELECTRIC COUPLINGS

- .1 General: Compatible with system, to suit pressure rating of system.
- .2 Locations: Where dissimilar metals are joined.
- .3 NPS 2 and under: isolating unions or bronze valves.
- .4 Over NPS 2: Isolating flanges.

3.6 ROUTE AND GRADES

- .1 Route piping in orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space. Run exposed piping parallel to walls. Group piping wherever practical at common elevations. Install concealed pipes close to the building structure to keep furrings to a minimum.
- .2 Slope water piping 25 mm in 12 m and arrange to drain at low points.
- .3 On closed systems, equip low points with 20 mm drain valves and hose nipples. Provide, at high points, collecting chambers and high capacity float operated automatic air vents.

- .4 Slope steam piping 12 mm in 3 m in direction of flow and condensate return piping 20 mm in 3 m. Provide drop trap assembly at low points and points where condensate may back-up in front of control valves. Run condensate lines from traps to nearest condensate receiver. Where condensate lines form a trap, provide vent loop over the trapped section.
- .5 Make reductions in water pipes with eccentric reducing fittings installed to provide drainage and venting.
- .6 Grade horizontal drainage and vent piping 20 mm per meter minimum.

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 the size of main.
 - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
 - .2 Do not project brach pipe inside the main pipe.
- .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 Provide clearance for proper installation of insulation and for access to valves, air vents, drains and unions. Valves to be complete with valve handle extensions where insulation is thicker than 25mm, extension to suit insulation thickness.
- .11 Group piping wherever possible.
- .12 Ream pipes, remove scale, welding slag and other foreign material, inside and outside before assembly.
- .13 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.

- .14 Install piping to allow for expansion and contraction without unduly stressing pipe or equipment connected.
- .15 Screw joint steel piping up to and including 38 mm . Weld piping 63 mm and larger, including branch connections. Screw or weld 50 mm piping.
- .16 Make screwed joints with full cut standard taper pipe threads with red lead and linseed oil or other approved non-toxic joint compound applied to male threads only.
- .17 Clamp cast iron water pipe at fittings with 20 mm rods and properly anchor and support.
- .18 Use grooved mechanical couplings and mechanical fasteners in accessible locations, risers, pipe chases, and in other locations as approved by Departmental Representative. Use flexible couplings at pumps, coils and all vibration isolated equipment in lieu of flexible connectors, all other couplings to be rigid.
 - .1 Grooved joints shall be installed in accordance with the manufacturer's latest published installation instructions.
 - .2 The grooved coupling manufacturer's factory trained representative shall provide on-site training for Contractor's field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the job site and review Contractor is following best recommended practices in grooved product installation. (A distributor's representative is not considered qualified to conduct the training or job site visits.)
- .19 Make connections to equipment and branch mains with unions or flanges, as indicated:
 - .1 Unions are not required in installations using grooved mechanical joint couplings (The couplings shall serve as disconnect points.)
- .20 Provide non-conducting type connections wherever jointing dissimilar metals in systems. Brass adaptors and valves are acceptable. Refer to dielectric couplings.
- .21 Pressfit piping and fittings are not permitted.
- .22 Install piping to allow for expansion and contraction without unduly stressing pipe or equipment connected.
 - .1 For mechanical pipe jointing systems, use adequate numbers of Victaulic Style 77 flexible couplings in header piping to accommodate thermal growth and contraction, and for the elimination of expansion loops. (In accordance with Victaulic instructions and as approved by the Departmental Representative.) Where expansion loops are required, use Victaulic Style 77 couplings on the loops.
- .23 Install piping material specified as inside the building to 2.4 meters outside of building.
- .24 Use of PVC plastic pipe allowed where approved by the authority having jurisdiction. PVC pipe run in plenum spaces shall have flame and smoke rating for that purpose. PVC pipe to be complete with ULC labelled fire stopping wherever penetrating fire separations.

- .25 Valves:
 - .1 Shall be flanged for steam and condensate 38 mm and larger.
 - .2 Install in accessible locations.
 - .3 Remove interior parts before soldering.
 - .4 Install with stems upright or horizontal, not inverted.
 - .5 Valves accessible for maintenance without removing adjacent piping.
 - .6 Install globe valves in bypass around control valves.
 - .7 Use ball valves up to 50 mm or butterfly valves 63 mm and larger at branch take-offs for isolating purposes except where otherwise specified.
 - .8 Install butterfly valves on chilled water and related condenser water systems only.
 - .9 Install butterfly valves between weld neck flanges to ensure full compression of liner.
 - .10 Install ball valves for glycol service and domestic water.
 - .11 Install gate valves on steam and condensate.
 - .12 Use chain operators on valves NPS 2-1/2 and larger where installed more than 2400 mm above floor in Mechanical Rooms.
 - .13 Install gate, ball and butterfly valves for isolating service, to isolate equipment, part of systems or vertical risers.
 - .14 Install globe, ball or angle valves for throttling service.
 - .15 Use plug cocks in water systems for throttling service. Use non-lubricated plug cocks only when shut-off or isolation valves are also provided.
 - .16 Grooved end triple service valves shall be 2068 kPa bubble tight dead end shutoff and non-slamming backflow prevention. Victualic Tri-Service valve assembly.
 - .17 Use butterfly valves in fire protection systems where approved.
 - .18 Provide drain valves at main shut-off valves, low points of piping and apparatus.
 - .19 Valve operators to be complete with extensions on systems with insulation thicker than 25mm, extension to suit insulation thickness.
- .26 Check Valves:
 - .1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and elsewhere as indicated.
 - .2 Install swing check valves in horizontal lines on discharge of pumps and elsewhere as indicated.
 - .3 Provide spring loaded check valves on discharge of condensate pumps and condenser water.
- .27 Provide thermometers, thermometer wells, and DDC sensor wells where thermometers are indicated on drawings and schematics.
- .28 Provide plug cocks at all pressure tapping locations.

3.8 SLEEVES

- .1 General: Install where pipes pass through masonry, concrete structures, fire rated assemblies, and elsewhere as indicated.
- .2 Material: Schedule 40 black steel pipe.

- .3 Construction: Foundation walls and where sleeves extend above finished floors to have annular fins continuously welded on at mid-point.
- .4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Installation:
 - .1 Concrete, masonry walls, concrete floors on grade: Terminate flush with finished surface.
 - .2 Other floors: Terminate 25 mm above finished floor.
 - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
- .6 Sealing:
 - .1 Foundation walls and below grade floors: Fire retardant, waterproof non-hardening mastic.
 - .2 Elsewhere: Provide space for firestopping. Maintain fire rating integrity.
 - .3 Sleeves installed for future use: Fill with lime plaster or other easily removable filler.
 - .4 Ensure no contact between copper pipe or tube and sleeve.

3.9 ESCUTCHEONS

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

3.10 PREPARATION FOR FIRESTOPPING

- .1 Material and installation within annular space between pipes, ducts, insulation and adjacent fire separation to Section 07 84 00 - Firestopping.
- .2 Uninsulated unheated pipes not subject to movement: No special preparation.
- .3 Uninsulated heated pipes subject to movement: Wrap with non-combustible smooth material to permit pipe movement without damaging firestopping material or installation.
- .4 Insulated pipes and ducts: Ensure integrity of insulation and vapour barriers.

3.11 FLUSHING OUT OF PIPING SYSTEMS

- .1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
- .2 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 11-Cleaning supplemented as specified in relevant sections of Mechanical.

- .3 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 Mechanical or to 1.5 times maximum operating pressure. All installed piping to be tested unless noted otherwise.
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant sections of Mechanical.
- .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 10 days minimum, prior to commencement of work.
- .3 Be responsible for damage to existing plant by this work.
- .4 Ensure daily clean-up of existing areas.

END OF SECTION

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, 23 and 25. Refer to Division 26 for quality of materials and workmanship.
 - .4 Sustainable requirements for construction and verification.

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 90.1, 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).

1.3 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .2 Shop Drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of Saskatchewan.
- .3 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 QUALITY ASSURANCE

- .1 Regulatory Requirements: work to be performed in compliance with CEPA, CEEA, TDGA, and applicable Provincial /Territorial regulations.
- .2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

Part 2 Products

2.1 GENERAL

- .1 Motors: premium efficiency, in accordance with local Hydro company standards and to ASHRAE 90.1.
- .2 Must be inverter duty for all variable frequency drive applications.
- .3 Must be CSA approved.

2.2 MOTORS

- .1 Provide motors for mechanical equipment as specified.
- .2 Motors 373 W (1/2 HP) and under: speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.
- .3 Motors 373 W (3/4 HP) and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40 degrees C, 3 phase, 208V, unless otherwise indicated.

2.3 TEMPORARY MOTORS

- .1 If delivery of specified motor will delay completion or commissioning work, install motor approved by Departmental Representative for temporary use. Work will only be accepted when specified motor is installed.

2.4 BELT DRIVES

- .1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.
- .2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise indicated.
- .3 For motors under 7.5 kW (10 HP) : standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.
- .4 For motors 7.5 kW (10 HP) 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.
- .5 Correct size of sheave determined during commissioning.
- .6 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
- .7 Motor slide rail adjustment plates to allow for centre line adjustment.

- .8 Supply one set of spare belts for each set installed in accordance with Section 01 78 00 - Closeout Submittals.

2.5 DRIVE GUARDS

- .1 Provide guards for unprotected drives.
- .2 Guards for belt drives;
 - .1 Expanded metal screen welded to steel frame.
 - .2 Minimum 1.2 mm thick sheet metal tops and bottoms.
 - .3 38 mm diameter 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 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 SECTION INCLUDES

- .1 Materials and installation for flexible connections, expansion joints, anchors and guides for building services piping.
- .2 Sustainable requirements for construction, verification and operation.

1.2 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A53/A53M-02, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - .2 ASTM A105/A105M-03, Standard Specification for Carbon Steel Forgings, for Piping Applications.

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit product data and indicate for items as applicable:
 - .1 Manufacturer, model number, line contents, pressure and temperature rating.
 - .2 Movement handled, axial, lateral, angular and the amounts of each.
 - .3 Nominal size and dimensions including details of construction and assembly.
- .3 Submit maintenance data in accordance with Section 01 78 00 - Closeout Submittals.
- .4 Data to include:
 - .1 Servicing requirements, including special requirements, stuffing box packing, lubrication and recommended procedures.

1.4 HEALTH AND SAFETY

- .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 GENERAL REQUIREMENTS

- .1 Verify, prior to installation, required anchors and expansion joints to adequately protect system.
- .2 Base expansion calculations on -10 deg.C installation temperature to 100 deg.C for hot water heating and low pressure steam and 60 deg.C for domestic hot water, plus 30% safety factor.

Part 2 Products

2.1 SLIP TYPE EXPANSION JOINTS

- .1 Application: for axial pipe movement, copper and steel to be 50 mm and under.
- .2 Repacking: under full line pressure.

- .3 Body and packing housings: Class 300, 2MPa carbon steel pipe to ASTM A53/A53M, Grade B. Wall thickness to match pipe with raised face flanges to match pipe.
- .4 Slip or traverse sleeves: carbon steel pipe to ASTM A53/A53M, Grade B, hard chrome plated.
- .5 Anchor base: construction steel, welded to body.
- .6 Guides (internal and external): embody into packing housing with concentric alignment of slip or traverse sleeve with packing housing.
- .7 Extension limit stop: stainless steel, to prevent over-extension with accessible and removable pins.
- .8 Packing rings: 6 minimum, PTFE or graphite impregnated non-asbestos.
- .9 Thermal plastic packing: PTFE or graphite impregnated non-asbestos slug supplied loose.
- .10 Lubricating fittings: pet cocks with grease nipple.
- .11 Plunger body and plunger:
 - .1 Plunger body: heavy wall carbon steel welded to body.
 - .2 Plunger: carbon steel with hex head for use with socket wrench.
- .12 Lubricant: to manufacturer's recommendations.
- .13 Lubricant gun: complete with hose assembly.
- .14 Drip connection: 20 MPa forged steel to ASTM A105/A105M. Include half coupling with drain plug.

2.2 BELLOWS TYPE EXPANSION JOINTS

- .1 For axial, lateral or angular movements, copper and steel pipe 64 and over.
- .2 Maximum working pressure: 862 kPa WSP, 1380 kPa WOG.
- .3 Maximum operating temperature: 204 degrees C at WSP, 121 deg.C at WOG.
- .4 Type A: controlled flexing, factory tested to 1 1/2 times maximum working pressure. Furnish test certificates.
- .5 Type B: externally pressurized, designed to eliminate pressure thrust, factory tested to 1-1/2 times maximum working pressure. Furnish test certificates.
- .6 Bellows:
 - .1 Multiple bellows, hydraulically formed, two ply, austenitic stainless steel for specified fluid, pressure and temperature, water treatment and pipeline cleaning procedures.
- .7 Reinforcing or control rings:
 - .1 2 piece nickel iron.

- .8 Ends:
 - .1 Butt weld flanges to match pipe.
- .9 Liner:
 - .1 Austenitic stainless steel in direction of flow.
- .10 Shroud:
 - .1 Carbon steel, painted.

2.3 GROOVED PIPE EXPANSION JOINTS

- .1 Grooved end expansion joints for steel piping:
 - .1 Packless, gasketed, slip expansion joints: 2400 kPa maximum working pressure, steel pipe fitting consisting of telescoping body and slip-pipe sections, PTFE modified polyphenylene sulfide coated slide section, with grooved ends. Suitable for axial end movement to 80 mm Victaulic Style 150.
 - .2 Expansion joint consisting of a series of grooved end pipe nipples joined in tandem with Victaulic Style 77 flexible couplings. Total joint movement dependent on the number of couplings and nipples used. Victaulic Series 155.

2.4 FLEXIBLE CONNECTION

- .1 Application: to suit motion as indicated.
- .2 Minimum length in accordance with manufacturer's recommendations to suit offset as indicated.
- .3 Inner hose: bronze corrugated for copper pipe, inner hose stainless steel corrugated for steel pipe.
- .4 Braided wire mesh bronze outer jacket, for copper pipe.
- .5 Braided wire mesh stainless steel after jacket for steel pipe.
- .6 Diameter and type of end connection: as indicated under Section 23 05 01.
- .7 Operating conditions:
 - .1 Working pressure: 1034 kPa minimum.
 - .2 Working temperature: 232 degrees C minimum.
 - .3 To match system requirements.

2.5 ANCHORS AND GUIDES

- .1 Anchors:
 - .1 Provide as indicated.
 - .2 Concrete: to Section 03 30 00 - Cast-in-Place.
 - .3 Reinforcement: to Section 03 20 33 - Concrete Reinforcing.
- .2 Alignment guides:
 - .1 Provide as indicated.
 - .2 To accommodate specified thickness of insulation.
 - .3 Vapour barriers, jackets to remain uninterrupted.

Part 3 Execution

3.1 INSTALLATION

- .1 Install expansion joints and flexible connections in accordance with manufacturer's instructions.
- .2 Install pipe anchors and guides as indicated and required. Anchors to withstand 150% of axial thrust.
- .3 Provide flexible pipe connectors on pipes connected to all equipment supported by vibration isolation and where shown on drawings and schematics.
- .4 Provide structural work and equipment required to control expansion and contraction of piping, loops, pipe offsets, and swing joints and provide corrugated bellows type expansion joints where indicated or required.
- .5 Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor at other end.
- .6 Rigidly anchor pipe to building structure at points shown and where required, where necessary provide pipe guides so that movement takes place along axis of pipe.
- .7 Three Victualic Style 77 couplings may be used in lieu of a flexible connector for vibration attenuation and stress relief. The couplings shall be placed in close proximity to the source of the vibration.
- .8 Rigidly anchor pipe to building structure at points shown, and where necessary provide pipe guides so that movement takes place along axis of pipe only.

3.2 CLEANING AND START-UP

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

3.3 PERFORMANCE VERIFICATION

- .1 In accordance with Section 23 08 01 - Performance Verification: Mechanical Piping Systems.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
 - .1 ANSI/ASME B31.1-1998, Power Piping.
 - .2 ANSI/ASME B31.3-2000, Process Piping Addenda A.
 - .3 ANSI/ASME B31.3-2001, Process Piping Addenda B.
 - .4 ANSI/ASME Boiler and Pressure Vessel Code-1998:
 - .1 Section I: Power Boilers.
 - .2 Section V: Nondestructive Examination.
 - .3 Section IX: Welding and Brazing Qualifications.
- .2 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA C206-97, Field Welding of Steel Water Pipe.
- .3 American Welding Society (AWS)
 - .1 AWS C1.1-2000, Recommended Practices for Resistance Welding.
 - .2 AWS Z49.1-1999, Safety Welding, Cutting and Allied Process.
 - .3 AWS W1-2000, Welding Inspection Handbook..
- .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-48.2-92, Spot Radiography of Welded Butt Joints in Ferrous Materials.
- .5 Canadian Standards Association (CSA International)
 - .1 CSA W47.2-M1987(R1998), Certification of Companies for Fusion Welding of Aluminum.
 - .2 CSA W48 series-01, Filler Metals and Allied Materials for Metal Arc Welding.
 - .3 CSA B51-97, Boiler, Pressure Vessel and Pressure Piping Code.
 - .4 CSA-W117.2-01, Safety in Welding, Cutting and Allied Processes.
 - .5 CSA W178.1-02, Certification of Welding Inspection Organizations.
 - .6 CSA W178.2-01, Certification of Welding Inspectors.

1.2 QUALIFICATIONS

- .1 Welders
 - .1 Welding qualifications in accordance with CSA B51.
 - .2 Use qualified and licensed welders possessing certificate for each procedure performed from authority having jurisdiction.
 - .3 Furnish 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.

1.3 QUALITY ASSURANCE

- .1 Registration of welding procedures in accordance with CSA B51.
- .2 Copy of welding procedures available for inspection.
- .3 Safety in welding, cutting and allied processes in accordance with CSA-W117.2.

Part 2 Products

2.1 ELECTRODES

- .1 Electrodes: in accordance with CSA W48 Series.

Part 3 Execution

3.1 WORKMANSHIP

- .1 Welding: in accordance with ANSI/ASME B31.1, B31.3, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to AWS B3.0, AWS C1.1, and applicable requirements of provincial authority having jurisdiction.

3.2 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.

3.3 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.

3.4 SPECIALIST EXAMINATIONS AND TESTS

- .1 Hydrostatically test welds to requirements of ANSI/ASME B31.1.

- .2 Visual examinations: include entire circumference of weld externally and wherever possible internally.
- .3 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.
- .4 Full radiographic tests for piping systems.
 - .1 Spot radiography to CAN/CGSB-48.2.
 - .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.
- .5 Magnetic particle tests for piping systems.

3.5 DEFECTS CAUSING REJECTION

- .1 As described in ANSI/ASME B31.1 and ANSI/ASME Boiler and Pressure Vessels Code.
- .2 In addition, chilled water systems:
 - .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 particle tests.

3.6 REPAIR OF WELDS WHICH FAILED TESTS

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

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Bronze - valves.
- .2 Sustainable requirements for construction and verification.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME).
 - .1 ANSI/ASME B1.20.1-1983(R2001), Pipe Threads, General Purpose (Inch).
 - .2 ANSI/ASME B16.18-2001, Cast Copper Alloy Solder Joint Pressure Fittings.
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A276-04, Specification for Stainless Steel Bars and Shapes.
 - .2 ASTM B62-02, Specification for Composition Bronze or Ounce Metal Castings.
 - .3 ASTM B283-99a, Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
 - .4 ASTM B505/B505M-02, Specification for Copper-Base Alloy Continuous Castings.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
 - .1 MSS-SP-25-1998, Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 MSS-SP-80-2003, Bronze Gate Globe, Angle and Check Valves.
 - .3 MSS-SP-110-1996, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 81 01 - Hazardous Materials.
 - .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Submit data for valves specified in this section.
- .3 Closeout Submittals:
 - .1 Submit maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

Part 2 Products

2.1 MATERIALS

- .1 Valves:
 - .1 Except for specialty valves, to be single manufacturer.
 - .2 All products to have CRN registration numbers.
- .2 End Connections:
 - .1 Connection into adjacent piping/tubing:
 - .1 Steel pipe systems: Screwed ends to ANSI/ASME B1.20.1.
 - .2 Copper tube systems: Solder ends to ANSI/ASME B16.18.
 - .3 Provide flanged ends as indicated under 23 05 05, Installation of Pipework.
- .3 Lockshield Keys:
 - .1 Where lockshield valves are specified, provide 10 keys of each size: malleable iron cadmium plated.
- .4 Gate Valves:
 - .1 Requirements common to gate valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: union with hexagonal shoulders.
 - .3 Connections: screwed with hexagonal shoulders.
 - .4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - .5 Packing: non-asbestos.
 - .6 Handwheel: non-ferrous.
 - .7 Handwheel Nut: bronze to ASTM B62.
 - .2 NPS 2 and under, non-rising stem, solid wedge disc, Class 125
 - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
 - .2 Operator: Handwheel.
 - .3 NPS 2 and under, non-rising stem, solid wedge disc, Class 150:
 - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
 - .2 Operator: Handwheel.
 - .4 NPS 2 and under, rising stem, split wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Disc: split wedge, bronze to ASTM B283, loosely secured to stem.
 - .3 Operator: Handwheel.
 - .5 NPS 2 and under, rising stem, solid wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Operator: Handwheel.
 - .6 NPS 2 and under, rising stem, solid wedge disc, Class 150:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Operator: Handwheel.
- .5 Globe Valves:
 - .1 Requirements common to globe valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: union with hexagonal shoulders.
 - .3 Connections: screwed with hexagonal shoulders.

- .4 Pressure testing: to MSS SP-80. Tests to be hydrostatic.
- .5 Stuffing box: threaded to bonnet with gland follower, packing nut, high grade non-asbestos packing.
- .6 Handwheel: non-ferrous.
- .7 Handwheel Nut: bronze to ASTM B62.
- .2 NPS 2 and under, composition disc, Class 125:
 - .1 Body and bonnet: screwed bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc, composition to suit service conditions, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
 - .3 Operator: Handwheel.
- .3 NPS 2 and under, composition disc, Class 150:
 - .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 NPS 2 and under, plug disc, Class 150, screwed ends:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat ring: tapered plug type with disc stem ring of AISI S420 stainless steel to ASTM A276, loosely secured to stem.
 - .3 Operator: Handwheel.
- .5 Angle valve, NPS 2 and under, composition disc, Class 150:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc in slip-on easily removable disc holder having integral guides, regrindable bronze seat, loosely secured to stem.
 - .3 Operator: Handwheel.
- .6 Check Valves:
 - .1 Requirements common to check valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Connections: screwed with hexagonal shoulders.
 - .2 NPS 2 and under, swing type, bronze disc, Class 125:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
 - .3 NPS 2 and under, swing type, bronze disc:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
 - .4 NPS 2 and under, swing type, composition disc, Class 200:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc: renewable rotating disc of number 6 composition to suit service conditions, bronze two-piece hinge disc construction.
 - .5 NPS 2 and under, horizontal lift type, composition disc, Class 150:
 - .1 Body: with integral seat, union bonnet ring with hex shoulders, cap.

- .2 Disc: renewable PTFE rotating disc in disc holder having guides top and bottom, of bronze to ASTM B62.
- .6 NPS 2 and under, vertical lift type, bronze disc, Class 125:
 - .1 Disc: rotating disc having guides top and bottom, disc guides, retaining rings.
- .7 Silent Check Valves:
 - .1 NPS 2 and under:
 - .1 Body: cast high tensile bronze to ASTM B62 with integral seat.
 - .2 Pressure rating: Class 125.
 - .3 Connections: screwed ends to ANSI B1.20.1 and with hex. shoulders.
 - .4 Disc and seat: renewable rotating disc.
 - .5 Stainless steel spring, heavy duty.
 - .6 Seat: regrindable.
- .8 Ball Valves:
 - .1 NPS 2 and under:
 - .1 Body and cap: cast high tensile brass to C37700.
 - .2 Pressure rating: Class 150 WSP/600 WOG.
 - .3 Connections: Screwed ends to ANSI B1.20.1 and with hexagonal shoulders or solder ends to ANSI.
 - .4 Stem: tamperproof ball drive.
 - .5 Stem packing nut: external to body.
 - .6 Ball and seat: replaceable solid hard chrome full port ball and teflon seals.
 - .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 or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal. Refer to 23 05 05 - Installation of Pipework.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Valves, gate, globe, and check.
- .2 Sustainable requirements for construction and verification.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME).
 - .1 ANSI/ASME B16.1-1998, Cast Iron Pipe Flanges and Flanged Fittings.
- .2 American Society for Testing and Materials International (ASTM).
 - .1 ASTM A49-01, Specification for Heat-Treated Carbon Steel Joint Bars.
 - .2 ASTM A126-95(2001), Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - .3 ASTM B61-93, Specification for Steam or Valve Bronze Castings.
 - .4 ASTM B62-93, Specification for Composition Bronze or Ounce Metal Castings.
 - .5 ASTM B85-03, Specification for Aluminum-Alloy Die Castings.
 - .6 ASTM B209-04, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
 - .1 MSS SP-70-1998, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .2 MSS SP-71-1997, Grey Iron Swing Check Valves, Flanged and Threaded Ends.
 - .3 MSS SP-82-1992, Valve Pressure Testing Methods.
 - .4 MSS SP-85-2002, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 81 01 - Hazardous Materials.
 - .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Submit data for valves specified in this section.
- .3 Closeout Submittals:
 - .1 Submit maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

Part 2 Products

2.1 MATERIAL

- .1 Valves:
 - .1 Except for specialty valves, to be of single manufacturer.
- .2 Standard specifications:
 - .1 Gate valves: MSS SP-70.
 - .2 Globe valves: MSS SP-85.
 - .3 Check valves: MSS SP-71.
- .3 Requirements common to valves, unless specified otherwise:
 - .1 Body, bonnet: cast iron to ASTM B209 Class B.
 - .2 Connections: flanged ends with 2 mm raised face with serrated finish to ANSI B16.1.
 - .3 Inspection and pressure testing: to MSS SP-82.
 - .4 Bonnet gasket: non-asbestos.
 - .5 Stem: to have precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut.
 - .6 Stuffing box: non-galling two-piece ball-jointed packing gland, gland bolts and nuts.
 - .7 Gland packing: non-asbestos.
 - .8 Handwheel: Die-cast aluminum alloy to ASTM B85 or malleable iron to ASTM A49. Nut of bronze to ASTM B62.
 - .9 Identification tag: with catalogue number, size, other pertinent data.
- .4 All products to have CRN registration numbers.

2.2 GATE VALVES

- .1 NPS 2 1/2 - 8, non rising stem, inside screw, bronze trim, solid wedge disc:
 - .1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly. Class 300.
 - .2 Disc: solid offset taper wedge, bronze to ASTM B62.
 - .3 Seat rings: renewable bronze to ASTM B62, screwed into body.
 - .4 Stem: bronze to ASTM B62.
 - .5 Disc: solid offset taper wedge, cast iron to ASTM A126 Class B, secured to wrought steel stem.
 - .6 Seat: Integral with body.
 - .7 Stem: wrought steel.
 - .8 Operator: Handwheel.
- .2 NPS 2 1/2-8, outside screw and yoke (OS&Y), bronze trim, solid wedge disc:
 - .1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, yoke, yoke hub, yoke sleeve and nut. Class 300.
 - .2 Disc: solid offset taper wedge, bronze to ASTM B62 up to NPS 3, cast iron with bronze disc rings on other sizes, secured to stem through integral forged T-head disc-stem connection.
 - .3 Seat rings: renewable bronze screwed into body.
 - .4 Stem: nickel-plated steel.
 - .5 Disc: solid offset taper all-cast iron, secured to stem through integral forged T-head disc-stem connection.

- .6 Seat rings: integral with body.
- .7 Stem: nickel-plated steel.
- .8 Pressure-lubricated operating mechanism.
- .9 Operator: Handwheel.
- .10 Bypass: complete with union and NPS globe valve as Section 23 05 05 - Installation of Pipework.

2.3 UNDERWRITERS APPROVED GATE VALVE

- .1 NPS 2 1/2 - 14, OS&Y:
 - .1 Approvals: UL and FM approved for fire service.
 - .2 UL and FM Label: on valve yoke.
 - .3 Body, Bonnet: cast iron to ASTM A126 Class B. Wall thicknesses to ANSI B16.1 and ULC 262 (B).
 - .4 Bonnet bushing, yoke sleeve: bronze, to FM requirements.
 - .5 Packing gland: bronze.
 - .6 Stem: manganese bronze. Diameter to ULC C-262 (B).
 - .7 Stuffing box dimensions, gland bolt diameter: to ULC C-262 (B).
 - .8 Bosses for bypass valve, drain: on NPS 4 and over.
 - .9 Disc: solid taper wedge. Up to NPS 3: bronze. NPS 4 and over: cast iron with bronze disc rings.
 - .10 Disc seat ring: self-aligning, Milwood undercut on NPS 3 - 12.
 - .11 Pressure rating:
 - .1 NPS 2-1/2 - 12: 1.7 Mpa CWP.
 - .12 Operator: handwheel.
 - .13 Bypass: complete with union and NPS globe valve as Section 23 05 23.01 - Valves - Bronze.

2.4 GLOBE VALVES

- .1 NPS 2 1/2 - 10, OSY:
 - .1 Body: with multiple-bolted bonnet, Class 300.
 - .2 WP: 860 kPa steam, 1.4 MPa CWP.
 - .3 Bonnet-yoke gasket: non-asbestos.
 - .4 Disc: bronze to ASTM B62, fully guided from bottom, securely yet freely connected to stem for swivel action and accurate engagement with disc.
 - .5 Seat ring: renewable, regrindable, screwed into body.
 - .6 Stem: bronze to ASTM B62.
 - .7 Operator: Handwheel.

2.5 BYPASSES FOR GATE AND GLOBE VALVES

- .1 Locations: on valves as indicated.
- .2 Position of bypass valve on main valves.
- .3 Size of bypass valve:
 - .1 Main valve up to NPS 8: NPS 3/4.
- .4 Type of bypass valves:
 - .1 On gate valve: globe, with composition disc, bronze trim, to Section 23 05 23.01 - Valves - Bronze. Pressure rating to match main valve.

- .2 On globe valve: globe, with composition disc, bronze trim, to Section 23 05 23.01 - Valves - Bronze. Pressure rating to match main valve.

2.6 VALVE OPERATORS

- .1 Install valve operators as follows:
 - .1 Handwheel: on valves except as specified.
 - .2 Handwheel with chain operators: on valves installed more than 2400 mm above floor in boiler rooms and mechanical equipment rooms.

2.7 CHECK VALVES

- .1 Swing check valves, Class 300:
 - .1 Body and bolted cover: cast iron to ASTM A126 Class B with tapped and plugged opening on each side for hinge pin.
 - .2 Flanged ends: 2 mm raised face with serrated finish.
 - .3 Rating: 300 psi steam; 500 psi CWP.
 - .4 Disc: rotating for extended life.
 - .1 Up to NPS 3: bronze to ASTM B61.
 - .2 NPS 4 - 8: Iron faced with ASTM B61 bronze.
 - .5 Seat rings: renewable bronze to ASTM B61, screwed into body.
 - .6 Hinge pin, bushings: renewable, bronze to ASTM B61.
 - .7 Hinge: galvanized malleable iron.
 - .8 Identification tag: fastened to cover.

Part 3 Execution

3.1 INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance and equipment removal. Refer to Section 23 05 05 Installation of Pipework.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Valves Cast Steel, gate, globe, and check.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME).
 - .1 ANSI/ASME B16.5-2003, Pipe Flanges and Flanged Fittings.
 - .2 ANSI/ASME B16.10-1992, Face-to-Face and End-to-End Dimensions Valves.
 - .3 ANSI/ASME B16.25-1997, Buttwelding Ends.
 - .4 ANSI/ASME B16.34-1996, Valves - Flanged, Threaded and Welding End.
- .2 American Petroleum Institute (API).
 - .1 API 598-1996, Valve Inspection and Testing.
- .3 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A49-01, Specification for Heat-Treated Carbon Steel Joint Bars.
 - .2 ASTM A193/A193M-04, Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
 - .3 ASTM A194/A194M-03b, Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.
 - .4 ASTM A216/A216M-1993(03), Specification for Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service.
 - .5 ASTM B85-03, Specification for Aluminum-Alloy Die Castings.
- .4 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
 - .1 MSS SP-25-1998, Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 MSS SP-61-2003, Pressure Testing of Steel Valves.

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 81 01 - Hazardous Materials.
 - .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Submit data for valves specified this section.
 - .3 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Closeout Submittals:
 - .1 Submit maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

Part 2 Products

2.1 MATERIAL

- .1 Valves:
 - .1 Except for specialty valves, to be of single manufacturer.
 - .2 Valves to be individually tested.
- .2 Requirements common to valves, unless specified otherwise:
 - .1 Pressure-temperature ratings: to ANSI B16.34.
 - .2 Inspections and tests: to API 598.
 - .3 Pressure Testing: to MSS SP-61.
 - .4 Flanged valves:
 - .1 Face-to-face dimensions: to ANSI B16.10.
 - .2 Flange dimensions: to ANSI B16.5 with 1.6 mm raised face.
 - .5 Butt-weld valves:
 - .1 End-to-end dimensions: to ANSI B16.10.
 - .2 End dimensions: to ANSI B16.25 bored for standard pipe schedule.
 - .6 Handwheel: non-heating type with raised rim of die-cast aluminum alloy to ASTM B85 or malleable iron to ASTM A49.
 - .7 Markings: to MSS SP-25.
 - .8 Identification:
 - .1 Plate showing catalogue number, size, material of body disc, stem seat, fluid, pressure-temperature rating.
 - .2 Body markings: manufacturer, size, primary service rating, material symbol.
 - .9 CRN registration number required for all products.

2.2 GATE VALVES

- .1 NPS 2 1/2 - 12, rising stem, OS&Y, solid flexible wedge disc, flanged or butt-weld ends, Class 300:
 - .1 Body and multiple-bolted integral yoke and bonnet: cast steel to ASTM A216/A216M WCB, with full length disc guides designed to ensure correct re-assembly.
 - .2 Body/bonnet joint: Flat face with corrugated metallic gasket.
 - .3 Bonnet studs: to ASTM A193/A193M Type B7.
 - .4 Bonnet nuts: to ASTM A194/A194M Type 2H.
 - .5 Stuffing box: including non-galling two-piece ball jointed packing gland, with swing-type eye bolts and nuts.
 - .6 Gland packing: containing corrosion inhibitor to prevent stem pitting.
 - .7 Yoke sleeve: Ni-Resist, minimum melting point above 954 degrees C.
 - .8 Hydraulic grease fitting: for lubrication of yoke sleeve bearing surfaces.

- .9 Disc: with disc stem ring to connect to stem, guided throughout its travel.
 - .1 NPS 2 1/2 - 6: Solid corrosion and heat resistant 13% chromium steel with minimum hardness of 350 HB.
 - .2 NPS 8 and larger: Carbon steel faced with corrosion and heat resistant 13 chromium steel with minimum hardness of 350 HB.
- .10 Seat ring: seamless carbon steel with hard-faced cobalt-chromium-tungsten alloy seating surface, slipped in, seal welded, ground to match disc.
- .11 Stem: heat treated corrosion and heat resistant 13% chromium steel with accurately-cut precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut, T-head disc-stem connection.
- .12 Operator: see elsewhere this section.

2.3 GLOBE VALVES

- .1 NPS 2 1/2 - 12, rising stem, OS&Y, flanged or butt-weld ends, Class 300:
 - .1 Body and multiple-bolted integral yoke and bonnet: cast steel to ASTM A216/A216M WCB.
 - .2 Body/bonnet joint: Flat face with corrugated metallic gasket.
 - .3 Bonnet studs: to ASTM A193/A193M Type B7.
 - .4 Bonnet nuts: to ASTM A194/A194M Type 2H.
 - .5 Stuffing box: including non-galling two-piece ball-jointed packing gland, with swing-type eye bolts and nuts.
 - .6 Gland packing: containing corrosion inhibitor to prevent stem pitting.
 - .7 Yoke bushing: Ni-Resist, minimum melting point above 954 degrees C.
 - .8 Hydraulic grease fitting: for lubrication of yoke sleeve bearing surfaces.
 - .9 Disc: Plug type with 15 degrees taper seat and bottom guide or ball type with 35 degrees taper seat.
 - .10 Seat rings: with 1.6 mm thick cobalt-chromium-tungsten alloy facings with minimum hardness of 375 HB (cold), slipped in, seal welded, ground to match disc.
 - .11 Stem: heat treated corrosion and heat resistant 13% chromium steel with bonnet bushing, long engagement with yoke bushing for accurate seating, accurately-cut precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut.
 - .12 Operator: see elsewhere this section.

2.4 VALVE OPERATORS

- .1 Handwheel: on all valves except as specified.
- .2 Handwheel with chain operators: on valves installed more than 2400 mm above floor in Boiler Rooms and Mechanical Equipment Rooms.

2.5 BYPASSES FOR GATE AND GLOBE VALVES

- .1 Locations: on valves as indicated.
- .2 Position of bypass valve on main valves.

- .3 Size of bypass valve:
 - .1 Main valve up to NPS 8: NPS 3/4.
- .4 Type of bypass valves:
 - .1 On gate valve: globe, with composition disc, bronze trim, to Section 23 05 22 - Valves - Bronze.
 - .2 On globe valve: globe, with composition disc, bronze trim, to Section 23 05 22 - Valves - Bronze.

2.6 CHECK VALVES

- .1 NPS 2 1/2 and over, flanged or butt-weld ends, Class 300: swing check.
 - .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 Hinge: cast carbon steel.
 - .8 Hinge pin: stainless steel (410).

2.7 SILENT CHECK VALVES

- .1 Construction:
 - .1 Body: Cast steel to ASTM A216 WCB with integral seat.
 - .2 Pressure rating: Class 300.
 - .3 Connections: Flanged or Wafer ends.
 - .4 Double bronze disc with SS seat and stem. Renewable disc, seat, stem and spring. Spring rating must match system design for silent operation and installation.
 - .5 Stainless steel spring, heavy duty.
 - .6 Seat: regrindable.

Part 3 Execution

3.1 INSTALLATION

- .1 Install in accordance with manufacturer's recommendations in upright position with stem above horizontal.
- .2 Install valves with unions or flanges to each piece of equipment arranged to allow servicing, maintenance, and equipment removal. Refer to Section 23 05 05 Installation of Pipework.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Plug Valves - Lubricated plug valves, Eccentric plug valves.
- .2 Sustainable requirements for construction and verification.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME).
 - .1 ANSI/ASME B1.20.1-1983(R2001), Pipe Threads, General Purpose (Inch).
 - .2 ANSI/ASME B16.1-1998, Cast Iron Pipe Flanges and Flanged Fittings.
 - .3 ANSI/ASME B16.11-2001, Forged Fittings, Socket-Welding and Threaded.
 - .4 ANSI/ASME B16.25-1997, Buttwelding Ends.
 - .5 ANSI/ASME B16.34-1996, Valves - Flanged, Threaded and Welding End.
 - .6 ANSI/ASME B16.10-2000, Face to Face and End to End Dimensions of Valves.
- .2 American Society for Testing and Materials International (ASTM).
 - .1 ASTM A126-95(2000), Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - .2 ASTM B62-02, Specification for Composition Bronze or Ounce Metal Castings.
 - .3 ASTM B209-04, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .3 Manufacturer's Standardization Society of the Valves and Fittings Industry Inc. (MSS).
 - .1 MSS SP-78-1998, Cast Iron Plug Valves, Flanged and Threaded Ends.

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 81 01 - Hazardous Materials.
 - .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
 - .3 Submit data for valves specified this Section.
- .3 Closeout Submittals:
 - .1 Submit maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

Part 2 Products

2.1 MATERIAL

- .1 Valves:
 - .1 Except for specialty valves, to be of single manufacturer.
 - .2 Products to have CRN registration number.

2.2 ECCENTRIC PLUG VALVES

- .1 General:
 - .1 Dead-tight shut-off on liquids and gases at pressure differentials up to 1.2 MPa in forward direction, 520 kPa in reverse direction.
- .2 Up to NPS 2, screwed ends:
 - .1 Body: cast iron to ASTM B209 Class B.
 - .2 Plug:
 - .1 NPS 1/2 and 3/4: bronze to ASTM B62.
 - .2 NPS 1 to NPS 2: bronze to ASTM B62.
 - .3 Bearings: permanently lubricated, bronze to ASTM B62 in upper and lower journals.
 - .4 Seals: double-seal consisting of:
 - .1 Plastic seat coating between plug and body.
 - .2 Resilient seal moulded into groove in plug face.
 - .3 Seal materials: BUNA Stem seals with Neoprene (gas service) plug seals.
 - .4 VITON stem seals with Fluorinated hydrocarbon plug seals (over 149 deg.C).
 - .5 Isobutene Isoprene stem seal with isobutene-isoprene plug seals (up to 121 deg.C)
 - .5 End connections: screwed.
 - .6 Operators: lever with adjustable memory stop.
- .3 NPS 2 1/2 to NPS 4, flanged ends:
 - .1 Body: cast iron to ASTM B209 Class B.
 - .2 Plug: nickel-plated cast iron to ANSI.
 - .3 Bearings: permanently lubricated, bronze to ASTM B62 in upper and lower journals.
 - .4 Seals: double-seal consisting of:
 - .1 Plastic seat coating between plug and body.
 - .2 Resilient seal moulded into groove in plug face.
 - .3 Seal materials: BUNA Stem seals with Neoprene plug seals (gas service)

- .4 VITON stem seals with Fluorinated hydrocarbon plug seals (over 149 deg.C).
- .5 Isobutene Isoprene stem seal with isobutene-isoprene plug seals (up to 121 deg.C)
- .5 End connections: flanged to ANSI B16.1 or roll grooved.
- .6 Operators: lever.

2.3 LUBRICATED PLUG VALVES

- .1 Principle of operation:
 - .1 Special sealing compound used to effect tight seal. When line pressure applied to valve in closed position, parallel plug forced against downstream side of valve. The metal-to-metal contact and sealing compound ensures leak-tight seal.
- .2 Testing to specifications: MSS SP-78 for non-shock pressure at specified temperature.
- .3 End connections:
 - .1 NPS 1/2 to 2: screwed ends.
 - .2 NPS 2½ to 12: flanged ends.
- .4 Valve:
 - .1 Body: cast iron to ASTM A126 Class B semi-steel.
 - .2 Pressure rating: NPS 1/2 to 12:
 - .1 Screwed end valves: screwed to NPT standards.
 - .2 Flanged end valves: flanged to ANSI B16.1 Class 300. Flanged valves NPS 2-8 face dimensions in accordance with ANSI B16.10 short pattern, making them interchangeable with Class 300 flanged cast iron gate valves.
 - .3 Hydrostatic tests: body 300 psig. Seat: 100 psig.
 - .3 Plug: tapered, with regular pattern port - 90 degrees from full open to fully closed, complete with PTFE thrust ring: 100% full port.
 - .4 Number of ports: as required.
 - .5 Ends: with ends screwed to ANSI B1.20.1, butt welding to ANSI B16.25, socket-welding to ANSI B16.11.
 - .6 Lubrication system, nickel-plated.
 - .7 Lubricant: to suit type, temperature and pressure of contained fluid.
 - .8 Provide sealing compound injection gun designed for use with pre-packed sealing compound cartridges and valve fitted with button head nipples and combination sealing screws.
 - .9 Feeding system: lubricant forced into lubrication grooves between seating surfaces of plug and body to form positive seal, leakproof operation, and corrosion preventing film. Lubricant receptacle to hold additional lubricant. Lubricant screw for lubrication. Check valve to prevent reverse flow of lubricant. O-rings between body and plug.
- .5 Operator:
 - .1 Up to NPS 5: manual lever.

- .6 3 port and 4 port valves:
 - .1 To be supplied transflow pattern, to allow reduced flow through ports during rotation of plug from one position to another.
 - .2 Limit stops: to be provided.
- .7 Accessories: lubricant gun.

Part 3 Execution

3.1 INSTALLATION OF LUBRICATED PLUG VALVES

- .1 Install with line pressure acting to hold plug against body ports which are to be cut-off from higher pressure.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Butterfly Valves.
- .2 Sustainable requirements for construction and verification.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME).
 - .1 ANSI/ASME B1.20.1-1983(R2001), Pipe Threads, General Purpose (Inch).
 - .2 ANSI/ASME B16.1-1998, Cast Iron Pipe Flanges and Flanged Fittings.
 - .3 ANSI/ASME B16.5-03, Pipe Flanges and Flanged Fittings.
 - .4 ANSI/ASME B16.11-01, Forged Fittings, Socket-Welding and Threaded.
 - .5 ANSI/ASME B16.25-1997, Buttwelding Ends.
 - .6 ANSI/ASME B16.34-1996, Valves - Flanged, Threaded and Welding Ends.
- .2 American National Standards Institute (ANSI)/American Petroleum Institute (API).
 - .1 ANSI/API 609-1997, Lug- and Water-Type Butterfly Valves.
- .3 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A126-95(01), Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - .2 ASTM B62-02, Specification for Composition Bronze or Ounce Metal Castings.
 - .3 ASTM B209M-04, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .4 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
 - .1 MSS SP-67-02, Butterfly Valves.

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 81 01 - Hazardous Materials.
 - .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
 - .3 Submit data for valves specified this section.
- .3 Closeout Submittals:
 - .1 Submit maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

Part 2 Products

2.1 BUTTERFLY VALVES - RESILIENT SEAT - 300 PSIG

- .1 Sizes: Lug type: NPS 2 to 48.
- .2 Pressure rating: 300 psig at 135 degrees C.
- .3 Lug body: 300 ANSI bolt pattern.
- .4 Full lug body (threaded).
- .5 Application: for on-off service.
- .6 Operators:
 - .1 NPS 2 - 6: Handles capable of locking in any of ten (10) positions - 0 degrees to 90 degrees. Handle and release trigger - ductile iron. Return spring and hinge pin: carbon steel. Latch plate and mounting hardware: cadmium plated carbon steel.
 - .2 Install parallel or perpendicular to pipeline.
- .7 Designed to comply with MSS SP-67 and API 609.
- .8 Compatible with ANSI B16.1 Class 250 (iron) and ANSI B16.5 Class 300 (steel) flanges.
- .9 Construction:
 - .1 Body: ductile iron.
 - .2 Disc: aluminum bronze.
 - .3 Seat: EPDM.
 - .4 Shaft: NPS 2 - 12: 416 stainless steel.
 - .5 Taper pin: 316 SS.
 - .6 Blowout proof stem.
 - .7 O-Ring: Buna-N.
 - .8 Bushings: teflon.
 - .9 Disc shall not be pinned to shaft.
 - .10 Bubble tight shutoff with downstream flanges removed, class 6 shutoff.

2.2 MOUNTING FLANGES

- .1 Class 300 steel to B16.5 pipe flanges.

2.3 ELECTRIC ACTUATORS

- .1 Operation: designed to provide precise quarter turn electric operation.
 - .1 Torque range: up to 1.130 N-m and speed ranges from 10 seconds to 30 seconds to move from fully open to fully closed.
 - .2 Gear train within actuator to provide smooth continuous rotary power stroke for accurate automatic valve positioning. Factory-set, field adjustable cam-actuated travel limit switches to provide precise control of shaft rotation.
- .2 Construction:
 - .1 Castings: heavy duty industrial grade for rugged use.
 - .2 Actuators: continuous duty with high efficiency single phase reversing capacitor motor with thermal overload protection.
 - .3 Gears and pinions constructed from hardened steel.
 - .4 Gear train to be permanently lubricated.
 - .5 Mechanical brake to ensure that gear is locked in precise position.
- .3 Electrical:
 - .1 Standard voltage: 120 VAC. 60 Hz.
 - .2 Control options: 4-20 Ma DC or 0-10 V DC.
 - .3 CSA approved.
 - .4 Electrical rating: NEMA IV.

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 centered between bolts before bolts are tightened and then opened and closed to ensure unobstructed disc movement. If interference occurs due, for example to pipe wall thickness, taper bore adjacent piping to remove interference.

3.3 ACTUATOR INSTALLATION

- .1 Electrical connections to be made by actuator manufacturer.
- .2 Cycle valve operation from fully closed to fully open then back to fully closed.
- .3 At same time, check travel stop settings for proper disc alignment.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Concrete housekeeping pads, hangers and supports for mechanical piping, ducting and equipment.
 - .2 Sustainable requirements for construction and verification.

1.2 REFERENCES

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
 - .1 ANSI/ASME B31.1-04, Power Piping.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A125-1996(R2001), Specification for Steel Springs, Helical, Heat-Treated.
 - .2 ASTM A307-04, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .3 ASTM A563-04a, Specification for Carbon and Alloy Steel Nuts.
- .3 Factory Mutual (FM)
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP58-2002, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - .2 ANSI/MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.
 - .3 MSS SP89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .6 Underwriter's Laboratories of Canada (ULC)

1.3 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 and prevent vibration.
 - .5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP58.

- .6 Pipe supports shall meet the requirements of ASME B31.1 Power Piping and ASME B31.9 Building Services Piping.
- .7 Automatic sprinkler pipe supports shall meet the requirements of NFPA No. 13, Standard for Installation of Sprinkler Systems.
- .8 Install supports of strength and rigidity to suit loading without unduly stressing building. Locate adjacent to equipment to prevent undue stresses in piping and equipment.
- .9 Select hangers and supports for the service and in accordance with the manufacturer's recommended maximum loading. Hangers shall have a safety factor of 5 to 1.
- .10 Fasten hangers and supports to building steel in accordance with the requirements of Structural or inserts in concrete construction.
- .11 Provide and set sleeves required for equipment, including openings required for placing equipment.
- .12 Obtain approval prior to drilling for inserts and supports for piping systems.
- .13 Obtain approval prior to using percussion type fastenings.
- .14 Use of existing piping or equipment for hanger supports is not permitted.
- .15 Use of perforated band iron, wire or chain as hangers is not permitted.

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.

Part 2 Products

2.1 GENERAL

- .1 Fabricate hangers, supports and sway braces in accordance with ASME B31.1, ASME B31.9 and MSS SP58.
- .2 Use components for intended design purpose only. Do not use for rigging or erection purposes.
- .3 Design hangers so they cannot become disengaged by movements of supported pipe.

2.2 PIPE HANGERS

- .1 Finishes:
 - .1 Pipe hangers and supports: galvanized after manufacture.
 - .2 Use electro-plating galvanizing process or 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 NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
 - .1 Rod: to be UL listed.

- .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed to MSS-SP58 and MSS-SP69.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed to MSS SP69.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed.
- .4 Upper attachment to concrete:
 - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
 - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed to MSS SP69.
- .5 Shop and field-fabricated assemblies:
 - .1 Trapeze hanger assemblies: Steel channels with welded spacers and hanger rods, cast iron roll and stand for hot pipe sizes 150 mm and over.
 - .2 Steel brackets: Welded and wrought steel clamp.
- .6 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.
 - .3 threaded both ends, one end or continuous.
- .7 Pipe attachments: material to MSS SP58:
 - .1 Attachments for steel piping: carbon steel black.
 - .2 Attachments for copper piping: copper plated black steel.
 - .3 Use insulation shields for hot pipework.
 - .4 Oversize pipe hangers and supports.
- .8 Adjustable clevis: material to MSS 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.
- .9 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.
- .10 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: black, with formed portion plastic coated.
- .11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.
- .12 Wall Support:
 - .1 Up to 75 mm: Cast iron hook.
 - .2 100 mm and over: Welded steel bracket and wrought steel clamp.

- .13 Floor Support:
 - .1 Pipe sizes up to 100 mm and all cold pipe sizes: Cast iron adjustable pipe saddle, locknut nipple, floor flange and concrete pier to steel support.
 - .2 Hot pipe sizes 150 mm and over: Adjustable cast iron roll and stand, steel screws and concrete pier or steel support.
- .14 Insulation:
 - .1 Supports shall be coordinated with requirements of insulation. Oversized hangers are required for all pipe systems that require insulation with a vapour barrier to maintain integrity of vapour barrier.
 - .2 Oversized hangers shall also be required for steam pipe systems.

2.3 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.

2.4 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 NPS 12 and over, carbon steel to comply with MSS SP69.

2.5 CONSTANT SUPPORT SPRING HANGERS

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

2.6 VARIABLE SUPPORT SPRING HANGERS

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

2.7 EQUIPMENT SUPPORTS

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of Section 05 50 00 - Metal Fabrications.

2.8 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

2.9 HOUSEKEEPING PADS

- .1 Provide 100 mm high concrete housekeeping pads for base-mounted equipment; size pads 50 mm larger than equipment; chamfer pad edges.
- .2 Concrete: to Section 03 30 00 - Cast-in-place Concrete.

2.10 SLEEVES

- .1 Pipes through floors: Form with 18 gauge galvanized steel.
- .2 Pipes through beams, walls, fire proofing, footings, potentially wet floor: Form with steel pipe or 18 gauge galvanized steel.
- .3 Size large enough to allow for movement due to expansion and to provide for continuous insulation.

2.11 OTHER EQUIPMENT SUPPORTS

- .1 Fabricate equipment supports from structural grade steel meeting requirements of Section 05 50 00 - Metal Fabrications.
- .2 Submit structural calculations with shop drawings.

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, at all vibration isolated equipment 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 INSERTS

- .1 Use inserts for suspending hangers for reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.
- .2 Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over 100 mm.
- .3 Where concrete slabs form finished ceiling, finish inserts flush with slab surface.
- .4 Where inserts are omitted, drill through concrete slab from below and provide rod with recessed square steel plate and nut above slab.

3.4 HANGER SPACING

- .1 Plumbing piping: to Canadian Plumbing Code, Provincial Code, authority having jurisdiction.
- .2 Fire protection: to applicable Fire Code.
- .3 Copper piping: up to NPS 1/2: every 1.5 m.
- .4 Flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.
- .5 Within 300 mm of each elbow.

Maximum Pipe Size : NPS	Maximum Spacing Steel	Maximum Spacing Copper	Rod Diameter
up to 32 mm	1.8 m	1.8 m	9.5 mm
38 mm	1.8 m	1.8 m	9.5 mm
50 mm and 63 mm	3.0 m	3.0 m	9.5 mm
75 mm - 100 mm	3.6 m	3.0 m	15.8 mm
150 mm - 200 mm	4.3 m	4.3 m	22.2 mm

- .6 Install hangers to provide a minimum 12 mm clear space between finished covering and adjacent work.

3.5 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.
- .4 Use hangers which are vertically adjustable 38 mm minimum after piping is erected.
- .5 Support horizontal soil pipe near each hub, with 1.5 m maximum spacing between hangers.
- .6 Support vertical piping at every other floor. Support vertical soil pipe at each floor at hub.
- .7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- .8 Where practical, support riser piping independently of connected horizontal piping.

- .9 Hangers: Pipe sizes 12 mm to 38 mm: Adjustable wrought steel ring.
- .10 Hangers: Pipe sizes 50 mm to 100 mm and Cold Pipe Sizes: Adjustable wrought steel clevis.

3.6 SLEEVES

- .1 Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeves.
- .2 Extend sleeves through potentially wet floors 25 mm above finished floor level. Caulk sleeves full depth and provide floor plate.
- .3 Where piping passes through floor, ceiling or wall close off space between pipe or duct and construction with non-combustible insulation. Provide tight fitting metal caps on both sides and caulk.
- .4 Install chrome plated escutcheons where piping passes through finished surfaces.
- .5 All penetrations through fire rated walls, floors or partition assemblies shall be sealed/fire stopped with fire stop materials that will remain in place and prevent the passage of smoke, toxic gases, flame, etc., when subjected to the standard test method Can 4-S115, "Standard Method of Fire Tests for Firestop Systems" for a period of time equal to fire protection rating required for the grade of fire separation of the penetrated wall or floor.
- .6 Acceptable Product: According to instructions provided, all penetrations in fire rated walls, floors, or partition assemblies shall be sealed/fire stopped with:
 - .1 3M Brand Intumescent, "Fire Barrier" Caulk CP-25, Putty 303, Penetration Sealing Systems 7902 or 7904 Series, Composite Sheet CS-195, or Wrap Strip FS-195.
 - .2 Tremco Firestop Systems: Fyresil, Fyreshield for penetrations and perimeters. Dymeric ULC, THC 900 ULC

3.7 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.

3.8 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.

END OF SECTION

1 General

1.1 SECTION INCLUDES

- .1 Inertia bases.
- .2 Vibration isolation.

1.2 PERFORMANCE REQUIREMENTS

- .1 Provide vibration isolation on all mechanical motor driven equipment plus connected piping and ductwork.
- .2 Supply vibration isolation equipment and materials by one supplier. Consider side loading of equipment and inertia bases when calculating maximum loads on isolators.
- .3 Ensure equipment is sufficiently rigid for isolator point loading.
- .4 Provide and install mechanical equipment so that Average Noise Criteria Curves, as outlined in ASHRAE Guide, are not exceeded.
- .5 Consider upper floor locations critical unless otherwise indicated.
- .6 Use concrete inertia bases where indicated and for fans having static pressure in excess of 0.85 kPa or motors in excess of 30 kW, and on base mounted pumps over 7.5 kW.

1.3 SUBMITTALS

- .1 Section 01 33 00: Procedures for submittals.
- .2 Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each.
- .3 Product Data: Provide schedule of vibration isolator type with location and load on each.
- .4 Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.
- .5 Manufacturer's Certificate: Certify that isolators are properly installed and adjusted to meet or exceed specified requirements.

1.4 PROJECT RECORD DOCUMENTS

- .1 Section 01 78 00: Submittals for project closeout.
- .2 Record actual locations of isolation including attachment points.

2 Products

2.1 VIBRATION ISOLATORS

- .1 Open Spring Isolators:
 - .1 Spring Isolators:
 - .1 For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
 - .2 Code: Colour code springs for load carrying capacity.
 - .2 Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 - .3 Spring Mounts: Provide with levelling devices, minimum 6 mm thick neoprene sound pads, and zinc chromate plated hardware.
 - .4 Sound Pads: Size for minimum deflection of 1.2 mm; meet requirements for neoprene pad isolators.
- .2 Restrained Spring Isolators:
 - .1 Spring Isolators:
 - .1 For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
 - .2 Code: Colour code springs for load carrying capacity.
 - .2 Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 - .3 Spring Mounts: Provide with levelling devices, minimum 6 mm thick neoprene sound pads, and zinc chromate plated hardware.
 - .4 Sound Pads: Size for minimum deflection of 1.2 mm; meet requirements for neoprene pad isolators.
 - .5 Restraint: Provide heavy mounting frame and limit stops.
- .3 Closed Spring Isolators:
 - .1 Spring Isolators:
 - .1 For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
 - .2 Code: Colour code springs for load carrying capacity.
 - .2 Type : Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
 - .3 Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 - .4 Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 7 mm clearance.
- .4 Restrained Closed Spring Isolators:
 - .1 Spring Isolators:
 - .1 For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
 - .2 Code: Colour code springs for load carrying capacity.
 - .2 Type : Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
 - .3 Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.

- .4 Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 7 mm clearance and limit stops.
- .5 Spring Hanger:
 - .1 Spring Isolators:
 - .1 For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
 - .2 Code: Colour code springs for load carrying capacity.
 - .2 Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 - .3 Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators.
 - .4 Misalignment: Capable of 20 degree hanger rod misalignment.
- .6 Neoprene Pad Isolators:
 - .1 Rubber or neoprene waffle pads.
 - .1 30 durometer.
 - .2 Minimum 13 mm thick.
 - .3 Maximum loading 275 kPa.
 - .4 Height of ribs: maximum 0.7 times width.
 - .2 Configuration: Single layer.
- .7 Rubber Mount or Hanger: Moulded rubber designed for 13 mm deflection with threaded insert.
- .8 Glass Fibre Pads: Neoprene jacketed pre-compressed moulded glass fibre.

3 Execution

3.1 INSTALLATION

- .1 Install to manufacturer's written instructions.
- .2 Install isolation for mechanical motor driven equipment throughout, unless specifically noted otherwise
- .3 Install spring hangers without binding.
- .4 On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.
- .5 Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.
- .6 Provide pairs of horizontal limit springs on fans with more than 1.5 kPa static pressure, and on hanger supported, horizontally mounted axial fans.

- .7 Provide resiliently mounted equipment, piping, and ductwork with seismic snubbers. Provide each inertia base with minimum of four seismic snubbers located close to isolators. Snub equipment designated for post disaster use to 1.5 mm maximum clearance. Provide other snubbers with clearance between 4 mm and 7 mm.
- .8 Support piping connections to isolated equipment resiliently for scheduled distance.
 - .1 Up to 100 mm Diameter: First three points of support.
 - .2 125 to 200 mm Diameter: First four points of support.
 - .3 250 mm Diameter and Over: First six points of support.
 - .4 Static deflection of first point shall be twice deflection of equipment. The next two hangers closest to vibration source shall have the greater deflection of 25 mm static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 25 mm static deflection or 1/2 static deflection of isolated equipment.
- .9 Connect wiring to isolated equipment with flexible hanging loop.

3.2 MANUFACTURER'S FIELD SERVICES

- .1 Examine systems to Section 01 45 00.
- .2 Inspect isolated equipment after installation and submit report. Include static deflections.

3.3 EQUIPMENT ISOLATION SCHEDULE

	ISOLATED EQUIPMENT Type	BASE Thickness	ISOLATOR Type	Deflection
.1	Fan Coil	Suspended	Spring	1"
.2	Outdoor Condensing Units	On concrete pad complete with metal stand	Rubber	
.3	Exhaust Fans	Suspended	Spring	2"

END OF SECTION

1 General

1.1 SECTION INCLUDES

- .1 Materials and requirements for the identification of piping systems, duct work, valves and controllers, including the installation and location of identification systems

1.2 REFERENCES

- .1 ASME A13.1 - Scheme for the Identification of Piping Systems.

1.3 SUBMITTALS

- .1 Section 01 33 00: Procedures for submittals.
- .2 Submit list of wording, symbols, letter size, and colour coding for mechanical identification.
- .3 Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- .4 Product Data: Provide manufacturers catalogue literature for each product required.

1.4 PROJECT RECORD DOCUMENTS

- .1 Section 01 78 00: Submittals for project closeout.
- .2 Record actual locations of tagged valves.

2 Products

2.1 LANGUAGE

- .1 Identification in English.

2.2 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

2.3 PIPING SYSTEMS GOVERNED BY CODES

- .1 Identification of Natural gas: to CSA/CGA B149.1 and authority having jurisdiction.
- .2 Identification of Sprinkler System: to NFPA 13

2.4 NAMEPLATES

- .1 3 mm thick laminated plastic or white anodized aluminum, matte finish, with square corners, letters accurately aligned and machine engraved into core.

- .2 Colours:
 - .1 Hazardous: red letters, white background
 - .2 Elsewhere: black letters, white background (except where required otherwise by applicable Codes)

- .3 Sizes: Conform to following table using a maximum of 25 characters per line.

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

Description: Laminated three-layer plastic with engraved black letters on light contrasting background colour.

2.5 TAGS

- .1 Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background colour. Tag size minimum 40 mm diameter.
- .2 Control Tag: Laminated plastic card with black letters on light contrasting background colour in multiple lines. Tag size minimum 85mm x 55mm. Inscriptions to include function and (where appropriate) fail-safe position
- .3 Metal Tags: Brass with stamped letters; tag size minimum 40 mm diameter with smooth edges.
- .4 Chart: Typewritten letter size list in anodized aluminum frame.

2.6 STENCILS

- .1 Stencils: With clean cut symbols and letters of following size:
 - .1 20-30 mm Outside Diameter of Insulation or Pipe: 200 mm long colour field, 15 mm high letters.
 - .2 40-50 mm Outside Diameter of Insulation or Pipe: 200 mm long colour field, 20 mm high letters.
 - .3 65-150 mm Outside Diameter of Insulation or Pipe: 300 mm long colour field, 30 mm high letters.
 - .4 200-250 mm Outside Diameter of Insulation or Pipe: 600 mm long colour field, 65 mm high letters.

- .5 Over 250 mm Outside Diameter of Insulation or Pipe: 800 mm long colour field, 90 mm high letters.
- .6 Ductwork and Equipment: 65 mm high letters.
- .2 Stencil Paint: As specified in Section 09 91 10, semi - Painting.1.

2.7 PIPE MARKERS

- .1 Colour: Conform to ASME A13.1.
- .2 Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- .3 Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- .4 Underground Plastic Pipe Markers: Bright coloured continuously printed plastic ribbon tape, minimum 150 mm wide by 0.10 mm thick, manufactured for direct burial service.

2.8 CEILING TACKS

- .1 Description: Steel with 20 mm diameter colour coded head.
- .2 Colour code as follows:
 - .1 Yellow - HVAC equipment
 - .2 Red - Fire dampers/smoke dampers
 - .3 Green - Plumbing valves
 - .4 Blue - Heating/cooling valves

2.9 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: where required to Workplace Hazardous Materials Information System (WHMIS) regulations.
- .3 Legend: 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 Extent of background colour marking.
- .7 Materials for background colour marking, legend, arrows:
- .1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.
- .2 Other pipes: pressure sensitive plastic-coated cloth or 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
- .8 Colours and Legends:
- .1 Where not listed, obtain direction from Departmental Representative.
- .2 Colours for legends, arrows: to following table:
- | | |
|--------------------|-----------------|
| Background colour: | Legend, arrows: |
| Yellow | BLACK |
| Green | WHITE |
| Red | WHITE |
- .3 Background colour marking and legends for piping systems:
- | Contents | Background colour marking | Legend |
|---------------------------------|---------------------------|-----------------------|
| City water | Green | CITY WATER |
| Chilled water supply | Green | CH. WTR. SUPPLY |
| Chilled water return | Green | CH. WTR. RETURN |
| Steam High Pressure | Yellow | H.P. STEAM (___ kPa) |
| Steam Low Pressure | Yellow | L.P. STEAM (103 kPa) |
| Steam condensate (gravity) | Yellow | ST.COND.RET (GRAVITY) |
| Steam condensate (pumped) | Yellow | ST.COND.RET (PUMPED) |
| Safety valve vent | Yellow | STEAM VENT |
| Domestic hot soft water | Green | DOM. HSW |
| Dom. Hot water recirculation | Green | DOM. HW CIRC |
| Domestic cold hard water supply | Green | DOM. CHW |
| Domestic cold soft water supply | Green | DOM. CSW |
| Sanitary | Green | SAN |
| Plumbing vent | Green | SAN. VENT |

Natural gas	to Codes	
Gas regulator vents	to Codes	
Fire protection water	Red	FIRE PROT. WTR
Sprinklers	Red	SPRINKLERS

2.10 IDENTIFICATION OF DUCTING 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

2.11 VALVES AND CONTROLLERS

- .1 Valves to be complete with brass tags with 12 mm stamped identification data filled with black paint coordinated with Valve Tag List.
- .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.
- .3 Controllers to be complete with controls laminated identification tag.
- .4 Identify all control systems components including but not limited to equipment, components, controls, sensors with control tags specified in this section.

2.12 FIRE DAMPERS

- .1 All new fire dampers shall be tagged with unique tag (FD-1, FD-2 etc.), 12 mm stamped identification data filled with black paint. Contractor shall compile a Fire Damper Tag List and include in O&M. List to identify fire damper tag and location in building.

2.13 EQUIPMENT WITHIN CEILING SPACE

- .1 Provide identification (equipment labels and colour coded dots) on the ceiling for all equipment concealed within a ceiling space in addition to identification on equipment.
- .2 Equipment Labels:
 - .1 Colours: Black lettering on transparent background.
 - .2 Height of letter: 5 mm.
 - .3 T-bar ceilings: Label shall be located on the metal ceiling grid beside the ceiling tile that provides service access to the equipment. The label shall include the equipment tag and an arrow indicating the ceiling tile to remove for servicing and access to the equipment.
 - .4 Solid ceilings: Label shall be located on the trim of the access panel used for servicing the equipment and include the equipment tag.

- .3 Colour Coded Dots:
 - .1 Confirm site standard colour coding with the Departmental Representative prior to commencing work. Coordinate with all trades.
 - .2 Provide a Legend in the operating and maintenance manual identifying the colour coding utilized on site.
 - .3 T-bar ceilings: Dot shall be located on the metal ceiling grid beside the ceiling tile that provides service access to the equipment.
 - .4 Solid ceilings: Dot shall be located on the trim of the access panel used for servicing the equipment.

3 Execution

3.1 PREPARATION

- .1 Degrease and clean surfaces to receive adhesive for identification materials.
- .2 Prepare surfaces to Section 09 91 23 for stencil painting.

3.2 INSTALLATION

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2 Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- .3 Install tags with corrosion resistant chain.
- .4 Apply stencil painting to Section 09 91 23.
- .5 Install plastic pipe markers to manufacturer's written instructions.
- .6 Install plastic tape pipe markers complete around pipe to manufacturer's written instructions.
- .7 Install underground plastic pipe markers 150 to 200 mm below finished grade, directly above buried pipe.
- .8 Identify equipment including air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as small in-line pumps, may be identified with tags.
- .9 Identify control panels and major control components outside panels with control tags.
- .10 Identify thermostats relating to terminal boxes or valves with nameplates.
- .11 Identify valves in main and branch piping with tags.
- .12 Identify air terminal units and radiator valves with numbered tags.
- .13 Tag automatic controls, instruments, and relays. Key to control schematic.

- .14 Identify piping, concealed or exposed, with plastic pipe markers. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Location of identification not to exceed 6 m on straight runs including risers and drops, adjacent to each valve and Tee, adjacent to each change in direction, at each side of penetration of structure or enclosure, and at each obstruction. Provide additional identification 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
- .15 Identify ductwork with stencilled painting. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
- .16 Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.
- .17 Identify electric starting switches and remote push button stations with nametags.
- .18 Provide identification on the ceiling for all equipment concealed within a ceiling space in addition to identification on the equipment.
- .19 Tag new fire dampers sequentially and record on Fire Damper Tag List.

3.3 VALVE, 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 Owner. Provide one copy (reduced in size if required) in each operating and maintenance manual.
- .3 Number valves in each system consecutively.

END OF SECTION

1 General

1.1 SECTION INCLUDES

- .1 Testing, adjustment and balance of air systems.
- .2 Testing, adjustment and balance of water systems.

1.2 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.

1.3 QUALIFICATIONS OF TAB PERSONNEL

- .1 Submit names of personnel to perform TAB to Consultant within 90 days of award of contract.
- .2 Personnel performing TAB shall be qualified to standards of AABC and/or NEBB
- .3 Provide documentation confirming qualifications, successful experience.
- .4 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.
- .5 Recommendations and suggested practices contained in the TAB Standard: mandatory.
- .6 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.
- .7 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.
- .8 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.
- .9 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, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.4 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.

1.5 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.

1.6 EXCEPTIONS

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

1.7 PRE-TAB REVIEW

- .1 Review contract documents before project construction is started confirm in writing to Consultant adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to Consultant 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.

1.8 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.

1.9 OPERATION OF SYSTEMS DURING TAB

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

1.10 START OF TAB

- .1 Notify Consultant 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.

1.11 APPLICATION TOLERANCES

- .1 Do TAB to following tolerances of design values:
 - .1 Laboratory HVAC systems: plus 10 %, minus 0 %.
 - .2 Other HVAC systems: plus 5 %, minus 5 %.
 - .3 Hydronic systems: plus or minus 10 %.

1.12 ACCURACY TOLERANCES

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

1.13 INSTRUMENTS

- .1 Use accurate instruments for measurements. Prior to TAB, submit to Consultant 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 Consultant.
- .4 Provide calibration histories for each instrument. Re-calibration or use of other instruments may be requested when accuracy of readings is questionable.

1.14 SUBMITTALS

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

1.15 PRELIMINARY TAB REPORT

- .1 Submit for checking and approval of Consultant, 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.

1.16 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 4 copies of TAB Report to Consultant for verification and approval, in English in D-ring binders, complete with index tabs.

1.17 VERIFICATION

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

1.18 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.

1.19 COMPLETION OF TAB

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

1.20 AIR SYSTEMS

- .1 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .2 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.
- .3 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

1.21 OTHER TAB REQUIREMENTS

- .1 Measurement of noise from equipment specified in Division 23.
 - .1 As specified elsewhere or as required to prove Noise Performance when operating performance is questioned.

1.22 CLOSEOUT SUBMITTALS

- .1 Section 01 33 00: Submission procedures.
- .2 Provide copies of complete final TAB report for Operation and Maintenance manual

1.23 BALANCE REPORTS

- .1 Balance reports to include the following at minimum (data shall always include design and actual measured data):
 - .1 Title Page: Company Name, Address, and Telephone Number; Project Name, Location, Architect, Engineer, and Project Contractor.
 - .2 Include types, serial number and dates of calibration of instruments used.
 - .3 Air Handling Units: Location, Local Identification, Manufacturer, Model, Size, Arrangement, discharge and class, Supply Air Flow, Return Air Flow, Outside Air Flow, Static Pressures, Fan RPM, inlet and outlet dry bulb and wet bulb temperatures.
 - .4 Duct air quantities: Mains, Branches, Outside Air and Exhausts (Maximum and Minimum), Duct sizes; Number of pressure readings; Sum of velocity measurements; Average velocity; duct air flow rate.
 - .5 Exhaust Fan Data: Location, Manufacturer, Model, Specified and Actual Air Flow, Static Pressure, and Fan RPM.
 - .6 Electric Motors: Manufacturer, HP/BHP, Phase, Voltage, Amperage (maximum operating and full load), RPM, Service Factor, Starter Heater Elements.
 - .7 V-Belt Drive: Identification/Location, Driven Sheave Diameter and RPM belt Size and Quantity, Motor Sheave Diameter and RPM.
 - .8 Air Distribution: Terminal Number, Room Number/Location, Terminal Type and Size, Area Factor, Design Velocity and Air Flow, Test Velocity and Air Flow.

- .9 Air Inlets and Outlets: Outlet identification location and Designation; Manufacturer's catalogue identification and type; Application factors; air velocities; air flow rates; Deflector vane or diffuser cone settings.
- .10 Pump Data: Location, Identification/Number, Manufacturer, Size/Model, Drive type, Motor type, Flow Rate, Head, BHP, Discharge and Suction Pressure (full flow and no flow).
- .11 Coil Data: Location, Identification/Number, Service, Manufacturer, Element type, Air Flow Rate, Entering Air and Leaving Air Temperatures (dry bulb and wet bulb), Water Flow rate and Pressure Drop, Entering and Leaving Water Temperatures, energy transfer rate.
- .12 Terminal Heating/Cooling Equipment with fans (unit heaters, force flows, unit ventilators, fan coils etc.): Location, Identification/Number, Manufacturer, Model, Heat transfer rate, Entering and Leaving Water Temperatures, Water Pressure drops, Water Flow Rates, air flow. If a steam system include steam pressure, temperature and condensate temperature. If a heating/cooling system provide data for both modes of operation.
- .13 Terminal Heating/Cooling Equipment (radiation, panels, in-floor etc.): Location, Element Type, Designation, Manufacturer, Entering and Leaving Water Temperatures, Length of Fin, Water Pressure drops, Water Flow Rates. If a steam system include steam pressure, temperature and condensate temperature. If a heating/cooling system provide data for both modes of operation. Provide total flow for in-floor manifold.

2 Products

2.1 NOT USED

3 Execution

3.1 PREPARATION

- .1 Before adjusting and balancing, verify that systems are complete and operable. Ensure temperature control systems are complete and operable, thermal overload protection is in place, final filters installed, hydronic systems, flushed, filled, and vented.
- .2 Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Consultant to facilitate spot checks during testing.
- .3 Recorded data shall represent actually measured, or observed condition.

3.2 GENERAL PROCEDURES

- .1 Balance to maximum measured flow, allowable deviation as specified.
- .2 Permanently mark settings on valves, splitters, dampers, and other adjustment devices.
- .3 Subsequent to correctional work, take measurements to verify balance has not been disrupted or that any such disruption has been rectified.
- .4 At final inspection, re-check random selections of data recorded in report. Re-check points of areas as selected and witnessed by the Owner.

- .5 Check and adjust systems approximately six (6) months after final acceptance and submit report.
- .6 The Balancing Contractor shall include the cost of sheave changes necessary to achieve specified air flow within limits specified.

3.3 AIR SYSTEM PROCEDURES

- .1 Adjust air handling and distribution systems to provide required or design supply, return and exhaust air quantities. Permanently mark settings of damper and other adjustment devices allowing settings to be restored.
- .2 Make air quantity measurements in ducts by Pitot tube traverse of entire cross-sectional area of duct.
- .3 Measure air quantities at each air inlet and outlet. Use volume control devices to regulate air quantities.
- .4 Vary total system air quantities by adjustment of fan speeds. Where Variable Frequency Drives (VFDs) are installed, utilize VFDs to adjust fan speed. Provide drive changes where required.
- .5 Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate - full cooling, and at minimum air flow rate - full heating.
- .6 Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- .7 Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

3.4 WATER SYSTEM PROCEDURE

- .1 Adjust water systems to provide required or design quantities. Permanently mark settings of valves and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- .2 Use calibrated venturi tubes, orifices, or other metered fittings and pressure gauges in conjunction with permanent and portable type flow meters to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- .3 Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- .4 Effect system balance with automatic control valves fully open to heat transfer elements.
- .5 Effect adjustment of water distribution systems by means of balancing cocks, valves and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

- .6 Where pump capacity available is less than total flow requirements or individual system parts, full flow in any part may be simulated by temporary restriction of flow to other parts.
- .7 Where flow restrictors are used provide record data of air and water inlet and outlet temperatures at design conditions.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and methods for pressure testing ducts over 5 m in length, forming part of a supply, return or exhaust ductwork system directly or indirectly connected to air handling equipment.
 - .2 Sustainable requirements for construction and verification.

1.2 REFERENCES

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .2 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)
 - .1 SMACNA HVAC Air Duct Leakage Test Manual, 1985.

1.3 SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Test Reports: submit test reports indicating compliance with specifications for specified performance characteristics and physical properties. Include pressure test information and results as follows:
 - .1 Submit proposed report form and test report format to Departmental Representative for approval at least three months before proposed date of first series of tests. Do not start tests until approval received in writing from Departmental Representative.
 - .2 Prepare report of results and submit to Departmental Representative within 7 days of completion of tests. Include:
 - .1 Schematic of entire system.
 - .2 Schematic of section under test showing test site.
 - .3 Required and achieved static pressures.
 - .4 Orifice differential pressure at test sites.
 - .5 Permissible and actual leakage flow rate (L/s) for test sites.
 - .6 Witnessed certification of results.
 - .3 Include test reports in final TAB report.
 - .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .5 Instructions: submit manufacturer's installation instructions.
 - .6 Manufacturer's field reports specified.

1.4 QUALITY ASSURANCE

- .1 Pre-Installation Meetings:
 - .1 Convene pre-installation meeting one week prior to beginning work of this Section and on-site installations in accordance with Section 01 32 16 - Construction Progress Schedules - Bar (GANTT) Chart.
 - .1 Verify project requirements.
 - .2 Review installation conditions.

- .3 Co-ordination with other building subtrades.
- .4 Review manufacturer's installation instructions and warranty requirements.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

Part 2 Products

2.1 TEST INSTRUMENTS

- .1 Test apparatus to include:
 - .1 Fan capable of producing required static pressure.
 - .2 Duct section with calibrated orifice plate mounted and accurately located pressure taps.
 - .3 Flow measuring instrument compatible with the orifice plate.
 - .4 Calibration curves for orifice plates used.
 - .5 Flexible duct for connecting to ductwork under test.
 - .6 Smoke bombs for visual inspections.
- .2 Test apparatus: accurate to within +/- 3 % of flow rate and pressure.
- .3 Submit details of test instruments to be used to Departmental Representative at least one month before anticipated start date.
- .4 Test instruments: calibrated and certificate of calibration deposited with Departmental Representative no more than 28 days before start of tests.
- .5 Re-calibrated every six months thereafter.

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 PREPARATION

- .1 Do not conceal or cover ductwork or equipment until inspected by consultant and tested.
- .2 Provide equipment, materials and labour for tests and pay expenses. Use test instruments by approved laboratory or manufacturer and furnish certificate showing degree of accuracy.
- .3 Test instruments shall have been calibrated within one year.
- .4 Install permanent gauges and thermometers just prior to tests to avoid changes in calibration.

- .5 Before adjusting and balancing, verify that systems are complete and operable. Ensure temperature control systems are complete and operable, thermal overload protection is in place, final filters installed, hydronic systems, flushed, filled, and vented.
- .6 Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Consultant to facilitate spot checks during testing.
- .7 Recorded data shall represent actually measured, or observed condition. And shall be included in O&M Manual

3.3 TEST PROCEDURES

- .1 Maximum lengths of ducts to be tested consistent with capacity of test equipment.
- .2 Section of duct to be tested to include:
 - .1 Fittings, branch ducts, tap-ins, fire dampers.
- .3 Repeat tests until specified leakage at test pressures are attained. Bear costs for repairs and repetition to tests.
- .4 Base partial system leakage calculations on SMACNA HVAC Air Duct Leakage Test Manual.
- .5 Seal leaks that can be heard or felt, regardless of their contribution to total leakage.

3.4 SITE TOLERANCES

- .1 Allowable system leakage tolerances are to follow SMACNA Leakage standards as specified under ductwork.
- .2 Evaluation of test results to use surface area of duct and pressure in duct as basic parameters.

3.5 TESTING

- .1 Test ducts before installation of insulation or other forms of concealment.
- .2 Test after seals have cured.
- .3 Test when ambient temperature will not affect effectiveness of seals and gaskets.
- .4 Low Pressure Ducts: Test for tightness such that leakage is inaudible and not detectable by feel. Check for audible leaks at 250 Pa above duct design operating pressure.

3.6 FIELD QUALITY CONTROL

- .1 Performance Verification:
 - .1 Departmental Representative to witness tests and to verify reported results.
 - .2 To be certified by same TAB agency approved by Departmental Representative to undertake TAB on this project.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE/IESNA 90.1-01, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.

- .2 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM B209M, Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric).
 - .2 ASTM C335, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C547, Specification for Mineral Fiber Pipe Insulation.
 - .6 ASTM C553, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .7 ASTM C612, Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .8 ASTM C795, Specification for Thermal Insulation for Use with Austenitic Stainless Steel.
 - .9 ASTM C921-(1998)e1, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

- .4 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (R1999).

- .5 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701, Thermal Insulation Polyotrene, Boards and Pipe Covering.

1.2 DEFINITIONS

- .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
 - .2 "EXPOSED" - will mean "not concealed" as defined herein.
 - .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.

- .2 TIAC Codes:
 - .1 CRD: Code Round Ductwork,
 - .2 CRF: Code Rectangular Finish.

1.3 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit for approval manufacturer's catalogue literature related to installation, fabrication for duct jointing recommendations.

1.4 MANUFACTURERS' INSTRUCTIONS

- .1 Submit manufacturer's installation instructions in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Installation instructions to include procedures used, and installation standards achieved.

1.5 QUALITY ASSURANCE

- .1 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.
- .2 Materials: UL listed; flame spread/smoke developed rating of 25/50 in accordance with ASTM E84.
- .3 Do work to TIAC standards.
- .4 Deliver material to job site in original non-broken factory packaging, labelled with manufacturer's density and thickness.
- .5 Perform work at ambient and equipment temperatures as recommended by the adhesive manufacturer. Make good separation of joints or cracking of insulation due to thermal movement or poor workmanship.

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: as 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. Maximum "K" factor to be 0.035 W/m. deg.K (0.24 BTU in/hr/sq.ft. Deg.K) to ASTM C5553.
- .3 TIAC Class C-1: Rigid mineral fibre board to ASTM C612, unfaced or faced with vapour retarder jacket; ksi value of 0.035 at 24 degrees C.

- .4 TIAC Code C-2: mineral fibre blanket to ASTM C553 with or without factory applied vapour retarder jacket; ksi value of 0.035 at 24 degrees C
- .5 Flexible Duct Liner: Flexible non-combustible mineral fiber blanket to ASTM C 1071 Type 1; ksi value of 0.035 at 24 degrees C, 24 kg/cu m minimum density; coated air side for maximum 20.3 m/s air velocity. Minimum NRC value of 0.65 at 25mm to ASTM 423.
- .6 Rigid Duct Liner: semi-rigid non-combustible mineral fiber to ASTM C 1071 Type 2; ksi value of 0.035 at 24 degrees C, 48 kg/cu m minimum density; coated air side for maximum 20.3 m/s air velocity. Minimum NRC value of 0.7 at 25mm to ASTM 423.

2.3 JACKETS

- .1 Interior Applications:
 - .1 Vapour Barrier Jackets: to CGSB 51-GP-52Ma.
 - .2 PVC Jackets: One piece, high-gloss pre-moulded type, 0.8 mm (30mls) thick. Jackets exposed to outdoor use or flourescent lighting shall be ultra-violet ray resistant.
 - .3 Canvas Jackets: ULC listed treated cotton fabric, 220 g/sq.m. to ASTM C 921
 - .4 Aluminum Jackets: 0.51 mm thick; stucco embossed.
- .2 Exterior Applications:
 - .1 Aluminum Jackets: 0.51 mm thick; stucco embossed.
 - .2 Stainless Steel Jackets: Type 304 stainless steel; 0.25 mm thick, stucco embossed
 - .3 Outdoor Jacket: Coated glass fibre sheet, 16 kg/sq m.

2.4 ACCESSORIES

- .1 Bands: 20 mm wide; 0.38 mm thick stainless steel.
- .2 Insulating Cement: Hydraulic setting on mineral wool.
- .3 Fibrous Glass Cloth: Untreated; 305 g/sq m weight.
- .4 Adhesives: Compatible with insulation, waterproof, fire-retardant type.
- .5 Impale Anchors: Galvanized steel, 2 mm diameter with 35mm diameter head, length as required for insulation.
- .6 Joint Tape: self adhesive reinforced aluminum, minimum 50mm wide
- .7 Tie Wire: stainless steel, 1.5 mm.
- .8 Outdoor vapour retarder mastic:
 - .1 Vinyl emulsion type acrylic, compatible with insulation
 - .2 Fibrous glass cloth

Part 3 Execution

3.1 PRE-INSTALLATION REQUIREMENTS

- .1 Pressure testing of ductwork systems complete, witnessed and certified.
- .2 Surfaces clean, dry, free from foreign material.

3.2 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 Fasteners: install at 300 mm on centre in horizontal and vertical directions, minimum 2 rows each side.
- .6 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .7 Locate insulation or cover seams in least visible location.
- .8 Provide recovering jackets on exposed insulation throughout, including equipment room. Insulation located in crawl spaces, shafts and suspended ceiling spaces is not considered exposed. Use pre-sized paper under recovering at uneven insulated surfaces.
- .9 External Duct Insulation:
 - .1 Secure insulation with vapour barrier with wires and seal jacket joints with vapour barrier adhesive or tape to match jacket.
 - .2 Secure insulation without vapour barrier with staples, tape, or wires.
 - .3 Install without sag on underside of duct work. Use adhesive or mechanical fasteners to prevent sagging. Seal vapour barrier penetrations with vapour barrier adhesive. Stop and point insulation around access doors and damper operators.
- .10 Exposed Rectangular: Secure rigid insulation with 50% coverage of adhesive and 12 gauge galvanized impale anchor tabs on 400 mm (16") centres. Seal joints and breaks with 250 mm (10") wide strips of open mesh glass cloth or tape imbedded between 2 coats of vapour barrier sealant. Point up other joints and breaks with hydraulic setting cement.
- .11 Round Duct and Concealed Rectangular Duct: Adhere flexible insulation to ductwork with adhesive applied in 150 mm (6") wide strips on 400 mm (16") centres. Provide 16 gauge annealed tie wire tied, spiral wound or half hitched at 200 mm (8") centres for securing duct insulation until adhesive sets. Butt insulation and seal joints and breaks with 50 mm (2") lap of foil adhered over joint.

- .12 Acoustic lining: Apply to interior of ducts where shown.
 - .1 Adhere insulation with adhesive for 100 percent coverage. Secure insulation with mechanical fasteners on 375 mm centres maximum on top and side of duct work with dimension exceeding 500 mm. Seal and smooth joints. Seal vapour barrier penetrations with vapour barrier adhesive. Cut off excess fastener length and cover with brush coat of mastic.
 - .2 Use 25 mm (1") thick insulation unless otherwise noted.
 - .3 Provide vapour barrier located on the warm side for outside air intakes.
 - .4 Ducts with acoustic insulation do not require external thermal insulation
 - .5 Ductwork dimensions indicated on drawings include insulation thickness.

3.3 INSTALLATION - JACKETS

- .1 Install in accordance with TIAC standards and manufacturers written requirements.
- .2 Provide recovering jackets on exposed insulation throughout, including equipment room. Insulation located in crawl spaces, shafts and suspended ceiling spaces is not considered exposed. Use pre-sized paper under recovering at uneven insulated surfaces.

3.4 DUCTWORK INSULATION SCHEDULE

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

System	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
Supply, return and exhaust ducts exposed in space being served	none, unless indicated otherwise on drawings		
Mixing plenums	C-1	yes	25
Exhaust duct between fan and louvre/discharge	C-1	no	25
Acoustically lining	none		25

- .2 Exposed round ducts 600 mm and larger, smaller sizes where subject to abuse:

- .1 Use TIAC code C-1 insulation, scored to suit diameter of duct.
 - .1 Finishes: conform to following TIAC codes noted in table:

	Rectangular	Round
Indoor, concealed	none	none
Indoor, exposed within mechanical room	CRF/1	CRD/2
Indoor, exposed elsewhere	CRF/2	CRD/3
Outdoor, exposed to precipitation	CRF/3	CRD/4
Outdoor, elsewhere	CRF/4	CRD/5

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE/IESNA 90.1-01-SI, Energy Standard for Buildings Except Low-Rise Residential Buildings.

- .2 American Society for Testing and Materials (ASTM International)
 - .1 ASTM B209M-01, Specification for Aluminum and Aluminum Alloy Sheet and Plate.
 - .2 ASTM C335-95, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411-97, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M-00, Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C533-95(2001), Specification for Calcium Silicate Block and Pipe Thermal Insulation.
 - .6 ASTM C547-00, Specification for Mineral Fiber Pipe Insulation.
 - .7 ASTM C553-00, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .8 ASTM C612-00a, Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .9 ASTM C795-92(1998)e1, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .10 ASTM C921-89(R1996), 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 CGSB 51-GP-53M-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts.

- .4 Thermal Insulation Association of Canada (TIAC)
 - .1 National Insulation Standards 1992(R1999).

- .5 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-M88(R2000), Surface Burning Characteristics of Building Materials and Assemblies.

1.2 PRODUCT DATA

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

1.3 SAMPLES

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

- .2 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on 12 mm plywood board. Affix typewritten label beneath sample indicating service.

1.4 MANUFACTURER'S INSTRUCTIONS

- .1 Submit manufacturer's installation instructions in accordance with 01 33 00 - Submittal Procedures.
- .2 Installation instructions to include procedures to be used, installation standards to be achieved.

1.5 QUALITY ASSURANCE

- .1 Applicator: Company specializing in mechanical insulation application with three years minimum experience.
- .2 Materials: UL listed; flame spread/smoke developed rating of 25/50 in accordance with ASTM E84.
- .3 Do work to TIAC standards.
- .4 Deliver material to job site in original non-broken factory packaging, labelled with manufacturer's density and thickness.
- .5 Perform work at ambient and equipment temperatures as recommended by the adhesive manufacturer. Make good separation of joints or cracking of insulation due to thermal movement or poor workmanship.

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: includes glass fibre and rock wool. Insulation on steam equipment to be rock wool only, glass fibre is not permitted.
- .2 Rock wool shall be utilized on steam systems.
 - .1 TIAC Code A-1; rigid pre-moulded mineral fibre to ASTM C 547 with or without factory applied vapour retarder jacket; ksi value of 0.035 at 24 deg.C
 - .2 TIAC Code A-2: rigid moulded calcium silicate to ASTM C533 in sections and blocks, and with special shapes to suit project requirements, asbestos free; ksi value of 0.060 at 147 degrees C

- .3 TIAC Code A-3: rigid pre-moulded mineral fibre to ASTM C 547 with or without factory applied vapour retarder jacket for high temperature applications; ksi value of 0.072 at 260 degrees C
- .4 TIAC Code A-6: flexible unicellular tubular elastomer to ASTM C534; ksi value of 0.04 at 24 degrees C
- .5 TIAC Class C-1: Rigid mineral fibre board to ASTM C612, unfaced or faced with CGSB 51-GP-52Ma vapour retarder jacket; ksi value of 0.035 at 24 deg.C.
- .6 TIAC Code C-2: mineral fibre blanket to ASTM C553 with or without factory applied vapour retarder jacket. Thermal conductivity; ksi value of 0.04 at 24 degrees C

2.3 CEMENT

- .1 Thermal insulating and finish
 - .1 To: ASTM C449/C449M.
 - .2 Hydraulic setting or Air drying on mineral wool, to ASTM C449.

2.4 INSULATION SECUREMENTS

- .1 Tape: Self-adhesive, aluminum, plain, reinforced, 50 mm wide minimum.
- .2 Contact adhesive: Quick setting.
- .3 Canvas adhesive: Washable.
- .4 Tie wire: 1.5 mm diameter stainless steel.
- .5 Bands: Stainless steel, 19 mm wide, 0.5 mm thick.
- .6 Fasteners: 2 mm diameter pins with 35 mm diameter clips. Length of pin to suit thickness of insulation.

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.

Part 3 Execution

3.1 PRE- INSTALLATION REQUIREMENTS

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

3.2 INSTALLATION

- .1 Install materials in accordance with manufacturer's instructions and TIAC National standards.
- .2 In exposed equipment in finished areas, locate insulation and cover seams in least visible locations.
- .3 Provide insulation with vapour barrier when medium may be below ambient temperature and as noted on schedules.
- .4 Neatly finish insulation at supports, protrusions, and interruptions.
- .5 Apply insulation with edges tightly butted, joints staggered and secured in place by steel bands. Where necessary weld on suitable anchors.
- .6 Provide sufficient clearance around openings for normal operation of equipment.
- .7 Finish hot surface insulation with 25 mm galvanized hexagonal mesh and coat with hydraulic setting insulation cement.
- .8 Finish cold surface insulation joints with 100 mm wide strips of vapour barrier sealed with vapour barrier adhesive finish insulation with heavy coat of vapour barrier mastic applied over whole body. Finish with a final coat of cement containing 25% by weight of Portland Cement. Recover and provide an extra coat of lagging adhesive.
- .9 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Hangers, supports outside vapour retarder jacket.
- .10 Supports, Hangers:
 - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.3 INSULATION SCHEDULES

- .1 Insulation for equipment to match requirements for associated piping or ductwork serving equipment unless otherwise specified.
- .2 Thickness of insulation, refer to Section 23 07 15 Thermal Insulation for Piping and 23 07 13 Duct Insulation .
- .3 Finishes:
 - .1 Exposed indoors: canvas
 - .2 Exposed in mechanical rooms: Aluminum jacket.
 - .3 Concealed, indoors: canvas on valves, fittings. No further finish.
 - .4 Use vapour retarder jacket on TIAC code A-3, A-6 and C-2 insulation compatible with insulation.
 - .5 Outdoors: water-proof aluminum jacket.
 - .6 Finish attachments: SS screws, at 150 mm on centre. Seals: wing.
 - .7 Installation: to appropriate TIAC code.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Thermal insulation for piping and piping accessories.

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 QUALITY ASSURANCE

- .1 Applicator: Company specializing in mechanical insulation application with three years minimum experience.
- .2 Materials: UL listed; flame spread/smoke developed rating of 25/50 in accordance with ASTM E84.
- .3 Do work to TIAC standards.
- .4 Deliver material to job site in original non-broken factory packaging, labelled with manufacturer's density and thickness.
- .5 Perform work at ambient and equipment temperatures as recommended by the adhesive manufacturer. Make good separation of joints or cracking of insulation due to thermal movement or poor workmanship.

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 and rock wool. Insulation on steam lines to be rock wool only, glass fibre is not permitted.
 - .1 TIAC Code A-1; rigid pre-moulded mineral fibre to ASTM C 547 with or without factory applied vapour retarder jacket; ksi value of 0.035 at 24 degrees
 - .2 TIAC Code A-2: rigid moulded calcium silicate to ASTM C533 in sections and blocks, and with special shapes to suit project requirements, asbestos free; ksi value of 0.060 at 147 degrees C
 - .3 TIAC Code A-3: rigid pre-moulded mineral fibre to ASTM C 547 with or without factory applied vapour retarder jacket for high temperature applications; ksi value of 0.072 at 260 degrees C
 - .4 TIAC Code A-6: flexible unicellular tubular elastomer to ASTM C534; ksi value of 0.04 at 24 degrees C
 - .5 TIAC Class C-1: Rigid mineral fibre board to ASTM C612, unfaced or faced with CGSB 51-GP-52Ma vapour retarder jacket; ksi value of 0.035 at 24 deg.C.
 - .6 TIAC Code C-2: mineral fibre blanket to ASTM C553 with or without factory applied vapour retarder jacket. Thermal conductivity; ksi value of 0.04 at 24 deg.C

2.3 REMOVABLE, PRE-FABRICATED INSULATING ENCLOSURES

- .1 Use of insulating materials other than those stated in this specification requires Departmental Representative's approval. Standard of acceptance for re-usable insulation blankets shall be Reflex Re-usable flexible insulation covers.
- .2 All materials shall be of flame resistant materials.
- .3 Re-usable flexible insulation blanket outer jacket material shall be 0.26 kg/m². Teflon coated fibreglass cloth.
- .4 Material used to secure seams and attachments on re-usable flexible insulation blankets shall be 10 strand stainless steel thread with polyester wrap.
- .5 Re-usable flexible insulation blanket liner material shall be 560 grams/m² Teflon coated fibreglass cloth for operating temperatures up to 232 deg.C.
- .6 Minimum insulation thickness shall be 25 mm insulation for operating temperatures up to 232 deg.C.
- .7 Insulation materials shall be Type E needled fibreglass mat containing no organic binders and no less than 11 pound density for operating temperatures up to 538 deg.C.
- .8 Fasteners shall be velcro closures incorporated with seam flaps in conjunction with sewn on straps and stainless steel D rings.
- .9 Flaps shall be used to cover all closing seams and cover slots. The flaps shall be 50 mm wide plain flaps for operating temperatures up to 232 deg.C.

- .10 6 mm matrix braded Nomex draw-cord closures shall be used on cover openings over 50 mm in diameter. Close the ends of covers over adjacent insulation or piping.
- .11 Quilting fasteners shall be 14 gauge stainless steel quilt pins and locking washers.
- .12 A stainless steel drain grommet, 11 mm in diameter, shall be installed at the low point on the cover.
- .13 A permanent stainless steel or aluminum identification tag shall be attached to each blanket. Tags shall be secured to the re-usable blanket with aluminum rivets and shall be installed in the most visible location on the blanket.

2.4 ACCESSORIES

- .1 Bands: 20 mm wide; 0.38 mm thick stainless steel.
- .2 Insulating Cement: Hydraulic setting on mineral wool.
- .3 Fibrous Glass Cloth: Untreated; 305 g/sq m weight.
- .4 Adhesives: Compatible with insulation, waterproof, fire-retardant type.
- .5 Impale Anchors: Galvanized steel, 2 mm diameter with 35mm diameter head, length as required for insulation.
- .6 Joint Tape: self adhesive reinforced aluminum, minimum 50mm wide
- .7 Tie Wire: stainless steel, 1.5 mm.
- .8 Outdoor vapour retarder mastic:
 - .1 Vinyl emulsion type acrylic, compatible with insulation
 - .2 Fibrous glass cloth

2.5 JACKETS

- .1 Interior Applications:
 - .1 Vapour Barrier Jackets: to CGSB 51-GP-52Ma.
 - .2 PVC Jackets: One piece, high-gloss pre-moulded type, 0.8 mm (30mls) thick. Jackets exposed to outdoor use or fluorescent lighting shall be ultra-violet ray resistant.
 - .3 Canvas Jackets: ULC listed treated cotton fabric, 220 g/sq.m. to ASTM C 921
 - .4 Aluminum Jackets: 0.51 mm thick; stucco embossed.
- .2 Exterior Applications:
 - .1 Aluminum Jackets: 0.51 mm thick; stucco embossed.
 - .2 Stainless Steel Jackets: Type 304 stainless steel; 0.25 mm thick, stucco embossed
 - .3 Outdoor Jacket: Coated glass fibre sheet, 16 kg/sq m.

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 ON PIPING

- .1 Install materials in accordance with manufacturer's instructions and TIAC National standards.
- .2 Continue insulation with vapour barrier through penetrations. pack around pipes with fire proof self-supporting insulation material, properly sealed.
- .3 In exposed piping, locate insulation and cover seams in least visible locations.
- .4 Provide insulation with vapour barrier when medium conveyed may be below ambient temperature and as noted on schedules.
- .5 Insulate fittings and valves on pipe systems.
- .6 On insulated piping with vapour barrier, insulate fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints. Cover with open mesh glass cloth sealed with vapour barrier sealant.
- .7 On insulated piping without vapour barrier and piping conveying fluids 60 degrees C or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation at such locations.
- .8 Provide an insert of cork or other heavy density material not less than 150 mm long, of same thickness and contour as adjoining insulation, between support shield and piping, but under the finish jacket, on piping 50 mm diameter or larger.
- .9 Neatly finish insulation at supports, protrusions, and interruptions.
- .10 Handicap Plumbing Fixtures: Insulate trap and drain with 25 mm (1") fibreglass insulation complete with high gloss white PVC jacket. Refer to Plumbing specifications.

- .11 Each and every chilled water pipe fitting and accessories located outside of the mechanical room shall be insulated to prevent sweating on exposed parts, this includes all unions, balancing valves, strainers, drains, air vent stems, etc. All parts utilized in maintaining the system shall be insulated with removable insulation. In mechanical rooms, insulation may be omitted on equipment where drain pans are provided including pumps and associated inlet valves.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

- .1 Removable insulation bags must be provided for the following: control valves, unions or flanges at equipment, steam traps and flanged valves.
- .2 Design: to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.
- .3 Blankets on flanged valves and equipment shall be designed to cover adjacent mating flanges and overlap line insulation by a minimum of 50 mm. Allowance of stud length plus 25 mm from the back of the mating flange shall be used to calculate the cut back distance of line insulation. Draw-cold flaps shall not be considered as part of the overlap.
- .4 Blankets on valves shall be designed to cover the valve body and the bonnet flange of the valve.
- .5 Blankets for pressure gauges include block and bleed valve.
- .6 Blankets for PSV's shall include the outlet flange. Blanket shall cover entire spring chamber.
- .7 All blankets shall be fitted with an identification tag clearly marked with the following information:
 - .1 Equipment size and type i.e. 6" 300# Control Valve
 - .2 Equipment location and tag number i.e. 21-PV-129
 - .3 Manufacturer's Serial Number i.e SN01010
- .8 All equipment shall be field measured by blanket supplier. Measurements shall be performed after equipment is installed. All necessary allowances for the blankets shall be coordinated between the blanket supplier and the mechanical, electrical and insulation Contractors.
- .9 Re-usable flexible insulation blanket construction:
 - .1 Blankets up to 25 mm thick shall be inside seam construction with double stitching, with the liner and jacket material sewn together to form the insulation pocket.
 - .1 Perimeter flaps shall be formed as an extension of the liner and jacket, and shall not be attached to blanket as separate pieces.

- .2 All blankets up to 25 mm thick must be double stitched. First stitch will be performed with cloth layers sewn together inside out. Blanket will then be turned right side out and top stitched around all penetrations and around the perimeter of the insulation pocket to create a separation between the insulation pocket and the perimeter flaps.
- .3 All draw-cord and closure flaps, required inside the perimeter of the blanket shall be attached inside the seam, between the liner and jacket layers of the blanket.
- .2 Blankets over 25 mm thick shall be constructed using boxed corners and gussets in order to maintain consistent thickness across the entire area of the blanket.
 - .1 Perimeter flaps shall be formed as an extension of the outer jacket, and shall not be attached to the blanket as separate pieces.
 - .2 All draw-cord and closure flaps, required inside the perimeter of the blanket, shall be attached inside the seam, between the liner and jacket layers of the blanket.
- .10 Existing insulation bags will all be salvaged. Contractor may reuse bags on this project. All unused bags will be turned over to Owner.

3.5 INSTALLATION - JACKETS

- .1 Install in accordance with TIAC standards and manufacturers written requirements.
- .2 Indoor, Concealed Pipes: Apply pipe insulation with an integral all-service jacket complete with vapour barrier if specified. Secure jacketing using appropriate fastenings on approximately 100mm centres. Cover longitudinal and circumferential joints with jacket finishing tape neatly applied. Alternately secure jacketing using integral self-sealing lap and self-sealing circumferential joint strips. Fittings, (valves and strainers if specified) not finished with PVC covers shall be covered with a hard coat cement and finish with treated fitting fabric applied with fabric adhesive. Finish jackets as scheduled.
- .3 Indoor, Exposed Applications: Insulate as for concealed applications. Finish jacket to be as indicated in schedule. Where indicated by Architect to be painted, finish insulation with canvas jacket; size for finish painting.
- .4 Exterior Applications: Vapour barrier jacket, covered with aluminum jacket with seams located on bottom side of horizontal piping. insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapour barrier cement. Lap joints 75 mm (3") minimum and seal with compatible waterproof lap cement.
- .5 Provide recovering jackets on exposed insulation throughout, including equipment room. Insulation located in crawl spaces, shafts and suspended ceiling spaces is not considered exposed. Use pre-sized paper under recovering at uneven insulated surfaces.
- .6 Metal Jackets: Over the pipe insulation apply metal jacketing using necessary fastenings on approximately 150mm centres. Over insulated fittings, (valve bodies, valve bonnets, strainers and flanges etc. as specified) apply metal jacket or preformed metal fitting covers to provide a complete jacket system. Secure with necessary fastenings.

- .7 PVC Jackets: Over the pipe insulation apply PVC jacketing using necessary fastenings on approximately 100mm centres. Cover longitudinal and circumferential joints with finishing tape neatly applied. Over insulated fittings, valve bodies, valve bonnets, strainers and flanges if specified) apply PVC jacket or preformed PVC fitting covers to provide a complete jacket system. Secure with appropriate fastenings and jacket finishing tape.

3.6 PIPING INSULATION SCHEDULES

- .1 Includes valves, valve bonnets, strainers, flanges, fittings and all associated equipment unless otherwise specified.
- .2 TIAC Code: A-1.
 - .1 Seals: lap seal adhesive, lagging adhesive.
 - .2 Installation: TIAC Code 1501-H.
- .3 TIAC Code: A-3.
 - .1 Seals: VR lap seal adhesive, VR lagging adhesive.
 - .2 Installation: TIAC Code: 1501-C.
- .4 TIAC Code: A-6.
 - .1 Seals: lap seal adhesive, lagging adhesive.
 - .2 Installation: to TIAC standards.
- .5 TIAC Code: C-2 vapour retarder jacket.
 - .1 Seals: lap seal adhesive, lagging adhesive.
 - .2 Installation: TIAC Code: 1501-C.
- .6 TIAC Code: A-2.
 - .1 Seals: lap seal adhesive, lagging adhesive.
 - .2 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.
 - .3 Chilled water insulation thicknesses are listed such that a minimum of 25mm is maintained over all fittings, valves and accessories.
 - .4 Note that in accordance with the National Energy Code of Canada for Buildings HVAC piping located outside the building envelope shall be insulated to the thickness specified for steam over 175 Deg.C. This requirement does not alter the TIAC Code defining the type of insulation to be used.

Application	Temp deg.C.	TIAC code	Pipe sizes (NPS) & insulation thickness (mm)				
			Run out	to 1	1 1/4 to 2	2 1/2 to 4	5 to 6
Steam	up to 175	A-1	38	50	65	75	90 90
Condensate							
Return	60 - 94	A-1	25	38	38	38	38 38
Hot Water	60 - 94	A-1	25	38	38	38	38 38
Hot Water	up to 59	A-1	25	25	25	25	38 38
Hot Water Equipment	All Temp.	A-1	38	38	38	38	38 38
Chilled Water	4 - 13	A-3	38	38	38	38	38 38
Chilled Water							
Equipment	All Temp	A-3	38	38	38	38	38 38
Dual Temp.	4 - 94	A-3	25	38	38	38	38 38
Cold Water		A-3	25	25	25	25	25 25
Refrigerant	4 - 13	A-6	25	25	25	25	25 25
Refrigerant	below 4	A-6	25	25	38	38	38 38
RWL and RWP		C-2	25	25	25	25	25 25
(insulate rainwater from roof to crawlspace/basement)							
Cooling Coil							
cond. drain and pan		C-2	25	25	25	25	25 25

.8 Finishes:

- .1 Exposed indoors: canvas or PVC
- .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, A-6 and C-2 insulation compatible with insulation.
- .5 Outdoors: water-proof aluminum jacket.
- .6 Finish attachments: SS screws, at 150 mm on centre. Seals: wing.
- .7 Installation: to appropriate TIAC code CRF/1 through CPF

3.3 CLEANING

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

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E202-04, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.2 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS

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

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 PREPARATION

- .1 Do not conceal or cover piping, fixtures or equipment until inspected by consultant and tested.
- .2 Provide equipment, materials and labour for tests and pay expenses. Use test instruments by approved laboratory or manufacturer and furnish certificate showing degree of accuracy.
- .3 Test instruments shall have been calibrated within one year
- .4 Install permanent gauges and thermometers just prior to tests to avoid changes in calibration.
- .5 Carry out hydraulic tests for 8 hours and maintain pressure. Where leakage occurs, repair and re-test.
- .6 Before adjusting and balancing, verify that systems are complete and operable. Ensure temperature control systems are complete and operable, thermal overload protection is in place, final filters installed, hydronic systems, flushed, filled, and vented.
- .7 Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Consultant to facilitate spot checks during testing.
- .8 Recorded data shall represent actually measured, or observed condition.

3.2 PRESSURE TESTS

- .1 Cooling Water Piping: Test to 1-1/2 times maximum working pressure or minimum 1034 kPa (150 psi) water pressure.
- .2 Domestic Water Piping: Test to 1-1/2 times maximum working pressure or 1034 kPa (150 psi) water pressure measured at system low point.
- .3 Drainage Systems: Test by filling with water to produce water pressure of 30 kPa (10') minimum and 75 kPa (25') maximum. Check for proper grade and obstruction by ball test.
- .4 Standpipe System: Test to 2070 kPa water pressure at the valve.
- .5 Sprinkler System: Test as required by authorities having jurisdiction.
- .6 Control Air Piping: Test to 345 kPa air pressure. Maintain pressure 1 hour with maximum 7 kPa pressure drop.
- .7 Refrigerant Piping: Test with nitrogen to 2070 kPa on high pressure side and 1035 kPa on low side and refrigerant halide torch test.
- .8 Check system during application of test pressure including visual check for leakage of water test medium, soap bubble test for air or nitrogen test medium and halide torch for refrigerant medium.
- .9 During heating and cooling piping system tests, check linear expansion at elbows, U bends, expansion joints, and offsets for proper clearance.
- .10 When using water as test medium for system not using water or steam, evacuate and dehydrate the piping and certify the lines are dry. Use agency specializing in this type of work.
- .11 Should tests indicate defective work or variance with specified requirements, make changes immediately to correct the defects. Correct leaks by remaking joints in screwed fittings, cutting out and rewelding welded joints, remaking joints in copper lines. Do not caulk.
- .12 Low pressure steam and condensate piping: Test to 700 kPa (100 psi) hydrostatic pressure.

3.3 PERFORMANCE TESTS

- .1 Conduct performance tests to demonstrate equipment and systems meet specified requirements after mechanical installations are completed and pressure tested. Conduct tests as soon as conditions permit. Make changes, repairs, and adjustments required as tests may indicate prior to operating tests.
- .2 Lubricate bearings, adjust and/or replace and set direct and "V" belt drives for proper alignment and tension.

- .3 Calibrate and adjust thermostats, thermometers, gauges, linkage and dampers. Control valves shall operate freely.
- .4 Operate and test motors and speed switches for correct wiring and sequences. Check overload heaters in motor starters.
- .5 Replace disposable filters with new testing filters and remove, clean and reinstall washable filters prior to conducting testing.
- .6 Clean fan wheel and coils prior to conducting tests.
- .7 Remove, clean, and reinstall strainers prior to conducting tests.
- .8 Fasten loose and rattling pieces of equipment. Unit heaters, pumps and other equipment shall operate quietly.
- .9 Make operating tests for minimum of 5 days during heating season and cooling season of first year of operation and at times when directed, for proper setting of controls under peak load conditions.
- .10 Provide services of mechanics and manufacturer's representatives, ladders, tools and associated equipment required to assist the Owner in final tests.
- .11 Conduct final operating tests in presence of the Owner. Vary loads to illustrate start-up and shut-down sequence and simulate emergency Conditions for safety shut-downs, with automatic and manual reset. Repair and test defects until satisfactory. Make final adjustments to suit exact building conditions.
- .12 Provide manufacturers start-ups and reports as specified under specific equipment. Provide copies reports in the Operation and Maintenance Manuals.

3.4 HYDRONIC SYSTEMS - PERFORMANCE VERIFICATION (PV)

- .1 Perform hydronic systems performance verification after cleaning is completed and system is in full operation.
- .2 When systems are operational, perform following tests:
 - .1 Conduct full scale tests at maximum design flow rates, temperatures and pressures for continuous consecutive period of 48 hours to demonstrate compliance with design criteria.
 - .2 Verify performance of hydronic system circulating pumps as specified, recording system pressures, temperatures, fluctuations by simulating maximum design conditions and varying.
 - .1 Pump operation.
 - .2 Heating Plant and Chilled Water Plant operation (only as pertains to supplying energy to modified systems in scope).
 - .3 Maximum heating demand.
 - .4 Maximum cooling demand.

3.5 HYDRONIC SYSTEM CAPACITY TEST

- .1 Perform hydronic system capacity tests after:
 - .1 TAB has been completed
 - .2 Verification of operating, limit, safety controls.
 - .3 Verification of primary and secondary pump flow rates.
 - .4 Verification of accuracy of temperature and pressure sensors and gauges.
- .2 Calculate system capacity at test conditions.
- .3 Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.
- .4 When capacity test is completed, return controls and equipment status to normal operating conditions.
- .5 Submit sample of system water to approved testing agency to determine if chemical treatment is correct. Include cost.
- .6 Chilled water system capacity test:
 - .1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:
 - .1 Adding heat from building heating system or;
 - .2 Raising space temperature by turning off cooling and air systems for sufficient period of time before starting testing and pre-heating building to summer design space temperature (occupied) or above.
 - .2 Test procedures:
 - .1 Open fully cooling coil control valves.
 - .2 Set thermostats on associated AHU's for maximum cooling.
 - .3 Set AHU's for design maximum air flow rates.
 - .4 After system has stabilized, record chilled water flow rates and supply and return temperatures simultaneously.

3.6 STEAM SYSTEMS

- .1 Performance verification:
 - .1 When systems are operational, perform relevant tests of steam and condensate return piping systems as specified under hydronic systems.
 - .2 Verify operation of components of steam system including:
 - .1 Steam traps by:
 - .1 Measuring temperature of condensate return and/or
 - .2 Using audio-sensing devices.
 - .3 Use of other approved methods.
 - .2 Thermostatic vents.
 - .3 Verify performance of condensate return system to ensure return of maximum quantity of condensate return water at with minimum temperature drop.
 - .4 Adjust piping system as required to eliminate water hammer.
- .2 Monitor system continuously until acceptance for proper operation of components including steam traps, thermostatic vents, flash tanks and condensate pumping units.

3.7 POTABLE WATER SYSTEMS

- .1 When cleaning is completed and system filled:
 - .1 Verify performance of equipment and systems as specified elsewhere in Division 22, 23 or 25.
 - .2 Check for proper operation of water hammer arrestors. Run one outlet for 10 seconds, then shut of water immediately. If water hammer occurs, replace water hammer arrestor or recharge air chambers. Repeat for each outlet and flush valve.
 - .3 Confirm water quality consistent with supply standards, verifying that no residuals remain resulting from flushing and/or cleaning.

3.8 WET AND DRY PIPE SPRINKLER SYSTEM, STANDPIPE AND HOSE SYSTEMS

- .1 Cleaning, testing, start-up, performance verification of equipment, systems, components, and devices is specified elsewhere in Division 23.
- .2 Verification of controls, detection devices, alarm devices is specified Division 26.
- .3 Demonstrate that fire hose will reach to most remote location regardless of partitions, and obstructions.
- .4 Verify operation of interlocks between HVAC systems and fire alarm systems as required by Code or specified.

3.9 SANITARY AND STORM DRAINAGE SYSTEMS

- .1 Ensure that traps are fully and permanently primed.
- .2 Ensure that fixtures are properly anchored, connected to system.
- .3 Operate flush valves and operate each fixture to verify drainage and no leakage.
- .4 Cleanouts: refer to Section 22 42 03 - Commercial Washroom Fixtures.
- .5 Roof drains:
 - .1 Refer to Section 22 42 03 - Commercial Washroom Fixtures.
 - .2 Remove caps as required.

3.10 REPORTS

- .1 Include record of all tests in Operation and Maintenance Manuals.

3.11 TRAINING

- .1 In accordance with Section 21 05 01 - Common Work Results Mechanical.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Procedures and cleaning solutions for cleaning mechanical piping systems.

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E202-00, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

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

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.

Part 2 Products

2.1 MATERIALS

- .1 Provide sufficient material and labour to adequately treat and monitor the steam and water system during temporary heat usage and for the first year of operation.
- .2 Provide on-site start-up services and support services as required during first year of operation to maintain chemical treatment program.
- .3 Materials which may contact finish areas through leakage shall be colourless.
- .4 Hydronic System Cleaner: Buffered alkaline compound degreasant which in solution removes grease and petroleum.
- .5 Steam and Condensate System Cleaner: Alkaline compound degreasant which in solution removes grease and petroleum.

- .6 Steam and Condensate System Treatment:
 - .1 Piping: Injection of an Amine to reduce scaling and corrosion of piping system.

2.2 EQUIPMENT

- .1 Pot Feeder: Two quart capacity cast iron or welded steel feeder with quick opening cap.
- .2 Chemical feed pumps, mix tanks, and agitators (see equipment schedule).
- .3 Adjustable timers for chemical feed pumps.
- .4 Side stream filter housing, site flow indicator and one case of thirty, 20 micron cartridges and one case of thirty, 5 micron cartridges.

2.3 TEST KITS

- .1 Provide test kits as required to determine proper systems treatment and not limited to the following:
- .2 System Test Kit: P & M Alkalinity, scale inhibitor, nitrite, sulphite, molybdate, Ph and hardness.

2.4 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 AND STEAM 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 2 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 if available 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 maximum design (on hot water systems). Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38 degrees C. Drain as quickly as possible. Refill with clean water. Circulate for 6 h at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water adding to sodium sulphite (test for residual sulphite).
- .8 Steam Systems: in addition to general requirements as specified above, perform following:
- .1 Remove internal components of steam traps until flushing and warm-up have been completed.
 - .2 Open drip points to atmosphere. If needed for protection of personnel or environment, install flexible hose and direct discharge to safe location.
 - .3 Starting at drip point closest to source, verify removal of condensate, then re-install steam trap internal parts. Repeat sequence down the line.
 - .4 Water hammer: determine source and eliminate cause.
 - .5 Flush steam system for four (4) days.
 - .6 Put condensate to drain for seven (7) days to remove oil before returning back to CHP.

3.3 START-UP OF HYDRONIC SYSTEMS

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

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Copper piping valves and fittings for hydronic systems.
- .2 Sustainable requirements for construction and verification.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Welding Society (AWS)
 - .1 ANSI/AWS A5.8/A5.8M-04, Specification Filler Metals for Brazing and Bronze Welding.
- .2 American Society of Mechanical Engineers (ASME)
 - .1 ANSI/ASME B16.4-98, Gray-Iron Threaded Fittings.
 - .2 ANSI/ASME B16.15-1985(2004), Cast Bronze Threaded Fittings.
 - .3 ANSI B16.18-2001, Cast Copper Alloy, Solder Joint Pressure Fittings.
 - .4 ANSI/ASME B16.22-2001, Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings.
- .3 American Society for Testing and Materials International (ASTM)
 - .1 ASTM B32-04, Standard Specification for Solder Metal.
 - .2 ASTM B61-02, Standard Specification for Steam or Valve Bronze Castings.
 - .3 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .4 ASTM B88M-03, Standard Specification for Seamless Copper Water Tube Metric.
 - .5 ASTM E202-04, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 Manufacturers Standardization Society (MSS)
 - .1 MSS SP67-2002a, Butterfly Valves.
 - .2 MSS SP70-1998, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS SP71-1997, Grey Iron Swing Check Valves, Flanged and Threaded Ends.
 - .4 MSS SP80-2003, Bronze Gate, Globe, Angle and Check Valves.
 - .5 MSS SP85-2002, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 QUALITY ASSURANCE

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

- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

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

Part 2 Products

2.1 TUBING

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

2.2 FITTINGS

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

- .2 Gate Valves Application: isolating equipment, control valves, pipelines:
 - .1 NPS 2 and under:
 - .1 Mechanical Rooms: Class 125, rising stem split wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 Elsewhere: Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.
- .3 Butterfly valves: application: isolating each section of multiple component equipment (eg. multi-section coils):
 - .1 NPS 2 1/2 and over: lug type, grooved ends: as specified Section 23 05 17 - Pipe Welding.
- .4 Globe valves: application: throttling, flow control, emergency bypass:
 - .1 NPS 2 and under:
 - .1 Mechanical Rooms: with PTFE disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 Elsewhere: with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.
- .5 Balancing, for TAB:
 - .1 Sizes: calibrated balancing valves, as specified.
 - .2 NPS 2 and under:
 - .1 Automatic flow control device.
- .6 Drain valves: gate, Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.
- .7 Swing check valves:
 - .1 NPS 2 and under:
 - .1 Class 125, swing, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS 2 1/2 and over:
 - .1 Flanged, Grooved ends: as specified Section 23 05 23.02 - Valves - Cast Iron.
- .8 Silent check valves:
 - .1 NPS 2 and under:
 - .1 As specified Section 23 05 23.01 - Valves - Bronze.
- .9 Ball valves:
 - .1 NPS 2 and under: as specified Section 23 05 23.01 - Valves - Bronze.

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 PIPING INSTALLATION

- .1 Refer to Section 23 05 05 Installation of Pipework
- .2 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.
- .3 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.
- .4 Slope piping in direction of drainage and for positive venting.
- .5 Use eccentric reducers at pipe size change installed to provide positive drainage or positive venting.
- .6 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.
- .7 Assemble piping using fittings manufactured to ANSI standards.

3.3 VALVE INSTALLATION

- .1 Refer to Section 23 05 05 - Installation of Pipework.
- .2 Install rising stem valves in upright position with stem above horizontal.
- .3 Install butterfly valves on chilled water and condenser water lines only.
- .4 Install gate, ball or butterfly valves at branch take-offs and to isolate each piece of equipment, and as indicated.
- .5 Install globe valves for balancing and in by-pass around control valves as indicated.
- .6 Install swing check valves in horizontal lines on discharge of pumps and as indicated.
- .7 Install chain operators on valves NPS 2 1/2 and over where installed more than 2400 mm above floor in Boiler Rooms and Mechanical Equipment Rooms.
- .8 Install ball valves for glycol service.

3.4 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.

3.5 AUTOMATIC CONTROL VALVES

- .1 Install where indicated.
- .2 Record flow or valve identification tag.
- .3 Flow to be within 10% of specified value.

3.6 FLUSHING AND CLEANING

- .1 Flush and clean in presence of Departmental Representative.
- .2 Flush after pressure test for a minimum of 4h.
- .3 Fill with solution of water and non-foaming, phosphate-free detergent 3% solution by weight. Circulate for minimum of 8h.
- .4 Refill system with clean water. Circulate for at least 4h. Clean out strainer screens/baskets regularly. Then drain.
- .5 Refill system with clean water. Circulate for at least 2h. 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/glycol solution, adding water treatment as specified.

3.8 FIELD QUALITY CONTROL

- .1 Testing:
 - .1 Test system in accordance with Section 230801 Performance Verification Mechanical Piping Systems.
- .2 Balancing:
 - .1 Balance water systems to within plus or minus 5% of design output.
- .3 Glycol Charging:
 - .1 Provide mixing tank and positive displacement pump for glycol charging.
 - .2 Retest for concentration to ASTM E202 after cleaning.
 - .3 Provide report to Departmental Representative.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes.
 - .1 Materials and installation for steel piping, valves and fittings for hydronic systems in building services piping.
 - .2 Sustainable requirements for construction and verification.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME).
 - .1 ASME B16.1-98, Cast Iron Pipe Flanges and Flanged Fittings.
 - .2 ASME B16.3-98, Malleable Iron Threaded Fittings.
 - .3 ASME B16.5-03, Pipe Flanges and Flanged Fittings.
 - .4 ASME B16.9-01, Factory-Made Wrought Butt welding Fittings.
 - .5 ASME B18.2.1-03, Square and Hex Bolts and Screws (Inch Series).
 - .6 ASME B18.2.2-87(R1999), Square and Hex Nuts (Inch Series).
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A47/A47M-99, Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M-02, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
 - .3 ASTM A536-84(1999)e1, Standard Specification for Ductile Iron Castings.
 - .4 ASTM B61-02, Standard Specification for Steam or Valve Bronze Castings.
 - .5 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .6 ASTM E202-00, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.
- .3 American Water Works Association (AWWA).
 - .1 AWWA C111-00, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .4 Canadian Standards Association (CSA International).
 - .1 CSA B242-M1980(R1998), Groove and Shoulder Type Mechanical Pipe Couplings.
 - .2 CAN/CSA W48-01, Filler Metals and Allied Materials for Metal Arc Welding (Developed in cooperation with the Canadian Welding Bureau).
- .5 Manufacturer's Standardization of the Valve and Fittings Industry (MSS).
 - .1 MSS-SP-67-025, Butterfly Valves.
 - .2 MSS-SP-70-98, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS-SP-71-97, Cast Iron Swing Check Valves Flanged and Threaded Ends.
 - .4 MSS-SP-80-03, Bronze Gate, Globe, Angle and Check Valves.
 - .5 MSS-SP-85-02, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 SUBMITTALS

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Closeout Submittals.
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals and include following:
 - .1 Special servicing requirements.

1.4 QUALITY ASSURANCE

- .1 Health and Safety.
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 MAINTENANCE

- .1 Extra Materials.
 - .1 Provide following spare parts:
 - .1 Valve seats: one for every ten valves, each size. Minimum one.
 - .2 Discs: one for every ten valves, each size. Minimum one.
 - .3 Stem packing: one for every ten valves, each size. Minimum one.
 - .4 Valve handles: two of each size.
 - .5 Gaskets for flanges: one for every ten flanges.

Part 2 Products

2.1 PIPE

- .1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:
 - .1 To NPS6.

2.2 PIPE JOINTS

- .1 NPS2 and under: screwed fittings with PTFE tape.
- .2 NPS2-1/2 and over: flanges to CAN/CSA W48.
- .3 Roll grooved: standard coupling to CSA B242.
- .4 Flanges: plain or raised face, slip-on weld neck to AWWA C111.
- .5 Orifice flanges: slip-on raised face, 2100 kPa.
- .6 Flange gaskets: to AWWA C111.
- .7 Pipe thread: taper.
- .8 Bolts and nuts: to ASME B18.2.1 and ASME B18.2.2.
- .9 Roll grooved coupling gaskets: type EPDM.

2.3 FITTINGS

- .1 Screwed fittings: malleable iron, to ASME B16.3, Class 150.
- .2 Pipe flanges and flanged fittings:
 - .1 Cast iron: to ASME B16.1, Class 125.
 - .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.
- .5 Fittings for roll grooved piping: malleable iron to ASTM A47/A47M, ductile iron to ASTM A536.

2.4 VALVES

- .1 Connections:
 - .1 NPS2 and smaller: screwed ends.
 - .2 NPS2.1/2 and larger: Flanged or grooved ends.
- .2 Gate valves: to MSS-SP-70. Application: Isolating equipment, control valves, pipelines:
 - .1 NPS2 and under:
 - .1 Mechanical Rooms: Class 125, rising stem, split wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 Elsewhere: Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS2 1/2 and over:
 - .1 Mechanical Rooms: non-rising stem, solid wedge disc, lead free bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.
 - .1 Operators: handwheel.
 - .2 Elsewhere: Non-rising stem, solid wedge disc, lead free bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.
 - .1 Operators: handwheel.
- .3 Butterfly valves: to MSS-SP-67 Application: Isolating cells or section of multiple component equipment (eg. multi section coils, multi-cell cooling towers):
 - .1 NPS2 1/2 and over: Lug type, Grooved ends: as specified Section 23 05 17 - Pipe Welding.
- .4 Globe valves: to MSS-SP-80, 85 Application: Throttling, flow control, emergency bypass:
 - .1 NPS2 and under:
 - .1 Mechanical Rooms: with PTFE disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 Elsewhere: Globe, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS2 1/2 and over:
 - .1 With composition lead free, bronze disc, lead free, bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.
 - .2 Operators: handwheel.

- .5 Balancing, for TAB:
 - .1 Sizes: Calibrated balancing valves, as specified this section.
 - .2 NPS2 and under:
 - .1 Automatic flow control device where specified.
 - .2 Circuit setter where specified.
- .6 Drain valves: Gate, Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.
- .7 Swing check valves: to MSS-SP-71.
 - .1 NPS2 and under:
 - .1 Class 125, swing, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS2 1/2 and over:
 - .1 Flanged or Grooved ends: as specified Section 23 05 23.02 - Valves - Cast Iron.
- .8 Silent check valves:
 - .1 NPS2 and under:
 - .1 As specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS2 1/2 and over:
 - .1 Flanged or Grooved ends: as specified Section 23 05 23.02 - Valves - Cast Iron.
- .9 Ball valves:
 - .1 NPS2 and under: as specified Section 23 05 23.01 - Valves - Bronze.
- .10 Lubricated Plug Valves
 - .1 NPS2 1/2 and over:
 - .1 As specified Section 23 05 23.02 - Valves - Cast Iron.

Part 3 Execution

3.1 PIPING INSTALLATION

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

3.2 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.

3.3 CLEANING, FLUSHING AND START-UP

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

3.4 TESTING

- .1 Test system in accordance with Section 23 05 00 Common Work Results for Mechanical.
- .2 For glycol systems, retest with propylene glycol to ASTM E202, inhibited, for use in building system after cleaning. Repair leaking joints, fittings or valves.

3.5 BALANCING

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

3.6 GLYCOL CHARGING

- .1 Provide mixing tank and positive displacement pump for glycol charging.
- .2 Retest for concentration to ASTM E202 after cleaning.

3.7 PERFORMANCE VERIFICATION

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

END OF SECTION

1 General

1.1 SECTION INCLUDES

- .1 Expansion tanks.
- .2 Air vents.
- .3 Air separators.
- .4 Strainers.
- .5 Pump suction fittings.
- .6 Combination fittings.
- .7 Flow indicators, controls, meters.
- .8 Radiator valves.
- .9 Relief valves.
- .10 Glycol specialties.

1.2 QUALITY ASSURANCE

- .1 Comply with Provincial Regulations and have CSA approval.
- .2 Grooved joint piping specialties shall be of the same manufacturer as the adjoining couplings.
- .3 Construct pressure tanks to ASME Code for unfired pressure vessels.

1.3 REFERENCES

- .1 ASME - SEC 8D - Boilers and Pressure Vessels Code - Rules for Construction of Pressure Vessels.

1.4 SUBMITTALS

- .1 Section 01 33 00: Procedures for submittals.
- .2 Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.
- .3 Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- .4 Provide operating and service procedures for expansion tank, including setting tank pressure, replacing bladder etc.

1.5 PROJECT RECORD DOCUMENTS

- .1 Section 01 78 00: Submittals for project closeout.
- .2 Record actual locations of flow controls.

1.6 OPERATION AND MAINTENANCE DATA

- .1 Section 01 78 00: Submittals for project closeout.

- .2 Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

2 Products

2.1 EXPANSION TANKS

- .1 Existing expansion tanks shall be utilized as is.

2.2 AIR VENTS

- .1 Manual Type: Short vertical sections of 50 mm diameter pipe to form air chamber, with 12mm (1/2") full port ball valve at top of chamber. Discharge to u-bend copper, PEX or plastic tubing of sufficient length to permit discharge to 5 gallon pail. Where pipe sizes are less than 64mm (2-1/2") air chamber shall be line size.
- .2 Float Type:
 - .1 Cast iron body and cover, with stainless steel, brass and EPDM internal components, and NPS 19 mm inlet connection, 9.5 mm discharge and rated at 1034 kPa working pressure.
 - .2 Float: solid material suitable for system operating temperature and pressure. Minimum temperature to be 121 Deg.C.
 - .3 Provide isolating valve before inlet.

2.3 SEPARATORS

- .1 Existing air separators are to be utilized as is.

2.4 SUCTION DIFFUSER

- .1 Fitting: Angle pattern, cast-iron body, threaded for 50 mm and smaller, flanged for 65 mm and larger, rated for 1200 kPa working pressure, with full length straightening vanes, cylinder strainer with 5 mm diameter openings, disposable fine mesh stainless steel strainer to fit over cylinder strainer, and permanent magnet located in flow stream and removable for cleaning.
- .2 Accessories: Adjustable foot support, 25mm (1") blowdown tapping in bottom, pressure gauge tappings.

2.5 COMBINATION PUMP INLET AND STRAINER FITTING

- .1 Provide angle type suction guide fitting with flanged cast iron or grooved (inlet) ductile iron body, stainless steel, steel or cast iron guide vanes and removable stainless steel strainer. Design based on Victaulic Series 731-I
- .2 Accessories: drain tapping in bottom, pressure gauge tappings

2.6 COMBINATION PUMP DISCHARGE VALVES

- .1 Valves: Straight or angle pattern, flanged cast-iron valve body with bolt-on bonnet for 1200 kPa operating pressure, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation.

.2 Triple-Duty Valve Assemblies will not be permitted for this project.

.3

2.7 CIRCUIT SETTER (STATIC BALANCING)

.1 Provide bronze (copper alloy), ductile iron or cast iron with bronze or copper alloy disc, complete with pressure tappings, memory lock and insulation blocks.

2.8 AUTOMATIC FLOW RESTRICTOR

.1 Automatic flow control valve complete with isolation sized for design flow rate

.2 Construction: Forged or cast brass or bronze body with union on inlet , temperature and pressure test ports on inlet and outlet

.3 Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 13.7 kPa.

.4 Control Mechanism: Stainless steel or nickel plated brass piston or regulator cup, operating against stainless steel helical or wave formed spring.

.5 In-line strainer with 20 mesh stainless steel filter screen and drain valve

.6 Isolation Valve: Ball valve with Teflon seats, refer to valve specifications.

.7 Supply side flow restrictors to be complete with strainer. Return side flow restrictors to be complete with supply side strainer or strainer/isolation valve combination.

2.9 RELIEF VALVES

.1 Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.10 RADIATOR BALANCING VALVES

.1 Angle or straight pattern, rising stem, inside screw globe valve for 860 kPa working pressure, with bronze body and integral union for screwed connections, renewable composition disc.

.2 Provide stainless steel indicating dial plate and lockable balancing yoke.

.3 Provide automatic flow restrictors and/or circuit setters where indicated on details.

2.11 SIDE-STREAM FILTRATION SYSTEM

.1 System: Flow indicator, filter housing with cartridge filter, shut-off valves, and flow control valve.

.2 Performance: Design flow 0.25 L/sec with maximum pressure drop of 20.7 kPa.

- .3 Hot Water and Glycol Filter Housing: Glass reinforced nylon plastic suitable for 105 degrees C and 1380 kPa operating conditions.
- .4 Chilled Water Filter Housing: Reinforced polypropylene plastic housing suitable for 52 degrees C and 860 kPa operating conditions.
- .5 Cartridges: 0.03 mm for start-up and 0.005 mm for system operation.
- .6 Provide one case of thirty 20-micron cartridges and one case of thirty 5-micron cartridges.

3 Execution

3.1 INSTALLATION

- .1 Install specialties to manufacturer's written instructions.
- .2 Clean and flush glycol system before adding glycol solution. Refer to Section 23 25 00.

3.2 AIR VENTS

- .1 Provide manual air vents at system high points and as indicated.
- .2 Install automatic air vents at system air separator, heating units and system high points not readily accessible for servicing.
- .3 Install gate valve on automatic air vent inlet. Run discharge to nearest drain or service sink.
- .4 For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- .5 Where large air quantities can accumulate, provide enlarged air collection standpipes.

3.3 RELIEF VALVES

- .1 Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, expansion tanks and where indicated.
- .2 Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
- .3 Pipe relief valve outlet to nearest floor drain.
- .4 Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

3.4 PUMP FITTINGS

- .1 Provide pump suction fitting and strainer on suction side of centrifugal pumps. Remove temporary strainers after cleaning systems.
- .2 Combination strainer and suction fitting may be utilized in lieu of individual suction diffuser and strainer.

- .3 Provide balancing device on discharge of pump, refer to details for style.
- .4 A combination balance, check, and isolation valve may be used on pump discharge where indicated or required to conserve space. An additional isolation valve shall be installed when combination valve is utilized.
- .5 Support pump fittings with floor mounted pipe and flange supports to eliminate undue stress on pump connection

3.5 RADIATOR BALANCING VALVES

- .1 Angle or straight pattern, rising stem, inside screw globe valve for 860 kPa working pressure, with bronze body and integral union for screwed connections, renewable composition disc.
- .2 Provide stainless steel indicating dial plate and lockable balancing yoke.

3.6 HYDRONIC BALANCING VALVES

- .1 Provide balancing valves on all heating and cooling equipment and all hydronic terminal devices to facilitate system balancing.
- .2 Provide balancing valves on branch lines, as indicated, to facilitate system balancing.
- .3 Provide circuit setters on heating and cooling equipment as indicated on details and schematics.
- .4 Provide automatic flow restrictors on heating and cooling equipment as indicated on details and schematics.

3.7 SIDE STREAM FILTER

- .1 Provide side-stream filtration system where indicated on closed loop hydronic system. Install across circulating pumps with flow from pump discharge to pump suction.

END OF SECTION

1 General

1.1 SECTION INCLUDES

- .1 In-line circulators.
- .2 Vertical in-line pumps.
- .3 Close coupled pumps.
- .4 Base mounted pumps.

1.2 REFERENCES

- .1 UL 778 - Motor-Operated Water Pumps.

1.3 PERFORMANCE REQUIREMENTS

- .1 Ensure pumps operate at specified system fluid temperatures without vapour binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

1.4 SUBMITTALS

- .1 Section 01 33 00: Procedures for submittals.
- .2 Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.
- .3 Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.
- .4 Millwright's Certificate: Certify that base mounted pumps have been aligned.

1.5 OPERATION AND MAINTENANCE DATA

- .1 Section 01 78 00: Submittals for project closeout.
- .2 Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.6 QUALITY ASSURANCE

- .1 Manufacturer: Company specializing in manufacture, assembly, and field performance of pumps with minimum three years experience.
- .2 The pump control package shall be fully assembled by the manufacturer. The manufacturer shall be responsible for the complete pump control package, including system interface with pumps and VFDs, as well as the successful operation of all components supplied by the pump control system manufacturer.
- .3 All functions of the variable speed pump control system shall be thoroughly field tested prior to actual start-up. This test shall be conducted with motors connected to AFD output and it shall test all inputs, outputs and program execution specific to this application.

- .4 Pump control package shall be listed by Underwriter's Laboratories and bear the UL label.

1.7 REGULATORY REQUIREMENTS

- .1 Products Requiring Electrical Connection: Listed and classified by ULC as suitable for the purpose specified and indicated.

2 Products

2.1 GENERAL REQUIREMENTS

- .1 Statically and dynamically balance rotating parts.
- .2 Construction shall permit complete servicing without breaking piping or motor connections.
- .3 Pumps shall operate at 1750 RPM unless specified otherwise.
- .4 Pump connections shall be flanged.
- .5 Refer to equipment schedules for pump size, capacity, and minimum efficiency.
- .6 Pumps to be complete with suction and discharge gauge ports.
- .7 Pumps shall be rated for greater of 862 kPa (125 psi) or 1.5 times maximum working pressure.

2.2 SYSTEM LUBRICATED CIRCULATORS

- .1 Type: Horizontal shaft, single stage, direct connected with multiple speed wet rotor motor for in-line mounting, 110 degrees C maximum water temperature.
- .2 Casing: Cast iron with flanged pump connections.
- .3 Impeller, Shaft, Rotor: Stainless Steel.
- .4 Bearings: Metal Impregnated carbon (graphite) and ceramic.
- .5 Starter housing and terminal box to be aluminum.
- .6 Motor: Impedance protected single speed or multiple speed with external speed selector as indicated on equipment schedule.

2.3 IN-LINE CIRCULATORS

- .1 Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated.

- .2 Casing: Cast iron, with flanged pump connections.
- .3 Impeller: Cadmium plated steel or bronze, keyed to shaft.
- .4 Bearings: Two, oil lubricated bronze sleeves.
- .5 Shaft: Alloy or stainless steel with copper or bronze sleeve, integral thrust collar.
- .6 Seal: Carbon rotating against a stationary ceramic seat, viton fitted, 135 degrees C maximum continuous operating temperature.
- .7 Drive: Flexible coupling.

2.4 VERTICAL IN-LINE PUMPS

- .1 Type: Vertical, single stage, close coupled, radially or horizontally split casing, for in-line mounting, suitable for horizontal or vertical operation.
- .2 Casing: Cast iron, with suction and discharge gauge port, casing wear ring, seal flush connection, drain plug, flanged suction and discharge.
- .3 Impeller: Bronze, fully enclosed, keyed directly to motor shaft or extension and secured with locknut.
- .4 Shaft: Stainless steel or carbon steel with bronze or stainless steel sleeve through seal chamber.
- .5 Seal Options:
 - .1 Carbon rotating against a stationary ceramic seat, viton fitted, 107 degrees C maximum continuous operating temperature.
 - .2 Packing gland with minimum four rings graphite impregnated packing and bronze lantern rings, 110 degrees C maximum continuous operating temperature.

2.5 INTEGRAL VARIABLE SPEED PUMPS

- .1 The self-sensing product shall consist of a factory prepackaged and preprogrammed pump, drive, motor, and integral controls package. Note that controller shall be mounted remotely from pump.
- .2 The drive shall be mounted on wall and wired to the motor. It shall be mounted with rubber vibration mounts. The mounting and packing of the drive shall be done in a manner that transmitted acceleration levels will be three times below the allowable limits published by the drive manufacturer. These limits will apply to a frequency range of 0-10,000 HZ. The performance speed of this package shall 1750 RPM nominal as standard. Exceptions
- .3 for 3600 RPM will be noted in the schedules. 3600 RPM shall NOT be an allowable substitution for a specified 1750 PRM package. 3600 RPM products might be considered as a substitution for 1750 RPM only if that manufacturer provides a spare motor, drive, and seal for each pumping unit.

- .4 Pump logic controller, variable frequency drives, sensor/transmitters and related equipment shall be installed by the mechanical contractor as shown on the plans. Electrical shall wire power to controller and from controller to pump motor.
- .5 Pump Logic Controller:
 - .1 The controller operation shall operate the system using a tested and proven program that safeguards against undesirable or damaging conditions including:
 - .1 Motor overload
 - .2 Pump flow surges
 - .3 Hydraulic cycling (hunting).
 - .4 End of curve unstable operation: The pump logic controller, through a factory pre-programmed algorithm, shall be capable of protecting the pumps from hydraulic damage due to operation beyond their published end-of-curve. This feature requires a flow meter for activation. The operator interface shall include an owner adjustable flow set point to set the parameters for this routine.
 - .2 The pump logic controller shall be capable of starting, unloading, and stopping pumps based on a system performance program that will minimize energy consumption , provide reliable performance and bumpless transitions.
 - .3 The integrated logic controller shall be capable of running four different hydronic optimization sub-routines
 - .1 Setup one: This subroutine shall allow the pump package to track a quadratic system curve and will optimize a secondary distribution loop. It shall use a technology that allows the pump, drive, and motor package to translate the hydronic data from both a pump and system curve and translate it to electrical data. This allows the drive to know exactly where it is in the hydronic world.
 - .2 Setup two: This subroutine shall allow two pumps to run as backup for each other and shall alternate the pumps based on a real time clock.
 - .3 Setup three: This subroutine shall allow the package to run in a customer defined flow rate. The package will always seek to run at the user defined flow even with fouling causing system changes. It shall use a technology that allows the pump, drive, and motor package to translate the hydronic data from both a pump and system curve and translate it to electrical data. This allows the drive to know exactly where it is in the hydronic world.
 - .4 Setup four: This subroutine shall incorporate a traditional external sensing and control platform. It shall allow the option of controlling the pumps with three zones of differential pressure or central plant differential temperature. This optional setup shall allow the owner the option of external sensing without adding an external controller.
 - .4 The control platform shall include a subroutine equal to allow for the automatic balancing of secondary system distribution pumps. The package shall automatically run system distribution pumps to a user defined duty point and will recognize that duty point and hold the pumps at a speed that matches the actual installed system quadratic system curve. The package will then use this data to set up a new duty point as the max point for the quadratic control curve. Use of external balancing devices will not be needed.
 - .5 The package shall serve as a flow metering device and will display pump flow at the user interface.

.6 Variable Frequency Drives:

- .1 The VFD shall convert incoming fixed frequency three-phase ac power into an adjustable frequency and voltage for controlling the speed of three-phase ac motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor derating. When properly sized, the VFD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.
 - .1 The VFD shall include an input full-wave bridge rectifier and maintain a fundamental (displacement) power factor near unity regardless of speed or load.
 - .2 The VFD shall have a dual 5% impedance DC link reactor on the positive and negative rails of the dc bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be non-saturating. Swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable. VFDs with saturating (non-linear) dc link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.
 - .3 The VFD's full load output current rating shall meet or exceed nec table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 120% of rated torque for up to 0.5 second while starting.
 - .4 The VFD shall provide full motor torque at any selected frequency from 20 hz to base speed while providing a variable torque v/hz output at reduced speed. This is to allow driving direct drive fans without high speed derating or low speed excessive magnetization, as would occur if a constant torque v/hz curve was used at reduced speeds. Breakaway current of 160% shall be available.
 - .5 A programmable automatic energy optimization selection feature shall be provided standard in the VFD. This feature shall automatically and continuously monitor the motor's speed and load to adjust the applied voltage to maximize energy savings.
 - .6 The VFD must be able to produce full torque at low speed to operate direct drive fans.
 - .7 Output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD.
 - .8 An automatic motor adaptation algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to perform the test.
 - .9 Galvanic isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either

- galvanic or optical isolation on both analog i/o and discrete digital i/o shall include additional isolation modules.
- .10 VFD shall minimize the audible motor noise through the used of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD operation while reducing motor noise. VFDs with fixed carrier frequency are not acceptable.
 - .11 All VFDs shall contain integral emi filters to attenuate radio frequency interference conducted to the ac power line.
 - .12 The drive enclosure shall be standard as NEMA 12 (ip 55) and optional shall be NEMA 4X (ip 66). See schedules for project requirements.
 - .13 Protective Features:
 - .1 A minimum of class 20 i2t electronic motor overload protection for single motor applications shall be provided. Overload protection shall automatically compensate for changes in motor speed.
 - .2 Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over voltage, under voltage, VFD over temperature and motor over temperature. The VFD shall display all faults in plain language. Codes are not acceptable.
 - .3 Protect VFD from input phase loss. The VFD should be able to protect itself from damage and indicate the phase loss condition. During an input phase loss condition, the VFD shall be able to be programmed to either trip off while displaying an alarm, issue a warning while running at reduced output capacity, or issue a warning while running at full commanded speed. This function is independent of which input power phase is lost.
 - .4 Protect from under voltage. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output, without faulting, with an input voltage as low as 70% of the nominal voltage.
 - .5 Protect from over voltage. The VFD shall continue to operate without faulting with a momentary input voltage as high as 130% of the nominal voltage.
 - .6 The VFD shall incorporate a programmable motor preheat feature to keep the motor warm and prevent condensation build up in the motor when it is stopped in a damp environment by providing the motor stator with a controlled level of current.
 - .7 VFD shall include a "signal loss detection" algorithm with adjustable time delay to sense the loss of an analog input signal. It shall also include a programmable time delay to eliminate nuisance signal loss indications. The functions after detection shall be programmable.
 - .8 VFD shall function normally when the keypad is removed while the VFD is running. No warnings or alarms shall be issued as a result of removing the keypad.
 - .9 VFD shall catch a rotating motor operating forward or reverse up to full speed without VFD fault or component damage.

- .10 Selectable over-voltage control shall be provided to protect the drive from power regenerated by the motor while maintaining control of the driven load.
 - .11 VFD shall include current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload. If an output phase loss is detected, the VFD will trip off and identify which of the output phases is low or lost.
 - .12 If the temperature of the VFD's heat sink rises to 80°C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. It shall also be possible to program the VFD so that it reduces its output current limit value if the VFD's temperature becomes too high.
 - .13 In order to ensure operation during periods of overload, it must be possible to program the VFD to automatically reduce its output current to a programmed value during periods of excessive load. This allows the VFD to continue to run the load without tripping.
 - .14 The VFD shall have temperature controlled cooling fan(s) for quiet operation, minimized losses, and increased fan life. At low loads or low ambient temperatures, the fan(s) may be off even when the VFD is running.
 - .15 The VFD shall store in memory the last 10 alarms. A description of the alarm, and the date and time of the alarm shall be recorded.
 - .16 When used with a pumping system, the VFD shall be able to detect no-flow situations, dry pump conditions, and operation off the end of the pump curve. It shall be programmable to take appropriate protective action when one of the above situations is detected.
- .2 Internal Control Algorithm
- .1 This is a standard HVAC drive that has been upgraded and modified by pump experts for hyronic applications. It is set up with a closed loop internal control sequence that will optimize life cycle, system comfort, and minimize energy consumption.
- .3 Interface Features
- .1 Hand, off and auto keys shall be provided to start and stop the VFD and determine the source of the speed reference. It shall be possible to either disable these keys or password protect them from undesired operation.
 - .2 There shall be an "info" key on the keypad. The info key shall include "on-line" context sensitive assistance for programming and troubleshooting.
 - .3 The VFD shall be programmable to provide a digital output signal to indicate whether the VFD is in hand or auto mode. This is to alert the building automation system whether the VFD is being controlled locally or by the building automation system.
 - .4 Password protected keypad with alphanumeric, graphical, backlit display can be remotely mounted. Two levels of password protection shall be provided to guard against unauthorized parameter changes.
 - .5 All VFDs shall have the same customer interface. The keypad and display shall be identical and interchangeable for all sizes of VFDs.

- .6 To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFD's keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters. Keypad shall provide visual indication of copy status.
- .7 Display shall be programmable to communicate in multiple languages including english, spanish and french.
- .8 A red fault light, a yellow warning light and a green power-on light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.
- .9 A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD. The VFD shall also have individual fan, pump, and compressor menus specifically designed to facilitate start-up of these applications.
- .10 A four-feedback PID controller to control the speed of the VFD shall be standard. This controller shall accept up to four feedback signals. It shall be programmable to compare the feedback signals to a common setpoint or to individual setpoints and to automatically select either the maximum or the feedback signal as the controlling signal. It shall also be possible to calculate the controlling feedback signal as the average of all feedback signals or the difference between a pair of feedback signals.
 - .1 The VFD shall be able to apply individual scaling to each feedback signal.
 - .2 The VFD's PID controller shall be able to actively adjust its setpoint based on flow. This allows the VFD to compensate for a pressure feedback sensor which is located near the output of the pump rather than out in the controlled system.
- .11 The VFD shall have three additional PID controllers which can be used to control damper and valve positioners in the system and to provide setpoint reset.
- .12 Floating point control interface shall be provided to increase/decrease speed in response to contact closures.
- .13 Five simultaneous meter displays shall be available. They shall include at a minimum, frequency, motor current, motor voltage, VFD output power, VFD output energy, VFD temperature in degrees, among others.
- .14 Programmable sleep mode shall be able to stop the VFD. When its output frequency drops below set "sleep" level for a specified time, when an external contact commands that the VFD go into sleep mode, or when the VFD detects a no-flow situation, the VFD may be programmed to stop. When the VFD's speed is being controlled by its PID controller, it shall be possible to program a "wake-up" feedback value that will cause the VFD to start. To avoid excessive starting and stopping of the driven equipment, it shall be possible to program a minimum run time before sleep mode can be initiated and a minimum sleep time for the VFD.
- .15 A run permissive circuit shall be provided to accept a "system ready" signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of initiating an output "run request" signal to

- indicate to the external equipment that the VFD has received a request to run.
- .16 VFD shall be programmable to display feedback signals in appropriate units, such as inches of water column (in-wg), pressure per square inch (psi) or temperature (deg.F).
 - .17 VFD shall be programmable to sense the loss of load and signal this condition via a keypad warning, relay output and/or over the serial communications bus. To ensure against nuisance indications, this feature must be based on motor torque, not current, and must include a proof timer to keep brief periods of no load from falsely triggering this indication.
- .4 Standard Control And Monitoring Inputs And Outputs
- .1 Six dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
 - .1 Two terminals shall be programmable to act as either as digital outputs or additional digital inputs.
 - .2 Two programmable relay outputs, Form C 240 V AC, 2 A, shall be provided for remote indication of VFD status.
 - .1 Each relay shall have an adjustable on delay / off delay time.
 - .3 Two programmable analog inputs shall be provided that can be either direct-or-reverse acting. Each shall be independently selectable to be used with either an analog voltage or current signal.
 - .1 The maximum and minimum range of each shall be able to be independently scalable from 0 to 10 V dc and 0 to 20 mA.
 - .2 A programmable low-pass filter for either or both of the analog inputs must be included to compensate for noise.
 - .3 The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting,
 - .4 One programmable analog current output (0/4 to 20 mA) shall be provided for indication of VFD status. This output shall be programmable to show the reference or feedback signal supplied to the VFD and for VFD output frequency, current and power. It shall be possible to scale the minimum and maximum values of this output.
 - .5 It shall be possible through serial bus communications to read the status of all analog and digital inputs of the VFD.
 - .6 It shall be possible to command all digital and analog output through the serial communication bus.
 - .5 Optional Control And Monitoring Inputs And Outputs
 - .1 It shall be possible to add optional modules to the VFD in the field to expand its analog and digital inputs and outputs.
 - .1 These modules shall use rigid connectors to plug into the VFD's control card.

- .2 The VFD shall automatically recognize the option module after it is powered up. There shall be no need to manually configure the module.
- .3 Modules may include such items as:
 - a) Additional digital outputs, including relay outputs
 - b) Additional digital inputs
 - c) Additional analog outputs
 - d) Additional analog inputs, including Ni or Pt temperature sensor inputs
- .4 It shall be possible through serial bus communications to control the status of all optional analog and digital outputs of the VFD.
- .6 Standard programmable firefighter's override mode allows a digital input to control the VFD and override all other local or remote commands. It shall be possible to program the VFD so that it will ignore most normal VFD safety circuits including motor overload. The VFD shall display firemode whenever in firefighter's override mode. Firemode shall allow selection of forward or reverse operation and the selection of a speed source or preset speed, as required to accommodate local fire codes, standards and conditions.
- .7 A real-time clock shall be an integral part of the VFD.
 - .1 It shall be possible to use this to display the current date and time on the VFD's display.
 - .1 Ten programmable time periods, with individually selectable ON and OFF functions shall be available. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter setpoints and output relays. It shall be possible to program unique events that occur only during normal work days, others that occur only on non-work days, and others that occur on specific days or dates. The manufacturer shall provide free PC-based software to set up the calendar for this schedule.
 - .2 All VFD faults shall be time stamped to aid troubleshooting.
 - .3 It shall be possible to program maintenance reminders based on date and time, VFD running hours, or VFD operating hours.
 - .4 The real-time clock shall be able to time and date stamp all faults recorded in the VFD fault log.
- .8 The VFD shall be able to store load profile data to assist in analyzing the system demand and energy consumption over time.
- .9 The VFD shall include a sequential logic controller to provide advanced control interface capabilities. This shall include:
 - .1 Comparators for comparing VFD analog values to programmed trigger values
 - .1 Logic operators to combine up to three logic expressions using Boolean algebra
 - .2 Delay timers
 - .3 A 20-step programmable structure
- .10 The VFD shall include a cascade controller which allows the VFD to operate in closed loop set point (PID) control mode one motor at a controlled speed and control the operation of 3 additional constant speed motor starters.

.11 Serial communications

- .1 The VFD shall include a standard eia-485 communications port and capabilities to be connected to the following serial communication protocols at no additional cost and without a need to install any additional hardware or software in the VFD:
 - .1 Modbus RTU
 - .2 BACnet MS/TP
 - .3 LonWorks Free Topology (FTP)
 - .4 VFD shall have standard rs-485 port for direct connection of personal computer (pc) to the VFD. The manufacturer shall provide no-charge pc software to allow complete setup and access of the VFD and logs of VFD operation through the rs-485 port. It shall be possible to communicate to the VFD through this usb port without interrupting VFD communications to the building management system.
 - .5 The VFD shall have provisions for an optional 24 v DC back-up power interface to power the VFD's control card. This is to allow the VFD to continue to communicate to the building automation system even if power to the VFD is lost.

12. Adjustments

- .1 The VFD shall have a manually adjustable carrier frequency that can be adjusted in 0.5 khz increments to allow the user to select the desired operating characteristics. The VFD shall also be programmable to automatically reduce its carrier frequency to avoid tripping due to thermal loading.
 - .1 Four independent setups shall be provided.
 - .2 Four preset speeds per setup shall be provided for a total of 16.
 - .3 Each setup shall have two programmable ramp up and ramp down times. Acceleration and deceleration ramp times shall be adjustable over the range from 1 to 3,600 seconds.
 - .4 Each setup shall be programmable for a unique current limit value. If the output current from the VFD reaches this value, any further attempt to increase the current produced by the VFD will cause the VFD to reduce its output frequency to reduce the load on the VFD. If desired, it shall be possible to program a timer which will cause the VFD to trip off after a programmed time period.
 - .5 If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: external interlock, under-voltage, over-voltage, current limit, over temperature, and VFD overload.
 - .6 The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.
 - .7 An automatic "start delay" may be selected from 0 to 120 seconds. During this delay time, the VFD shall be programmable to either apply no voltage to the motor or apply a DC braking current if desired.

- .8 Four programmable critical frequency lockout ranges to prevent the VFD from operating the load at a speed that causes vibration in the driven equipment shall be provided. Semi-automatic setting of lockout ranges shall simplify the set-up.
- .13 Optional features
 - .1 All optional features shall be built and mounted by VFD manufacturer. All optional features shall be UL listed by the VFD manufacturer as a complete assembly and carry a UL label.
 - .1 All panels shall be marked for their short circuit current rating in compliance with UL.
- .14 Service conditions
 - .1 Ambient temperature, continuous, full speed, full load operation:
 - .1 -10 to 45°C (14 to 113°F) through 125 hp @ 460 and 600 volt, through 60 hp @ 208 volt
 - .2 -10 to 40°C (14 to 104°F) 150 hp and larger
 - .1 0 to 95% relative humidity, non-condensing.
 - .2 Elevation to 3,300 feet without derating.
 - .3 AC line voltage variation, -10 to +10% of nominal with full output.
 - .4 No side clearance shall be required for cooling.
 - .5 All power and control wiring shall be done from the bottom.
 - .6 All VFDs shall be plenum rated.
- .7 Pumps
 - .1 Inline pump matched to VFD and factory tested.

3 Execution

3.1 PREPARATION

- .1 Verify that electric power is available and of the correct characteristics (voltage and phase) prior to ordering pump.

3.2 INSTALLATION

- .1 Install to manufacturer's written instructions.
- .2 Provide access space around pumps for service. Provide no less than minimum as recommended by manufacturer.
- .3 Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close coupled or base mounted pumps, provide supports under elbows on pump suction and discharge line sizes 102 mm and over. Refer to Section 23 05 48.

- .4 Provide line sized shut-off isolation valve and strainer on pump suction, and line sized soft seated check valve, balancing device, and shut-off isolation valve on pump discharge.
- .5 Provide air cock and drain connection on horizontal pump casings.
- .6 Provide drains for bases and stuffing boxes piped to and discharging into floor drains.
- .7 Provide common pressure gauge, piped complete with isolation valves to suction and discharge side of pump.
- .8 Check, align, and certify alignment of base mounted pumps prior to start-up.
- .9 Lubricate pumps before start-up.

3.2 INTEGRAL VARIABLE SPEED PUMPS

- .1 Install equipment in accordance with manufacturer's instructions and all applicable codes.
- .2 Ensure that pump is pipe-mounted and free to float with any movement, expansion and contraction of piping system.
 - .1 Support pump using floor mounted saddle or wall bracket as required.
 - .2 For vertical in-line pumps supported from structure, ensure no pipe strain is imposed on pump flanges.
- .3 Power wiring, as required, shall be the responsibility of the electrical contractor. All wiring shall be performed per manufacturers instructions and all applicable codes.
- .4 Control wiring for remote mounted switches and sensor/transmitters shall be the responsibility of the controls contractor. All wiring shall be performed per manufacturers instructions and all applicable codes.
- .5 Demonstration:
 - .1 The control package manufacturer's factory trained representative shall provide start-up of the packaged pumping system. This start-up shall include verification of proper installation, system initiation, adjustment and fine tuning. Start-up shall not be considered complete until the sequence of operation, including all alarms, has been sufficiently demonstrated to the Owner or Owner's designated representative. This jobsite visit shall occur only after all hook-ups, tie-ins, and terminations have been completed and signed-off on the manufacturer's start-up request form.
 - .2 The pump control package manufacturer's factory trained representative shall provide on-site training for owner's personnel. This training shall fully cover maintenance and operation of all system components.

3.3 PERFORMANCE VERIFICATION

- .1 General
 - .1 In accordance with manufacturer's recommendations and as specified herein.
- .2 Exclusions:
 - .1 This article does not apply to small fractional horse-power (lower than 1/2 hp) circulators.
- .3 Assumptions: these PV procedures assume that:
 - .1 Manufacturer's performance curves are accurate.
 - .2 Valves on pump suction and discharge provide tight shut-off.
- .4 Multiple Pump Installations - Series and Parallel:
 - .1 Repeat PV procedures specified above for pump performance and pump BHP for combinations of pump operations.
- .5 Mark points of design and actual performance at design conditions as finally set upon completion of TAB.
- .6 Include reports in Operation and Maintenance Manuals:
 - .1 Record of point(s) of actual performance at maximum and minimum conditions and for single and parallel operation as finally set at completion of commissioning on pump curves.
 - .2 Pump performance curves (family of curves) to be provided with report.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation of steel piping valves, fittings for low pressure steam and condensate building services piping.
- .2 Sustainable requirements for construction, verification and operation.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI).
 - .1 ANSI/ASME B16.1-98, Cast Iron Pipe Flanges and Flanged Fittings.
 - .2 ANSI/ASME B16.25-97, Buttwelding Ends.
 - .3 ANSI/ASME B16.3-98, Malleable Iron Threaded Fittings.
 - .4 ANSI/ASME B16.5-03, Pipe Flanges and Flanged Fittings.
 - .5 ANSI/ASME B16.9-01, Factory-Made Wrought Steel Buttwelding Fittings.
 - .6 ANSI B18.2.1-03, Square and Hex Bolts and Screws (Inch Series).
 - .7 ANSI/ASME B18.2.2-87(R1999), Square and Hex Nuts (Inch Series).
- .2 American Water Works Association (AWWA).
 - .1 AWWA C111-2000, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .3 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A47/A47M-99, Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M-02, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
 - .3 ASTM A126-95(2001), Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
- .4 Canadian Standards Association (CSA International).
 - .1 CSA W48-01, Filler Metals and Allied Materials for Metal Arc Welding (Developed in cooperation with the Canadian Welding Bureau).
- .5 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.
 - .1 MSS-SP-70-98, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .2 MSS-SP-71-97, Gray Iron Swing Check Valves, Flanged and Threaded Ends.
 - .3 MSS-SP-80-97, Bronze Gate, Globe, Angle and Check Valves.
 - .4 MSS-SP-85-94, Gray Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit product data and include manufacturer's literature data sheets for following: valves.

- .3 Submit shop drawings.
- .4 Submit operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals and include following:
 - .1 Special servicing requirements.

1.4 HEALTH AND SAFETY

- .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

Part 2 Products

2.1 PIPE

- .1 Steel pipe: to ASTM A53/A53M, Grade B, to be Schedule 80, refer to 23 05 05.

2.2 PIPE JOINTS

- .1 NPS 2 and under: screwed fittings with PTFE tape or lead-free dope.
- .2 NPS 2-1/2 and over: welding fittings and flanges to CSA W48.
- .3 Flanges: plain or raised face. Flange gaskets to AWWA C111.
- .4 Pipe thread: taper.
- .5 Bolts and nuts: carbon steel, to ANSI/ASME B18.2.1 and ANSI/ASME B18.2.2.
- .6 Butt welding ends: to ANSI/ASME B16.25 as indicated.

2.3 FITTINGS

- .1 Pipe flanges: cast-iron to ANSI/ASME B16.1, Class 250.
- .2 Screwed fittings: malleable iron to ANSI/ASME B16.3, Class 300.
- .3 Steel pipe gaskets, flanges and flanged fittings: to ANSI/ASME B16.5.
- .4 Buttwelding fittings: steel to ANSI/ASME B16.9.
- .5 Unions: malleable iron, to ASTM A47/A47M and ANSI/ASME B16.3.

2.4 VALVES

- .1 Connections:
 - .1 NPS 2 and smaller: screwed ends.
 - .2 NPS 2 1/2 and larger:
 - .1 Equipment: Flanged ends.
 - .2 Elsewhere: Flanged ends.

- .2 Gate valves: Application: Steam service, for isolating equipment, control valves, pipelines.
 - .1 NPS 2 and under:
 - .1 Mechanical Rooms: Class 300, rising stem, split wedge disc, as specified Section 23 05 22- Valves-Bronze.
 - .2 Elsewhere: Class 300, non-rising stem, solid wedge disc, as specified Section 23 05 22- Valves-Bronze.
 - .2 NPS 2 1/2 -8:
 - .1 Mechanical Rooms: Class 300, rising stem, split wedge disc, cast iron, lead- free bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.
 - .1 Operators.
 - .2 Elsewhere: Class 300, Non-rising stem, solid wedge disc, cast iron with lead- free bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.
 - .1 Operators.
- .3 Globe valves: Application: Steam service, throttling, flow control, emergency bypass.
 - .1 NPS 2 and under:
 - .1 Mechanical Rooms: with PTFE disc as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 Elsewhere: with composition disc as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS 2 1/2 and over:
 - .1 With composition lead-free bronze disc, cast iron with bronze trim, to Section 23 05 23.02 - Valves - Cast Iron.
 - .1 Operators.
- .4 Gate valves: Application: Pumped and gravity condensate return service, steam drip point assemblies.
 - .1 NPS 2 and under:
 - .1 Mechanical Rooms: Class 300, rising stem, split wedge disc, as specified Section 23 05 23.01 - Valves-Bronze.
 - .2 Elsewhere: Class 300, non-rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS 2 1/2 and over:
 - .1 Mechanical Rooms: Class 300, rising stem, split wedge disc, cast iron, lead-free bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.
 - .1 Operators.
 - .2 Elsewhere: Class 300, non-rising stem, solid wedge disc, cast iron with lead-free bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.
- .5 Drain valves: Gate, Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.
- .6 Bypass valves around large size gate and globe valves: as specified Section 23 05 23.03 - Valves - Cast Steel.

- .7 Lift check valves:
 - .1 NPS 2 and under: Class 300, lift, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS 2 1/2 and over: as specified Section 23 05 23.02 - Valves - Cast Iron.

2.5 VALVE OPERATORS

- .1 Handwheel: on valves except as specified.
- .2 Handwheel with chain operators: on valves installed more than 2400 mm above floor in Boiler Rooms and Mechanical Equipment Rooms.

Part 3 Execution

3.1 PIPING

- .1 Install pipework in accordance with Section 23 05 05 - Installation of Pipework, supplemented as specified herein.
- .2 Connect branch lines into top of mains.
- .3 Install piping in direction of flow with slopes as follows, unless otherwise indicated:
 - .1 Steam: 1:240.
 - .2 Condensate return: 1:70.
- .4 Make provision for thermal expansion as indicated.
- .5 Drip pocket: line size.

3.2 VALVES

- .1 Install globe valves around, NPS 8 and over, gate valves.

3.3 TESTING

- .1 Test system in accordance with Section 23 08 01.

3.4 CLEANING, FLUSHING, START-UP

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

3.5 PERFORMANCE VERIFICATION (PV)

- .1 General:
 - .1 In accordance with Section 23 08 01 - Performance Verification of Mechanical Piping supplemented as specified herein.
- .2 Timing, only after:
 - .1 Pressure tests successfully completed.
 - .2 Flushing as specified has been completed.
 - .3 Water treatment system has been commissioned.

- .3 PV Procedures:
 - .1 Verify complete drainage of condensate from steam coils.
 - .2 Verify proper operation of system components, including, but not limited to:
 - .1 Steam traps - verify no blow-by.
 - .2 Thermostatic vents.
 - .3 Monitor operation of provisions for controlled pipe movement including expansion joints, loops, guides, anchors.
 - .1 If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation of steel piping valves, fittings for steam and condensate building services piping.
- .2 Sustainable requirements for construction, verification and operation.

1.2 REFERENCES

- .1 American Society for Mechanical Engineers (ASME International).
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A126-95(2001), Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
 - .2 ASTM A167-99, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
 - .3 ASTM A216/A216M-2003, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding for High-Temperature Service.
 - .4 ASTM A240/A240M-04, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - .5 ASTM A276-03, Standard Specification for Stainless Steel Bars and Shapes.
 - .6 ASTM A278/A278M-01, Standard Specification for Gray Iron Castings for Pressure - Containing Parts for Temperatures up to 650 Degrees F (350 deg.C).
 - .7 ASTM A351/A351M-03, Standard Specification for Steel Castings, Austenitic, Austenitic- Ferritic (Duplex) for Pressure-Containing Parts.
 - .8 ASTM A564/A564M-02a, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
 - .9 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit shop drawings and product data and include manufacturer's literature indicating Canadian Registration Number (CRN): Steam traps, vacuum breakers, pressure reducing valves, air vents and safety relief valves.
- .3 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals and include following:
 - .1 Special servicing requirements.

1.4 HEALTH AND SAFETY

- .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 QUALITY ASSURANCE

- .1 Low pressure steam is steam at 103 kPa or less.
- .2 Comply with Provincial regulations.
- .3 Equipment to have CSA approval.

Part 2 Products

2.1 MATERIALS

- .1 Cast steel: to ASTM A216/A216M.
- .2 Cast iron: to ASTM A278, Class 300.
- .3 Bronze: to ASTM B62.
- .4 Stainless steel: to ASTM A351/A351M.

2.2 FLOAT AND THERMOSTATIC STEAM TRAPS 0-110 KPA

- .1 Application: for modulating steam service on convertors as indicated.
- .2 Materials: body - cast-steel; valve - stainless steel with stainless steel seat; float and mechanisms - stainless steel; air vent - stainless steel thermostatic type.
- .3 Capacity: as indicated.

2.3 FLOAT AND THERMOSTATIC STEAM TRAPS 111-1000 KPA

- .1 Application: for modulating steam service on convertors as indicated.
- .2 Materials: body - cast-steel; valve - stainless steel with stainless steel seat; air vent - stainless steel thermostatic type.
- .3 Capacity: as indicated.

2.4 INVERTED BUCKET STEAM TRAP 0-1000 KPA

- .1 Not permitted.

2.5 VACUUM BREAKERS 0.85-68 KPA

- .1 Application: on inlets to heat exchangers as indicated.
- .2 Materials: body and cap - lead-free stainless steel; spring - stainless steel; stem and seat - lead-free stainless steel.
- .3 Capacity: as indicated.

2.6 SAFETY AND RELIEF VALVES

- .1 Spring loaded type of bronze with high capacity and full nozzle and to ASME code.
- .2 Material: body - forged copper alloy; valve - housing lead-free cast bronze; spring - steel, cadmium plated; lead-free bronze/brass trim.

2.7 DRIP PAN ELBOWS

- .1 Application: on discharge of steam safety relief valves as indicated.
- .2 Cast iron or steel with screwed or flanged inlet and threaded drain connections.

2.8 PIPE LINE STRAINERS UP TO NPS 2

- .1 Application: ahead of condensate pumps, steam traps, control valves and elsewhere as indicated.
- .2 Working pressure: 860 kPa.
- .3 Body: lead-free bronze.
- .4 Connections: screwed.
- .5 Screen: stainless steel with 0.8 mm perforations.

2.9 PIPE LINE STRAINERS NPS 2-1/2 AND OVER

- .1 Application: ahead of condensate pumps, steam traps, control valves as indicated.
- .2 Working pressure: 860 kPa.
- .3 Body: cast iron.
- .4 Connections: flanged.
- .5 Blowdown connection: NPS 1-1/4 complete with gate valve and cap.
- .6 Screen: stainless steel with 3.2 mm perforations.

Part 3 Execution

3.1 GENERAL

- .1 Install in accordance with manufacturers' recommendations.
- .2 Maintain proper clearance around equipment to permit maintenance.

3.2 STRAINERS

- .1 Install as indicated.
- .2 Ensure clearance for removal of basket.
- .3 Install valved blow-down as indicated.

3.3 SAFETY RELIEF VALVE

- .1 Pipe to atmosphere independent of other vents and in accordance with applicable Code.
- .2 Support discharge pipe against reaction forces and to take up thermal movement.
- .3 Drain pipe from drip pan elbow to terminate over floor drain.

3.4 STEAM TRAPS

- .1 Install unions on inlet and outlet.
- .2 Install float and thermostatic steam traps to drain condensate from convertors, flash tanks, steam jacketed equipment and direct steam injected equipment.
- .3 Install inverted bucket steam traps to drain condensate from steam main headers and branch lines.
- .4 Size steam traps to handle a minimum of two times the maximum condensate load of the apparatus served.
- .5 Traps used for dripping steam mains and branches shall be minimum 20 mm size.

3.5 LOW PRESSURE TRAP ASSEMBLIES

- .1 Install trap with union or flanged connection at both ends.
- .2 Provide gate valve and strainer at inlet, gate valve and check valve at discharge.
- .3 Provide minimum 250 mm long dirt pocket of same pipe size as apparatus return connection.
- .4 Do not use thermostatic elements in traps until system has been operated and dirt pockets cleared of sediment and scale. Provide temporary covers for use prior to this time.

3.6 PERFORMANCE VERIFICATION

- .1 In accordance with Section 23 08 01 - Performance Verification of Mechanical Piping Systems.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation for copper tubing and fittings for refrigerant.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.22-01, Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings.
 - .2 ASME B16.24-02, Cast Copper Pipe Flanges and Flanged Fittings: Class 150, 300, 400, 600, 900, 1500 and 2500.
 - .3 ASME B16.26-88, Cast Copper Alloy Fittings for Flared Copper Tubes.
 - .4 ASME B31.5-01, Refrigeration Piping and Heat Transfer Components.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A307-04, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .2 ASTM B280-03, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- .3 Canadian Standards Association (CSA International)
 - .1 CSA B52-99, Mechanical Refrigeration Code.
- .4 Environment Canada (EC)
 - .1 EPS 1/RA/1-96, Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.
- .5 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet for piping, fittings and equipment.
 - .2 Submit WHMIS MSDS in accordance with Section 02 81 01 - Hazardous Materials. Indicate VOC's for adhesive and solvents during application and curing.
- .3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

- .5 Instructions: submit manufacturer's installation instructions.
- .6 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

- .1 Comply with Provincial Regulations and Mechanical Refrigeration Codes.
- .2 Pre-Installation Meeting:
 - .1 Convene pre-installation meeting one week prior to beginning work of this Section and on-site installations in accordance with Section 01 32 16 - Construction Progress Schedules - Bar (GANTT) Charts.
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.
 - .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 START-UP AND TESTING

- .1 Supply initial charge of refrigerant and oil for each refrigeration system. Losses of oil or refrigerant prior to acceptance of equipment or due to defects covered under guarantee shall be replaced. Supply to the Owner, one complete charge of lubricating oil in addition to that placed in the system.
- .2 Charge the system with refrigerant and test entire system for leaks after completion of installation. Repair leaks, put system into operation, and test equipment performance.
- .3 Shut-down system if initial start-up testing takes place in winter and machines are to remain inoperative. Repeat start-up and testing operation at beginning of first cooling season.
- .4 Provide cooling season start-up, winter season shut-down for first year of operation.

Part 2 Products

2.1 TUBING

- .1 Processed for refrigeration installations, deoxidized, dehydrated and sealed.
 - .1 Hard copper: to ASTM B280, type ACR.
 - .2 Annealed copper: to ASTM B280, with minimum wall thickness as per CSA B52 and ASME B31.5.

2.2 FITTINGS

- .1 Service: design pressure 2070 kPa and temperature 121 degrees C.
- .2 Brazed:
 - .1 Fittings: wrought copper to ASME B16.22.
 - .2 Joints: silver solder or copper-phosphorous, 95% Cu-5%P and non-corrosive flux.
- .3 Flanged:
 - .1 Bronze or brass, to ASME B16.24, Class 150 and Class 300.
 - .2 Gaskets: suitable for service.
 - .3 Bolts, nuts and washers: to ASTM A307, heavy series.
- .4 Flared:
 - .1 Bronze or brass, for refrigeration, to ASME B16.26.

2.3 PIPE SLEEVES

- .1 Hard copper or steel, sized to provide 6 mm clearance around between sleeve and uninsulated pipe or between sleeve and insulation.

2.4 VALVES

- .1 22 mm and under: Class 500, 3.5 Mpa, globe or angle non-directional type, diaphragm, packless type, with forged brass body and bonnet, moisture proof seal for below freezing applications, brazed connections.
- .2 Over 22 mm: Class 375, 2.5 Mpa, globe or angle type, diaphragm, packless type, back-seating, cap seal, with cast bronze body and bonnet, moisture proof seal for below freezing applications, brazed connections.

2.5 LIQUID INDICATORS

- .1 Liquid indicators shall be double port type with copper or brass body, and flared or solder ends.
- .2 Provide removable seal caps on each port to inspect refrigerant condition.

2.6 STRAINERS

- .1 Refrigerant strainers shall be angle replaceable cartridge type with brass shell.
- .2 Cartridge material and screen size shall be suitable for refrigerant and pipe material utilized in the system.

2.7 FILTER DRIERS

- .1 Combination filter driers shall be angle type, with brass shell and incorporate a combined straining and drying material.

- .2 Desiccant material shall be replaceable.

2.8 SOLENOID VALVES

- .1 Solenoid valves shall have copper or brass body with flared or screwed ends.
- .2 Coil assembly shall be replaceable.
- .3 Valves shall incorporate a manually operated stem to serve as a bypass in case of coil failure.

2.9 EXPANSION VALVES

- .1 Provide angle type or straight through expansion valves suitable for the refrigerant utilized in the system.
- .2 Valves shall have brass body, internal or external equalizer, adjustable super-heat setting and be complete with capillary tube and remote sensing bulb.

2.10 CHARGING VALVES

- .1 Provide general purpose type refrigerant charging valves with brass body, flared or solder ends and with removable valve core.
- .2 Provide valve inlet with quick coupling connection for ease of charging.

2.11 FLEXIBLE CONNECTORS

- .1 Flexible connectors shall consist of close pitch corrugated bronze hose with single layer of exterior braiding to provide additional strength and prevent elongation of corrugated section.
- .2 Connectors shall be minimum 9" long and provided with bronze fittings to facilitate connection to equipment.

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 GENERAL

- .1 Install in accordance with CSA B52, EPS1/RA/1 and ASME B31.5, Section 23 05 01 - Installation of Pipework.

3.3 BRAZING PROCEDURES

- .1 Bleed inert gas into pipe during brazing.
- .2 Remove valve internal parts, solenoid valve coils, sight glass.
- .3 Do not apply heat near expansion valve and bulb.

3.4 PIPING INSTALLATION

- .1 General:
 - .1 Soft annealed copper tubing: bend without crimping or constriction. Hard drawn copper tubing: do not bend. Minimize use of fittings.
- .2 Hot gas lines:
 - .1 Pitch at least 1:240 down in direction of flow to prevent oil return to compressor during operation.
 - .2 Provide trap at base of risers greater than 2400 mm high and at each 7600 mm thereafter.
 - .3 Provide inverted deep trap at top of risers.
 - .4 Provide double risers for compressors having capacity modulation.
 - .1 Large riser: install traps as specified.
 - .2 Small riser: size for 5.1 m/s at minimum load. Connect upstream of traps on large riser.

3.5 PRESSURE AND LEAK TESTING

- .1 Close valves on factory charged equipment and other equipment not designed for test pressures.
- .2 Leak test to CSA B52 before evacuation to 2MPa and 1MPa on high and low sides respectively.
- .3 Test Procedure: build pressure up to 35 kPa with refrigerant gas on high and low sides. Supplement with nitrogen to required test pressure. Test for leaks with electronic or halide detector. Repair leaks and repeat tests.

3.6 DX EQUIPMENT START-UP AND TESTING

- .1 Refrigeration equipment: Prepare system for start-up by having manufacturer's factory trained representative supervise testing, dehydration and charging of machine. Do start-up including co-ordination on start-up of condensers.
- .2 Testing:
 - .1 Provide sufficient refrigerant, dry nitrogen and refrigeration oil for pressure and operational testing under manufacturer's supervision.
 - .2 Prior to testing ensure that system is complete. Protect relief valves during test procedure. After completion of test, reconnect and make good piping connections and leak test entire system.

3.7 AIR COOLED CONDENSING UNIT

- .1 Check unit for damage before and after placement:
 - .1 Protect and cover exposed units to the elements during construction.
 - .2 Conform to installation drawings. Mount units on roof mounting frame.

3.8 LIQUID INDICATORS

- .1 Provide full size liquid indicators in main liquid line leaving condenser. If receiver is used install in liquid line leaving receiver.

3.9 STRAINERS

- .1 Provide full size strainer ahead of each automatic valve. Where multiple expansion valves with integral strainers are used, install single main liquid line strainer.
- .2 On steel piping systems provide adequate strainer in suction line to remove scale and rust inherent in steel pipe.
- .3 Provide shut-off valve on each side of strainer to facilitate maintenance.

3.10 FILTER-DRIERS

- .1 Filter-driers may be used in systems instead of separate strainers and driers.
- .2 Install with three valve bypass assembly to permit isolation for servicing.

3.11 SOLENOID VALVES

- .1 Provide solenoid valves in liquid line of systems operating with single pump-out or pump-down compressor control, in liquid line of single or multiple evaporator systems and in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into the suction line when system shuts down.
- .2 Provide solenoid valves with manually operated stems.

3.12 EXPANSION VALVES

- .1 Size expansion valves properly to avoid penalty of being undersized at full load and of being excessively oversized at partial load.
- .2 Properly evaluate refrigerant pressure drop through system to determine the available pressure drop across the valve.
- .3 Select valves for maximum load at design operating pressure and minimum 7.2 deg.C. of superheat.
- .4 Locate remote expansion valve sensing bulb immediately after evaporator outlet on suction line.

3.13 CHARGING VALVES

- .1 Provide refrigerant charging connections in liquid line between receiver shut-off valve and expansion valve.

3.14 FLEXIBLE CONNECTORS

- .1 In general install suction and hot gas piping connections to compressors with three directional changes for distance of minimum six pipe diameters before reaching point of support.
- .2 Flexible connectors shall only be utilized at or near compressors where it is not physically possible to absorb vibration within piping configuration.

3.15 FIELD QUALITY CONTROL

- .1 Site Tests/Inspection:
 - .1 Close service valves on factory charged equipment.
- .2 Ambient temperatures to be at least 13 degrees C for at least 12 hours before and during dehydration.
- .3 Use copper lines of largest practical size to reduce evacuation time.
- .4 Use two-stage vacuum pump with gas ballast on 2nd stage capable of pulling 5Pa absolute and filled with dehydrated oil.
- .5 Measure system pressure with vacuum gauge. Take readings with valve between vacuum pump and system closed.
- .6 Triple evacuate system components containing gases other than correct refrigerant or having lost holding charge as follows:
 - .1 Twice to 14 Pa absolute and hold for 4 h.
 - .2 Break vacuum with refrigerant to 14 kPa.
 - .3 Final to 5 Pa absolute and hold for at least 12 h.
 - .4 Isolate pump from system, record vacuum and time readings until stabilization of vacuum.
 - .5 Submit test results to Departmental Representative.
- .7 Charging:
 - .1 Charge system through filter-drier and charging valve on high side. Low side charging not permitted.
 - .2 With compressors off, charge only amount necessary for proper operation of system. If system pressures equalize before system is fully charged, close charging valve and start up. With unit operating, add remainder of charge to system.
 - .3 Re-purge charging line if refrigerant container is changed during charging process.

- .8 Checks:
 - .1 Make checks and measurements as per manufacturer's operation and maintenance instructions.
 - .2 Record and report measurements Departmental Representative.

- .9 Manufacturer's Field Services:
 - .1 Have manufacturer of products, supplied under this Section, review Work involved in the handling, installation/application, protection and cleaning, of its products and submit written reports, in acceptable format, to verify compliance of Work with Contract.
 - .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, at stages listed:
 - .1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.
 - .2 Twice during progress of Work at 25% and 60% complete.
 - .3 Upon completion of the Work, after cleaning is carried out.
 - .4 Obtain reports, within 3 days of review, and submit, immediately, to .

END OF SECTION

1 General

1.1 SECTION INCLUDES

- .1 Metal duct work.
- .2 Nonmetal duct work.
- .3 Casing and plenums.
- .4 Buried duct work.
- .5 Kitchen hood duct work.
- .6 Duct cleaning.

1.2 REFERENCES

- .1 ASTM A36/A36M - Carbon Structural Steel.
- .2 ASTM A90/A90M - Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
- .3 ASTM A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
- .4 ASTM A480/A480M - General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
- .5 ASTM A568/A568M - General Requirements for Steel Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled.
- .6 ASTM A653/A653M - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .7 ASTM A1008/A1008M - Steel, Sheet, Cold-Rolled Carbon, Structural, High-Strength Low-Alloy and High Strength Low-Alloy with Improved Formability.
- .8 ASTM A1011/A1011M - Standard Specification for Steel, Sheet, and Strip Hot-Rolled, Carbon, Structural, High-Strength, Low-Alloy with Improved Formability.
- .9 ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
- .10 ASTM C14/C14M - Concrete Sewer, Storm Drain, and Culvert Pipe.
- .11 ASTM C443 - Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
- .12 AWS D9.1 - Sheet Metal Welding Code.
- .13 NBS PS 15 - Voluntary Product Standard for Custom Contact-Moulded Reinforced-Polyester Chemical Resistant Process Equipment.
- .14 NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- .15 NFPA 90B - Installation of Warm Air Heating and Air-Conditioning Systems.
- .16 NFPA 91 - Exhaust Systems for Air Conveying of Vapours, Gases, Mists, and Noncombustible Particulate Solids.
- .17 NFPA 96 - Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .18 SMACNA - HVAC Air Duct Leakage Test Manual.
- .19 SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- .20 SMACNA - Fibrous Glass Duct Construction Standards.
- .21 UL 181 - Factory-Made Air Ducts and Connectors.

1.3 DEFINITIONS

- .1 Low pressure/low velocity: static pressure in duct less than 498 Pa (2" w.g.) and velocities less than 10 meters/second (2000 fpm).
- .2 Medium pressure/high velocity: Static pressure in duct less than 996 Pa (4" w.g.) and velocities between 10 meters/second (2000 fpm) and 20 meters/second (4000 fpm).

- .3 High pressure/high velocity: Static pressure in ducts more than 996 Pa (4" w.g.) And velocities greater than 4000 fpm.
- .4 Duct sizes: as shown on drawings are outside dimensions. For acoustically lined or internally insulated ducts, sizes shown are actual duct sizes and the insulation thickness has been accounted for.

1.4 PERFORMANCE REQUIREMENTS

- .1 No variation of duct configuration or sizes permitted except by written permission. Size round ducts installed in place of rectangular ducts to ASHRAE table of equivalent rectangular and round ducts.

1.5 SUBMITTALS

- .1 Section 01 33 00: Procedures for submittals.
- .2 Shop Drawings: Indicate duct fittings, particulars such as gauges, sizes, welds, and configuration prior to start of work for 1000 kPa pressure class and higher systems.
- .3 Product Data: Provide data for duct materials.
- .4 Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.

1.6 QUALITY ASSURANCE

- .1 Perform Work to SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- .2 Ductwork shall meet the requirements of NFPA 90A, Air Conditioning and Ventilating Systems, and NFPA No. 96, Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapours from Commercial Cooking Equipment

1.7 QUALIFICATIONS

- .1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- .2 Installer: Company specializing in performing the work of this section with minimum 3 years documented experience.

1.8 ENVIRONMENTAL REQUIREMENTS

- .1 Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- .2 Maintain temperatures during and after installation of duct sealants.

2 Products

2.1 DUCT MATERIALS

- .1 Galvanized Steel Ducts: ASTM A653 galvanized steel sheet, lock-forming quality, having G60 zinc coating to ASTM A90 on both sides.
- .2 Steel Ducts: ASTM A1008.
- .3 Aluminum Ducts: ASTM B209; aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061- T6 or of equivalent strength.
- .4 Stainless Steel Ducts: ASTM A167, Type 304.
- .5 Concrete Ducts: ASTM C14; hub and spigot concrete sewer pipe with ASTM C443 joints, rubber gaskets.
- .6 Fasteners: use rivets and bolts throughout; sheet metal screws accepted on low pressure ducts.

2.2 SEALANT

- .1 Oil resistant, water based or solvent based, anti-microbial, anti-bacterial, ultra violet resistant, polymer type, flame resistant duct sealant.
- .2 VOC content to be less than VOC limits of the State of California's South Coast Air Quality District Rule #1168. VOC content less than 30 g/L (less water and less exempt compounds) for sealing metal to metal contact.
- .3 Sealant shall be cured for a minimum of 48 hours.
- .4 Flame Spread Rating: 0 (zero).
- .5 Smoke Spread Rating: 0 (zero).

2.3 TAPE

- .1 Polyvinyl treated, open weave fibre glass, 50 mm wide.

2.4 SEAL CLASSIFICATION

- .1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
up to 500	B
Over 500	A
- .2 Seal classification:
 - .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.
 - .2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant.

- .3 Class C: transverse joints and connections made air tight with gaskets. Longitudinal seams unsealed.
- .4 Unsealed seams and joints.

2.5 DUCT WORK FABRICATION

- .1 Fabricate and support to SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
- .2 Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centreline. Where not possible and where rectangular elbows are used, provide air foil turning vanes.
- .3 Complete metal ducts within themselves with no single partition between ducts. Where width of duct exceeds 450 mm, cross break for rigidity. Open corners are not acceptable.
- .4 Lap metal ducts in direction of air flow. Hammer down edges and slips to leave smooth duct interior.
- .5 Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- .6 Fabricate continuously welded round and oval duct fittings two gauges heavier than duct gauges indicated in SMACNA Standard. Joints: minimum 100 mm cemented slip joint, brazed or electric welded. Prime coat welded joints.
- .7 Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.
- .8 Rigidly construct metal ducts with joints mechanically tight, substantially airtight, braced and stiffened so as not to breath, rattle, vibrate or sag. Caulk duct joints and connections with sealant as ducts are being assembled.
- .9 Provide easements where low pressure ductwork conflicts with piping and structure where easements exceed 10% duct area, split into two ducts maintaining original duct area.
- .10 Exposed ductwork to be fabricated from Aluminum for aesthetics.

2.6 FITTINGS

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows.
 - .1 Rectangular: standard radius with single thickness turning vanes. Centreline radius: 1.5 times width of duct.
 - .2 Round: smooth radius. Centreline radius: 1.5 times diameter.
- .3 Mitred elbows, rectangular:
 - .1 To 400 mm: with single thickness Airfoil turning vanes.
 - .2 Over 400 mm: with double thickness Airfoil turning vanes.

- .4 Branches:
 - .1 Rectangular main and branch: with radius on branch 1.5 times width of duct.
 - .2 Round main and branch: enter main duct at 45 degrees with conical connection.
 - .3 Provide volume control damper in branch duct near connection to main duct.
 - .4 Main duct branches: with splitter damper.
- .5 Transitions:
 - .1 Diverging: 15 degrees maximum included angle when increasing duct sizes.
 - .2 Converging: 45 degrees maximum included angle downstream of equipment.
 - .3 Diverging: 30 degrees maximum included angle upstream of equipment.
- .6 Offsets:
 - .1 Full radiused elbows, as indicated.
- .7 Obstruction deflectors: maintain full cross-sectional area.
 - .1 Maximum included angles: as for transitions.

2.7 MANUFACTURED DUCT WORK AND FITTINGS

- .1 Manufacture to SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
- .2 Flat Oval Ducts:
 - .1 Machine made from round spiral lockseam duct with light reinforcing corrugations; fittings manufactured of at least two gauges heavier metal than duct.
- .3 Double Wall Insulated Flat Oval Ducts:
 - .1 Machine made from round spiral lockseam duct with light reinforcing corrugations, galvanized steel outer wall, 25 mm thick fibreglass insulation, perforated galvanized steel inner wall; fittings manufactured with solid inner wall.
- .4 PVC Coated Steel Ducts:
 - .1 UL 181, Class 1, galvanized steel duct coated with polyvinyl chloride plastic, 0.1 mm thick on outside and 0.05 mm thick on inside.
- .5 Transverse Duct Connection System:
 - .1 SMACNA "E" rated rigidly class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips.

2.8 CASINGS

- .1 Fabricate casings to SMACNA HVAC Duct Construction Standards - Metal and Flexible and construct for operating pressures indicated.
- .2 Mount floor mounted casings on 100 mm high concrete curbs. At floor, rivet panels on 200 mm centres to angles. Where floors are acoustically insulated, provide liner of 1.20 mm galvanized expanded metal mesh supported at 300 mm centres, turned up 300 mm at sides with sheet metal shields.

- .3 Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection. Provide clear wire glass observation ports, minimum 150 X 150 mm size.
- .4 Fabricate acoustic casings with reinforcing turned inward. Provide 1.50 mm back facing and 0.80 mm perforated front facing with 2.4 mm diameter holes on 4 mm centres. Construct panels 75 mm thick packed with 72 kg/cu m minimum glass fibre media, on inverted channels of 1.50 mm.

2.9 FIRESTOPPING

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

3 Execution

3.1 GENERAL REQUIREMENTS

- .1 Do work in accordance with SMACNA.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods.
 - .1 Ensure diffuser is fully seated.
- .3 Support risers in accordance with SMACNA.
- .4 Install breakaway joints in ductwork on sides of fire separation.
- .5 Install proprietary manufactured flanged duct joints and manufactured equipment in accordance with manufacturer's instructions.
- .6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.
- .7 At each point where ducts pass through partitions, the joints around the duct shall be sealed with non-combustible material.

3.2 INSTALLATION

- .1 Install and seal ducts to SMACNA HVAC Duct Construction Standards - Metal and Flexible according to seal classification specified.
- .2 Provide openings in duct work where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated duct work, install insulation material inside a metal ring.
- .3 Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- .4 Use double nuts and lock washers on threaded rod supports.

- .5 Provide access doors for inspection.
- .6 Tape joints of PVC coated metal duct work with PVC tape.
- .7 Connect terminal units to supply ducts directly or with 300 mm maximum length of flexible duct. Do not use flexible duct to change direction.
- .8 Connect diffusers to low pressure ducts directly. To decouple diffuser from duct system, use 1.5 m maximum length of flexible duct held in place with caulking compound and strap or clamp. Do not use flexible duct to change direction.
- .9 Connect flexible ducts to metal ducts with adhesive and strap or clamp.
- .10 Set plenum doors 150 to 300 mm above floor. Arrange door swings so that fan static pressure holds door in closed position.
- .11 During construction provide temporary closures of metal or taped polyethylene on open duct work to prevent construction dust from entering duct work system.
- .12 Provide floor drains in fresh air coil, and humidifier sections with deep seal traps.

3.3 CLEANING

- .1 Clean work to requirements of Division 1 and as detailed herein.
- .2 Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.
- .3 Provide adequate access into duct work for cleaning purposes.
- .4 Prior to occupancy and during initial occupancy, building shall be flushed at maximum outdoor air volume. Supply a total of 4,300 cu.m of outdoor air per sq.m of floor area or approximately 30,564,400cu.m of outdoor air or approximately 54 days of flushing. Note that a minimum of 3 weeks of flushing will be required prior to occupancy.

3.4 WATER TIGHT DUCTS

- .1 Provide watertight duct for:
 - .1 Fresh air intake.
 - .2 As indicated.
- .2 Form bottom of horizontal duct without longitudinal seams.
 - .1 Solder or weld joints of bottom and side sheets.
 - .2 Seal other joints with duct sealer.
- .3 Slope horizontal branch ductwork down towards hoods served.
 - .1 Slope header ducts down toward risers.
- .4 Fit base of riser with 150 mm deep drain sump and 32 mm drain connected, with deep seal trap and discharging to open funnel drain.

3.5 LEAKAGE TESTS

- .1 Refer to Section 23 05 94.
- .2 In accordance with SMACNA HVAC Duct Leakage Test Manual.
- .3 Do leakage tests in sections.
- .4 Make trial leakage tests as instructed to demonstrate workmanship.
- .5 Do not install additional ductwork until trial test has been passed.
- .6 Test section minimum of 30 m long with not less than three branch takeoffs and two 90 degrees elbows.
- .7 Complete tests before performance insulation or concealment Work.

3.6 SEALANT APPLICATION

- .1 Contractor shall apply sealant on exposed ductwork in a 50mm band centered on joint.
- .2 Sealant shall be applied evenly with a clean edge finish perpendicular to duct and plumb.
- .3 Tape shall be utilized to provide clean edge finish to sealant application.

3.7 SOUND ATTENUATING TRANSFER DUCTS

- .1 Sound attenuating transfer air ducts shall be installed where indicated on drawings complete with internal acoustic insulation in accordance with Section 23 07 13.
- .2 Elbows on sound attenuating transfer air ducts shall not utilize turning vanes.
- .3 Geometry of all sound attenuating transfer air ducts shall ensure that sound contacts a minimum of two duct surfaces.
- .4 Provide single elbow configurations or double elbow configurations as indicated on drawings. It is permissible to utilize double elbow configurations in lieu of single elbow but not vice versa.

END OF SECTION

1 General

1.1 SECTION INCLUDES

- .1 Air turning devices/extractors.
- .2 Backdraft dampers.
- .3 Combination fire and smoke dampers.
- .4 Duct access doors.
- .5 Duct test holes.
- .6 Fire dampers.
- .7 Flexible duct connections.
- .8 Volume control dampers.

1.2 REFERENCES

- .1 NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- .2 NFPA 92A - Smoke-Control Systems.
- .3 SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- .4 UL 33 - Heat Responsive Links for Fire-Protection Service.
- .5 UL 555 - Fire Dampers.
- .6 UL 555S - Smoke Dampers.

1.3 SUBMITTALS

- .1 Section 01 33 00: Procedures for submittals.
- .2 Shop Drawings: Provide for shop fabricated assemblies including volume control dampers.
- .3 Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.
- .4 Manufacturer's Installation Instructions: Indicate for dampers including fire and fireés smoke dampers.

1.4 PROJECT RECORD DOCUMENTS

- .1 Section 01 78 00: Submittals for project closeout.
- .2 Record actual locations of access doors.

1.5 QUALITY ASSURANCE

- .1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- .2 Accessories shall meet the requirements of NFPA 90A, Air Conditioning and Ventilating Systems.
- .3 Fabricate in accordance with ASHRAE handbooks and SMACNA duct manuals.

1.6 REGULATORY REQUIREMENTS

- .1 Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories Inc., as suitable for the purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Section 01 61 00: Transport, handle, store, and protect products.
- .2 Protect dampers from damage to operating linkages and blades.

1.8 EXTRA MATERIALS

- .1 Section 01 78 00: Submittals for project closeout.
- .2 Provide two of each size and type of fusible link.

2 Products

2.1 TURNING VANES

- .1 Factory or shop fabricated single thickness or double thickness, to recommendations of SMACNA and as indicated.
- .2 Shall be airfoil type.
- .3 Where acoustical lining is provided, provide turning vanes of perforated metal type with fibre glass inside.

2.2 BACKDRAFT DAMPERS.

- .1 Gravity Backdraft Dampers, Size 450 x 450 mm or Smaller Provided with Air Moving Equipment: Air moving equipment manufacturers standard construction.
- .2 Extruded aluminum 6063T5 backdraft damper frame shall not be less than 1.52 mm in thickness. Frame shall be 63.5 mm deep.
- .3 Blades shall be extruded aluminum (6063T5) profiles and shall be less than 1.52 mm in thickness.
- .4 Blade and side seals shall be extruded silicone. Seals are to be secured in integral slots within the aluminum extrusions.
- .5 Bearing system shall be composed of Celcon bearings rotating on zinc-plated 12.7 mm steel pivot points.
- .6 Linkage system shall consist of hard alloy aluminum (6005T6) crank arms fastened to zinc-plated steel pivot rods and shall be doubly secured within channel running along top of blade. Large diameter 8.73 mm hard alloy aluminum (6065-T6C) linkage rod shall connect the crank arms by means of a zinc-plated steel trunnion.
- .7 Cup point trunnion set screw shall create a compression hard spot where it secures to the linkage rod for a slip-proof grip.
- .8 Trunnions shall be zinc-plated to provide a hard, smooth and long-lasting rotating surface.
 - .1 Performance:
 - .2 Temperature range: -40 deg.C to 100 deg.C.
 - .3 Leakage: 101.2 l/s per square meter at 0.25 kPa.
 - .4 Pressure Drop: less than 24.9 Pa.

- .9 Backdraft dampers shall be made to size required. Minimum section size shall be 152 mm wide x 152 mm high. Maximum section size shall be 914 mm wide by 3658 mm high. Mullion breaks shall be used when damper height exceeds 1220 mm.
- .10 Backdraft dampers with dimensions greater than maximum section size shall be manufactured in multiple sections. Multiple sections are not interlinked or connected. To install, each section must be individually fastened to a structural frame prepared on site.
- .11 Fully adjustable device to permit setting for varying differential static pressures less than 2.49 Pa.

2.3 DUCT ACCESS DOORS

- .1 Fabricate to SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
- .2 Access doors to be ULC labelled.
- .3 Fabrication for un-insulated ducts: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices.
- .4 Fabrication for insulated ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation with sealing gaskets and quick fastening locking devices.
- .5 Gaskets: neoprene.
- .6 Hardware:
 - .1 Less Than 300 mm Square: Secure with sash locks complete with safety chain.
 - .2 Up to 450 mm Square: Provide two hinges and two sash locks.
 - .3 451 to 1000 mm: piano hinge and minimum two sash locks.
 - .4 Doors over 1000 mm: piano hinge and two handles operable from both sides.
 - .5 300 x 300 mm glass viewing panels where indicated.
 - .6 Hold open devices.
- .7 Access doors with sheet metal screw fasteners are not acceptable.

2.4 DUCT TEST HOLES

- .1 Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- .2 Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.5 FLEXIBLE DUCT CONNECTIONS

- .1 Fabricate to SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

- .2 Connector:
 - .1 Fabric: cUL listed fire-retardant self extinguishing neoprene coated woven glass fibre fabric to NFPA 90A, minimum density 1.0 kg/sq m. Approximately 50mm of fabric clenched by means of double locked seams.
 - .2 Frame: 75 mm wide, 0.6 mm thick galvanized sheet metal.
 - .3 Attach edging strip to ducting and equipment by screws or bolts at 150 mm (6") intervals
- .3 Leaded Vinyl Sheet: Minimum 14 mm0.55 inch thick, 4.2 kg/sq m0.87 lbs per sq ft, 10 dB attenuation in 10 to 10,000 Hz range.

2.6 DRYER VENT

- .1 Provide stainless steel side wall commercial dryer vent complete with backdraft damper, wind guard, and rain cap. Vent to be minimum 26 gauge metal.

3 Execution

3.1 INSTALLATION

- .1 Install accessories to manufacturer's written instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 23 31 00 for duct construction and pressure class.
- .2 Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

3.2 ACCESS DOORS

- .1 Provide adequately sized duct access doors for inspection and cleaning.
- .2 Sizes:
 - .1 600 x 600 mm for person size entry.
 - .2 900 x 900 mm for servicing entry.
 - .3 300 x 300 mm for viewing.
 - .4 As indicated.
- .3 Locations (before and after):
 - .1 Fire and smoke dampers (install at fire dampers).
 - .2 Control dampers.
 - .3 Devices requiring maintenance.
 - .4 Required by code.
 - .5 Reheat coils.
 - .6 Filters.
 - .7 To facilitate cleaning of ductwork (minimum
 - .8 Elsewhere as indicated.
- .4 Provide 100 mm x 100 mm (4" x 4") quick opening access doors for inspection at balancing dampers, before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide for cleaning kitchen exhaust duct work to NFPA 96. Provide minimum 200 x 200 mm size for hand access, 450 x 450 mm size for shoulder access, and as indicated. Provide 100 x 100 mm for balancing dampers only. Review locations prior to fabrication.

3.3 TEST PORTS

- .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .2 Provide duct test ports where indicated and required for testing and balancing purposes.
- .3 Install insulation port extensions as required.
- .4 Locations:
 - .1 For traverse readings:
 - .1 Ducted inlets to roof and wall exhausters.
 - .2 Inlets and outlets of other fan systems.
 - .3 Main and sub-main ducts.
 - .4 And as indicated.
 - .2 For temperature readings:
 - .1 At outside air intakes.
 - .2 In mixed air applications in locations as approved by Departmental Representative.
 - .3 At inlet and outlet of coils.
 - .4 Downstream of junctions of two converging air streams of different temperatures.
 - .5 And as indicated.

3.4 FLEXIBLE CONNECTORS

- .1 Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment , and supported by vibration isolators, including but not limited to the following:
 - .1 Inlets and outlets to supply air units and fans.
 - .2 Inlets and outlets of exhaust and return air fans.
 - .3 As indicated.
- .2 Length of connection: 100 mm.
- .3 Minimum distance between metal parts when system in operation: 75 mm.
- .4 Install in accordance with recommendations of SMACNA.
- .5 When fan is running:
 - .1 Ducting on sides of flexible connection to be in alignment.
 - .2 ensure slack material in flexible connection.
- .6 For fans developing static pressures of 1250 Pa and over, cover connections with leaded vinyl sheet, held in place with metal straps.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Balancing dampers for mechanical forced air ventilation and air conditioning systems.
 - .2 Sustainable requirements for construction and verification.

1.2 REFERENCES

- .1 Sheet Metal and Air Conditioning National Association (SMACNA).
 - .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible-1985.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

- .1 Health and Safety Requirements:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

Part 2 Products

2.1 GENERAL

- .1 Manufacture to SMACNA standards.

2.2 MANUAL VOLUME CONTROL DAMPERS.

- .1 Fabricate to SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

- .2 Splitter Dampers:
 - .1 Fabricate from same material as duct but one sheet metal thickness heavier (minimum 16 gauge), with appropriate stiffening to avoid vibration.
 - .2 Blade: Fabricate of double thickness sheet metal to streamline shape, secured with continuous piano hinge.
 - .3 Operator: Minimum 6 mm diameter rod in self aligning, universal joint action, flanged bushing with set screw and position indicator.
 - .4 Rod configuration to prevent end from entering duct.
 - .5 Folded leading edge.
 - .6 Size on basis of straight air volume proportioning.
- .3 Single Blade Dampers:
 - .1 Fabricate for duct sizes up to 150 (in depth) x 760 mm.
 - .2 Fabricate from same material as duct, but one sheet metal thickness heavier (minimum 16 gauge). V-groove stiffened.
 - .3 Size and configuration to recommendations of SMACNA
 - .4 Locking quadrant with shaft extension to accommodate insulation thickness.
 - .5 Inside and outside nylon end bearings.
 - .6 Channel frame of same material as adjacent duct, complete with angle stop.
- .4 Multi-Blade Damper:
 - .1 Factory manufactured of material compatible with duct.
 - .2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.
 - .3 Maximum blade height: 100 mm
 - .4 Bearings: self-lubricating oil impregnated nylon.
 - .5 Linkage: shaft extension with locking quadrant.
 - .6 Channel frame of same material as adjacent duct, complete with angle stop.
- .5 End Bearings: Except in round duct work 300 mm and smaller, provide end bearings.
- .6 Quadrants:
 - .1 Provide locking, indicating quadrant regulators on single and multi-blade dampers.
 - .2 On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
 - .3 Where rod lengths exceed 750 mm provide regulator at both ends.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install where specified, where required for balancing and where indicated on drawings.

- .2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .3 Use splitter dampers only where indicated.
- .4 Provide commercial balancing dampers on all low velocity duct take-offs to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly unless specifically noted otherwise.
- .5 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts. Where indicated on the drawings, a balancing damper is not required for runouts in non-accessible ceiling spaces provided a damper is specified on the register and diffuser.
- .6 Dampers: shall be installed vibration free.
- .7 Ensure damper operators are observable and accessible. Provide access doors in ceilings/ walls where required.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Operating dampers for mechanical forced air ventilation and air conditioning systems.
 - .2 Sustainable requirements for construction and verification.

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A653/A653M-04a, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
- .3 Closeout Submittals
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- .2 Certificates:
 - .1 Catalogue or published ratings those obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency.

Part 2 Products

2.1 MULTI-LEAF DAMPERS

- .1 Opposed airfoil blade type as indicated.
- .2 Extruded aluminum (6063T5) damper frame shall not be less than 2.03 mm thickness. Damper frame to be 100 mm deep.
- .3 Blades to be extruded aluminum (6063T5) profiles. Aluminum end caps are to be press fitted to blade ends, in order to seal hollow interior and reduce air leakage rate.
- .4 Blade and frame seals shall be of extruded silicone. Seals are to be secured in an integral slot within the aluminum extrusions.
- .5 Bearings are to be composed of a Celcon inner bearing fixed to a 11.11 mm aluminum hexagon blade pin, rotating within a polycarbonate outer bearing inserted in the frame, resulting in no metal-to-metal or metal-to-plastic contact.
- .6 Linkage hardware shall be installed in the frame side and constructed of aluminum and corrosion-resistant, zinc-plated steel, complete with cup-point trunnion screws for a slip-proof grip.
- .7 Standard air leakage data to be certified under the AMCA Certified Ratings Program.
- .8 Dampers shall be made to size required without blanking off free area.
- .9 Intermediate or tubular steel structural support is required to resist applied pressure loads for dampers that consist of two or more sections in both height and width.
- .10 Operator: to Division 25.
- .11 Insulated aluminum dampers:
 - .1 Frames: insulated with extruded polystyrene foam with RSI 0.88.
 - .2 Blades: constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, RSI 0.88.
- .12 Performance:
 - .1 Temperature Range: -40 deg.C to 100 deg.C.
 - .2 Leakage: 15.2 l/s per sq.meter at 0.25 kPa, 40.5 l/s per sq.meter at 1.0 kPa. Shall meet Class 1A at 0.25 kPa.
 - .3 Pressure Drop: less than 4 Pa at 5.08 m/s.

2.2 DISC TYPE DAMPERS

- .1 Frame: insulated brake formed, welded, 1.6 mm thick, galvanized steel to ASTM A653/A653M.
- .2 Disc: insulated spin formed, 1.6 mm thick, galvanized steel to ASTM A653/A653M.

- .3 Gasket: extruded neoprene, field replaceable, with 10 year warranty.
- .4 Bearings: roller self lubricated and sealed.
- .5 Operator: compatible with damper, linear stroke operator, spring loaded actuator, zinc-aluminum foundry alloy casting cam follower.
- .6 Performance:
 - .1 Leakage: in closed position less than 0.001 % of rated air flow at .25 kPa pressure differential across damper.
 - .2 Pressure drop: at full open position less than 5 Pa differential across damper at 5.08 m/s.

2.3 BACK DRAFT DAMPERS

- .1 Extruded aluminum 6063T5 backdraft damper frame shall not be less than 1.52 mm in thickness. Frame shall be 63.5 mm deep.
- .2 Blades shall be extruded aluminum (6063T5) profiles and shall be less than 1.52 mm in thickness.
- .3 Blade and side seals shall be extruded silicone. Seals are to be secured in integral slots within the aluminum extrusions.
- .4 Bearing system shall be composed of Celcon bearings rotating on zinc-plated 12.7 mm steel pivot points.
- .5 Linkage system shall consist of hard alloy aluminum (6005T6) crank arms fastened to zinc-plated steel pivot rods and shall be doubly secured within channel running along top of blade. Large diameter 8.73 mm hard alloy aluminum (6065-T6C) linkage rod shall connect the crank arms by means of a zinc-plated steel trunnion.
- .6 Cup point trunnion set screw shall create a compression hard spot where it secures to the linkage rod for a slip-proof grip.
- .7 Trunnions shall be zinc-plated to provide a hard, smooth and long-lasting rotating surface.
- .8 Performance:
 - .1 Temperature range: -40 deg.C to 100 deg.C.
 - .2 Leakage: 101.2 l/s per square meter at 0.25 kPa.
 - .3 Pressure Drop: less than 24.9 Pa.
- .9 Backdraft dampers shall be made to size required. Minimum section size shall be 152 mm wide x 152 mm high. Maximum section size shall be 914 mm wide by 3658 mm high. Mullion breaks shall be used when damper height exceeds 1220 mm.

- .10 Backdraft dampers with dimensions greater than maximum section size shall be manufactured in multiple sections. Multiple sections are not interlinked or connected. To install, each section must be individually fastened to a structural frame prepared on site.
- .11 Fully adjustable device to permit setting for varying differential static pressures less than 2.49 Pa.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- .3 Seal multiple damper modules with silicon sealant.
- .4 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.
- .5 Ensure dampers are observable and accessible.
- .6 Install insulated dampers at interface with outdoors including outdoor air intakes, exhaust ducts, and relief ducts.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Fire and smoke dampers, and fire stop flaps.
 - .2 Sustainable requirements for construction and verification.

1.2 REFERENCES

- .1 American National Standards Institute/National Fire Protection Association (ANSI/NFPA)
 - .1 ANSI/NFPA 90A-2002, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .3 Underwriters Laboratories of Canada (ULC)
 - .1 CAN4-S112-M1990, Fire Test of Fire Damper Assemblies.
 - .2 CAN4-S112.2-M84, Standard Method of Fire Test of Ceiling Firestop Flap Assemblies.
 - .3 ULC-S505-1974, Fusible Links for Fire Protection Service.

1.3 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Indicate the following:
 - .1 Fire dampers.
 - .2 Smoke dampers.
 - .3 Fire stop flaps.
 - .4 Operators.
 - .5 Fusible links.
 - .6 Design details of break-away joints.
- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
- .3 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

- .2 Provide a Fire Damper Schedule identifying the following: damper tag, duct size, location, access door size, location.

1.4 QUALITY ASSURANCE

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- .2 Certificates:
 - .1 Catalogue or published ratings those obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

1.5 MAINTENANCE

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

Part 2 Products

2.1 FIRE DAMPERS

- .1 Fabricate to NFPA 90A and as indicated.
- .2 Fire dampers: arrangement Type A, B and C, listed and bear label of ULC, UL, Warnock Hersey, meet requirements of authorities having jurisdiction. Fire damper assemblies fire tested in accordance with CAN4-S112. Fusible links on fire dampers shall be constructed to ULC Standard S505.
- .3 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 unless otherwise indicated or required.
 - .2 Fire dampers: automatic operating type and have dynamic rating suitable for maximum air velocity and pressure differential to which it will be subjected.
- .4 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area.
- .5 Ceiling Dampers: Galvanized steel, 0.76 mm frame and 1.5 mm flap, two layers 3.2 mm ceramic fibre on top side , and one layer on bottom side for round flaps, with locking clip
- .6 Horizontal Dampers: Galvanized steel, 0.76 mm frame, stainless steel closure spring, and lightweight, heat retardant non-asbestos fabric blanket.
- .7 Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream except for 250 Pa pressure class ducts up to 300 mm in height.

- .8 Multiple Blade Dampers: 1.5 mm galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 3.2 x 12.7 mm plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.
- .9 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.
- .10 Fusible Links: separate at 71 degrees C (161 Deg.F.) with adjustable link straps for combination fire/balancing dampers.
- .11 Fire dampers in low pressure ductwork may be multi-blade, offset butterfly or curtain type.
- .12 Fabricate combination fire and balancing dampers with linkage readily adjustable in open position.
- .13 50 x 50 x 3 mm retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.
- .14 Equip fire dampers with steel sleeve and frame installed disruption ductwork (breakaway ductwork) to ensure damper operation is not impaired. 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.

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 Provide fire dampers at locations indicated, where ducts and outlets pass through fire rated components , and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- .2 Install fire dampers and combination smoke and fire dampers to ANSI/NFPA 90A and in accordance with conditions of ULC listing.
- .3 Maintain integrity of fire separation.
- .4 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.
- .5 Install access door adjacent to each damper.

- .6 Co-ordinate with installer of firestopping.
- .7 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible.
- .8 Install break-away joints of approved design on each side of fire separation.
- .9 Contractor to individually tag each and every fire damper and provide a fire damper schedule in the Operation and Maintenance manual showing tag, size, type and location.
- .10 Contractor shall tag fire damper and access door with fire damper tag.
- .11 Demonstrate re-setting of fire dampers to Owner's representative.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation of flexible ductwork, joints and accessories.
- .2 Sustainable requirements for construction and verification.

1.2 REFERENCES

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- .2 Department of Justice Canada (Jus).
 - .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
 - .2 Transportation of Dangerous Goods Act, 1992 (TDGA), c. 34.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .4 National Fire Protection Association (NFPA).
 - .1 NFPA 90A-02, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B-02, Standard for Installation of Warm Air Heating and Air-Conditioning Systems.
- .5 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA).
 - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 95 (Addendum No.1, November 1997).
 - .2 SMACNA IAQ Guideline for Occupied Buildings under Construction, 1st Edition 1995.
- .6 Underwriters' Laboratories Inc. (UL).
 - .1 UL 181-96, Standard for Factory-Made Air Ducts and Air Connectors.
- .7 Underwriters' Laboratories of Canada (ULC).
 - .1 CAN/ULC-S110-1986(R2001), Fire Tests for Air Ducts.

1.3 SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS in accordance with Section 02 81 01 - Hazardous Materials for the following:
 - .1 Thermal properties.
 - .2 Friction loss.
 - .3 Acoustical loss.
 - .4 Leakage.
 - .5 Fire rating.

- .3 Samples: submit samples with product data of different types of flexible duct being used in accordance with Section 01 33 00 - Submittal Procedures.

1.4 QUALITY ASSURANCE

- .1 Certification of Ratings:
 - .1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to Codes and Standards.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

Part 2 Products

2.1 GENERAL

- .1 Factory fabricated to CAN/ULC-S110.
- .2 Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.
- .3 Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50.

2.2 FLEXIBLE DUCT MATERIALS

- .1 Two ply vinyl film supported by helically wound spring steel wire.
 - .1 Pressure Rating: 2.50 kPa positive and 250 Pa negative.
 - .2 Maximum Velocity: 20.3 m/sec.
 - .3 Temperature Range: -23 to 71 degrees C.
- .2 ULC Labeled, black polymer film supported by helically wound spring steel wire.
 - .1 Pressure Rating: 1000 Pa positive and 175 Pa negative.
 - .2 Maximum Velocity: 20.3 m/sec.
 - .3 Temperature Range: -28 to 79 degrees C.
- .3 ULC labeled, multiple layers of aluminum laminate supported by helically wound spring steel wire.
 - .1 Pressure Rating: 2.50 kPa positive and 250 Pa negative.
 - .2 Maximum Velocity: 20.3 m/sec.
 - .3 Temperature Range: -28 to 99 degrees C.

2.3 INSULATED FLEXIBLE DUCT MATERIALS

- .1 Two ply vinyl film supported by helically wound spring steel wire; fibreglass insulation; polyethylene vapour barrier film.
 - .1 Pressure Rating: 2.50 kPa positive and 250 Pa negative.
 - .2 Maximum Velocity: 20.3 m/sec.
 - .3 Temperature Range: -23 to 71 degrees C.

- .2 Black polymer film supported by helically wound spring steel wire; fiberglass insulation; polyethylene vapour barrier film.
 - .1 Pressure Rating: 1000 Pa positive and 175 Pa negative.
 - .2 Maximum Velocity: 20.3 m/sec.
 - .3 Temperature Range: -28 to 79 degrees C.

- .3 Multiple layers of aluminum laminate supported by helically wound spring steel wire; fiberglass insulation; polyethylene vapour barrier film.
 - .1 Pressure Rating: 2.50 kPa positive and 250 Pa negative.
 - .2 Maximum Velocity: 20.3 m/sec.
 - .3 Temperature Range: -28 to 99 degrees C.

Part 3 Execution

3.1 DUCT INSTALLATION

- .1 Install in accordance with: SMACNA.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Fans, motors, accessories and hardware for commercial use.
 - .2 Sustainable requirements for construction and verification.

1.2 REFERENCES

- .1 Air Conditioning and Mechanical Contractors (AMCA)
 - .1 AMCA Publication 99-2003, Standards Handbook.
 - .2 AMCA 300-1996, Reverberant Room Method for Sound Testing of Fans.
 - .3 AMCA 301-1990, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .2 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ANSI/AMCA 210-1999, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 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 in force.
 - .2 Capacity: flow rate, total static pressure, bhp, W, efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.
 - .3 Fans: statically and dynamically balanced, constructed in conformity with AMCA 99.
 - .4 Sound ratings: comply with AMCA 301, tested to AMCA 300. Supply unit with AMCA certified sound rating seal.
 - .5 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210. Supply unit with AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter.

1.4 SUBMITTALS

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

- .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
 - .1 Submit shop drawings and product data 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 Saskatchewan, Canada.
- .3 Provide :
 - .1 Fan performance curves showing point of operation, BHP, kW and efficiency.
 - .2 Sound rating data at point of operation.
- .4 Indicate:
 - .1 Motors, sheaves, bearings, shaft details.
 - .2 Minimum performance achievable with variable speed controllers as appropriate.
- .5 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.
- .6 Closeout Submittals:
 - .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 QUALITY ASSURANCE

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

1.6 MAINTENANCE

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .1 Spare parts to include:
 - .1 Matched sets of belts.
 - .2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:
 - .1 Bearings and seals.
 - .2 Addresses of suppliers.
 - .3 List of specialized tools necessary for adjusting, repairing or replacing.

Part 2 Products

2.1 FANS GENERAL

- .1 Motors:
 - .1 In accordance with Section 23 05 13 - Common Motors Requirements for HVAC Equipment supplemented as specified herein.
 - .2 For use with variable speed controllers.
 - .3 Sizes as indicated and specified.
- .2 Accessories and hardware: matched sets of V-belt drives, adjustable slide rail motor bases, belt guards, and as specified in Section 23 05 13 - Common Motor Requirements for HVAC Equipment. Flexible inlet and outlet connections. Spring isolation.
- .3 Factory primed before assembly in colour standard to manufacturer.
- .4 Scroll casing drains: as indicated.
- .5 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .6 Vibration isolation: to Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- .7 Flexible connections: to Section 23 33 00 - Air Duct Accessories.

2.2 CABINET FANS

- .1 Duct mounted cabinet fan complete with direct drive motor.
- .2 Factory fabricated heavy gauge galvanized steel casing complete with 12 mm acoustic insulation and vibration isolators.
- .3 Outlet duct collar to be complete with aluminum backdraft damper.
- .4 Motor disconnect shall be internal and of the plug in type.
- .5 Fan wheels shall be forward curved centrifugal type and dynamically balanced.
- .6 All fans shall bear the AMCA Certified Ratings Seal for sound and air performance and shall be cUL listed.
- .7 Furnish fans complete with factory mounted solid state speed control for air balancing.
- .8 Performance: Refer to equipment schedule for performance.

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 FAN INSTALLATION

- .1 Install fans as indicated, complete with resilient mountings specified in Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment, flexible electrical leads and flexible connections in accordance with Section 23 33 00 - Air Duct Accessories.
- .2 Provide sheaves and belts required for final air balance.
- .3 Bearings and extension tubes to be easily accessible.
- .4 Access doors and access panels to be easily accessible.

3.3 ANCHOR BOLTS AND TEMPLATES

- .1 Size anchor bolts to withstand seismic acceleration and velocity forces as specified .

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 Supply, return and exhaust grilles and registers, diffusers and linear grilles, for commercial and residential use.
 - .2 Sustainable requirements for construction and verification.

1.2 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.

1.3 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Indicate following:
 - .1 Capacity.
 - .2 Throw and terminal velocity.
 - .3 Noise criteria.
 - .4 Pressure drop.
 - .5 Neck velocity.
- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.

1.4 QUALITY ASSURANCE

- .1 Air flow tests and sound level measurement shall be made in accordance with ANSI/ASHRAE Standard 70.
- .2 Manufacturer shall have published performance data.
- .3 Manufacturer shall certify catalogued performance and ensure correct application of air outlet types.

1.5 JOB CONDITIONS

- .1 Review requirements of outlets as to size, finish and type of mounting prior to submitting shop drawings and schedules of outlet.

- .2 Positions indicated are approximate only. Check location of outlets and make necessary adjustment in position to conform with Architectural features, symmetry, performance, and lighting arrangement.

Part 2 Products

2.1 GENERAL

- .1 To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity as indicated.
- .2 Base air outlet application on space noise level, either by Noise Criteria (NC) curves or Room Criteria (RC) curves, as listed below:
 - .1 Classroom NC 30
 - .2 Offices NC 30
 - .3 Scenario Spaces NC 30
- .3 Frames:
 - .1 Full perimeter gaskets.
 - .2 Plaster frames for diffusers, located in plaster surface.
 - .3 Concealed fasteners.
- .4 Concealed manual volume control damper operators.
- .5 Provide baffles to direct air away from walls, columns or other obstructions within the radius of diffuser operation.
- .6 Provide anti-smudge frames or plaques on diffusers located in rough textured surfaces such as acoustical plaster.
- .7 Refer to equipment schedule for specification of air outlets.
- .8 Colour: as directed by Departmental Representative.

2.2 MANUFACTURED UNITS

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

2.3 RETURN AND EXHAUST GRILLES AND REGISTERS

- .1 Sidewall and ceiling exhaust grilles shall have streamlined blades, depth of which exceeds 20 mm spacing. Provide spring tension or other device to set blades. Provide units with horizontal face.
- .2 Provide 25 mm narrow margin frame with countersunk screw holes.
- .3 Fabricate of steel with 20 gauge minimum frames and 22 gauge minimum blades, steel and aluminum with 20 gauge minimum frame, or heavy aluminum extrusions.
- .4 Provide exhaust grilles, with integral, gang-operated opposed blade dampers with removable key operator, operable from face, where indicated.

- .5 Finish in factory baked enamel finish, colour by Departmental Representative.

2.4 GRID CORE RETURN AND EXHAUST GRILLES

- .1 Fabricate fixed grilles of 13 mm x 13 mm x 13 mm louvres.
- .2 Provide 32 mm margin frame with lay-in frame for suspended grid ceilings.
- .3 Fabricate of aluminum.
- .4 Provide exhaust grilles, where not individually connected to exhaust fans, with integral, gang-operated opposed blade dampers with removable key operator, operable from face, where indicated.

2.5 LOUVRED SUPPLY GRILLES

- .1 Ceiling supply grilles shall have streamlined and individually adjustable curved blades to discharge air along face of grille. Units shall have two-way deflection.
- .2 Provide 25 mm narrow margin frame with countersunk screw holes.
- .3 Fabricate of heavy aluminum extrusions.
- .4 Provide grilles with integral, gang-operated opposed blade dampers with removable key operator, operable from face, and equalizing grid, where indicated.
- .5 Finish in factory enamel finish, colour as selected by Departmental Representative.

2.6 SQUARE PLAQUE DIFFUSER

- .1 Diffuser shall consist of a precision formed back cone of one piece seamless construction which incorporates a round inlet collar of sufficient length for connecting rigid ductwork.
- .2 Removable inner plaque assembly shall be incorporated that drops no more than 1/4" below the ceiling plane to assure proper air distribution performance.
- .3 Sizes and mounting as detailed on drawings.

2.7 DUCT MOUNTED SPIRAL DUCT GRILLE

- .1 Double deflection type with two sets of fully adjustable deflection blades spaced 19 mm (3/4").
- .2 Front blades to run parallel to long dimension.
- .3 Provide adjustable air scoop with operator on side of frame.
- .4 Sizes and mounting as detailed on drawings.
- .5 Contractor shall ensure grille does not rattle during operation.

2.8 SECURITY GRILLE

- .1 Perforated faced steel maximum security grilles of size and mountings as indicated on drawings.
- .2 Grille face shall consist of 5mm (3/16") hot rolled steel with 8mm (5/16") diameter holes spaced on 11mm (7/16") centers staggered 60 degrees.
- .3 Grille to be attached to a wall sleeve of 5mm (3/16") hot rolled steel with a rear mounting frame for a concealed and secure fastening.
- .4 Unit to be complete with opposed blade volume control damper constructed of cold rolled steel. Damper shall be mounted in wall sleeve and operable from front to register.
- .5 Finish: as noted on drawings.

2.9 OUTSIDE LOUVRES

- .1 Refer to Section 23 37 20 - Louvres, Intakes and Vents.

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 manufacturer's instructions.
- .2 Install with oval head, stainless steel screws in countersunk holes where fastenings are visible.
- .3 Bolt grilles, registers and diffusers, in place, where indicated.

3.3 CLEANING

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

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Mechanical louvers; intakes; vents; and reinforcement and bracing for air vents, intakes and gooseneck hoods.
 - .2 Sustainable requirements for construction and verification.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/ National Fire Protection Association (NFPA)
 - .1 ANSI/NFPA 96-04, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E90-04, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
- .5 Society of Automotive Engineers (SAE)

1.3 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.

1.4 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Indicate following:
 - .1 Pressure drop.
 - .2 Face area.
 - .3 Free area.

- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
- .3 Test Reports:
 - .1 Submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E90.

1.5 QUALITY ASSURANCE

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

Part 2 Products

2.1 FIXED LOUVRES - ALUMINUM

- .1 Construction: welded with exposed joints ground flush and smooth. Blade and frame fillet welds concealed from view.
- .2 Material: extruded aluminum alloy 6063-T5; blades and frames minimum 2.7 mm thick.
- .3 Blade: stationary with drainable gutters, reinforcing bosses and maximum blade length of 1500 mm or manufacturer's recommendations.
- .4 Frame, head, sill and jamb: 100 or 150 mm deep one piece extruded aluminum, minimum 2 mm thick with approved caulking slot, integral to unit. Depth as indicated. Frames shall be jointed at each corner with full length weld.
- .5 Mullions: at 1500 mm maximum centres, visible vertical mullions.
- .6 Fastenings: stainless steel SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, ss washer and aluminum body.
- .7 Screen: 12 mm exhaust, 19 mm intake mesh, 2 mm diameter wire aluminum birdscreen on inside face of louvres in formed U-frame.
- .8 Finish: factory applied enamel. Colour: as selected by Departmental Representative.

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 In accordance with manufacturer's and SMACNA recommendations.
- .2 Reinforce and brace as indicated.
- .3 Anchor securely into opening. Seal with caulking to ensure weather tightness.

3.3 CLEANING

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

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute/National Fire Prevention Association (ANSI/NFPA)
 - .1 ANSI/NFPA 96- 1994 , Ventilation Control and Fire Protection of Commercial Cooking Operations .
- .2 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 52.1- 1992 , Gravimetric And Dust Spot for Testing Air-cleaning Devices Used in General Ventilation for Removing Particulate Matter.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-115.10- M90 , Disposable Air Filters for the Removal of Particulate Matter from Ventilating Systems.
 - .2 CAN/CGSB-115.11- M85 , Filters, Air, High Efficiency, Disposable, Bag Type (Reaffirmed April 1985).
 - .3 CAN/CGSB-115.12- M85 , Filters, Air, Medium Efficiency, Disposable, Bag Type (Reaffirmed April 1985).
 - .4 CAN/CGSB-115.13- 85 , Filter Media, Automatic Roll (Reaffirmed April 1985).
 - .5 CAN/CGSB-115.14- M91 , High Efficiency Cartridge Type Supported Air Filters for the Removal of Particulate Matter from Ventilating Systems.
 - .6 CAN/CGSB-115.15- M91 , High Efficiency Rigid Type Air Filters for Removal of Particulate Matter from Ventilating Systems.
 - .7 CAN/CGSB-115.16- M82 , Activated Carbon for Odor Removal from Ventilating Systems.
 - .8 CAN/CGSB-115.18- M85 , Filter, Air, Extended Area Panel Type, Medium Efficiency.
 - .9 CAN/CGSB-115.20- 95 , Polarized Media Air Filter.
- .4 Underwriters' Laboratories of Canada
 - .1 ULC -S111- M80 , "Fire Tests for Air Filter Units".
 - .2 ULC-S649-1993, Grease Filters for Commercial and Institutional Kitchen Exhaust Systems.

1.2 SHOP DRAWINGS AND PRODUCT DATA

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

1.3 CLOSEOUT SUBMITTALS

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

1.4 QUALITY ASSURANCE

- .1 Filters shall be product of and supplied by one manufacturer. Filter components assembled to form filter banks shall be products of same manufacturer.

- .2 Filter media shall be UL listed, Class I or Class II, as approved by local authority.

1.5 MAINTENANCE MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Furnish list of individual manufacturer's recommended spare parts for equipment such as frames and filters, addresses of suppliers, list of specialized tools necessary for adjusting, repairing or replacing for inclusion in operating manual.

1.6 ALTERNATIVES

- .1 Size, media face area, Merv rating, initial and final resistance of alternative manufacturer's shall be same as type specified.

1.7 EXTRA MATERIALS

- .1 Spare filters: in addition to filters to be installed immediately prior to acceptance by Departmental Representative , supply one complete set of filters for each filter unit or filter bank in accordance with section 01 78 00 - Closeout Submittals. Total number of filters for each and every filter bank as follows:
 - .1 One set for testing, balancing and commissioning.
 - .2 One set to be installed at acceptance.
 - .3 One spare set to be used by Owner during first year of operation.

Part 2 Products

2.1 GENERAL

- .1 Media: suitable for air at 100% RH and air temperatures between minus 40 and 50 °C.
- .2 Number of units, size and thickness of panels, overall dimensions of filter bank, configuration and capacities: as indicated .
- .3 Pressure drop when clean and dirty, sizes and thickness: as indicated on schedule.

2.2 ACCESSORIES

- .1 Holding frames: permanent "T" section or channel section construction of galvanized steel or extruded aluminum, same material as casing/hood, 1.6 mm thick, except where specified otherwise. Provide standard sized frames for interchangeability of filter media.
- .2 Seals: to ensure leakproof operation.
- .3 Blank-off plates: as required, to fit all openings and of same material as holding frames.
- .4 Access and servicing: through doors/panels on each side and/or from upstream or downstream face of filter bank .

2.3 FIBROUS GLASS PANEL FILTERS

- .1 Disposable fibrous glass media: to CAN/CGSB-115.10 with adhesive.
- .2 Holding frame: 1.2 mm minimum thick galvanized steel with 3 mm diam hinged wire mesh screen.
- .3 Performance: as indicated, to ASHRAE 52.2.
- .4 Fire rated: to ULC -S111.
- .5 Nominal thickness: as indicated.

2.4 COTTON PANEL FILTERS

- .1 Disposable pleated reinforced cotton dry media: to CAN/CGSB 115.18.
- .2 Holding frame: galvanized steel, or slide in channel for side access.
- .3 Performance: as indicated, to ASHRAE 52.2.
- .4 Fire Rated: to ULC -S111.
- .5 Nominal thickness: as indicated.

2.5 FILTER GAUGES - MANOMETER TYPE

- .1 Inclined acrylic tube.
- .2 Complete with levelling screws.
- .3 Range: 0 to 2 times initial pressure.

Part 3 Execution

3.1 INSTALLATION GENERAL

- .1 Install in accordance with manufacturer's recommendations and with adequate space for access, maintenance and replacement.
- .2 Filter banks shall have removal and access indicated.
- .3 Do not operate fan systems without filtration in place.

3.2 REPLACEMENT MEDIA

- .1 Replace all media with new upon acceptance.
- .2 Filter media to be new and clean, as indicated by pressure gauge, at time of acceptance.

3.3 FILTER GAUGES

- .1 Install type as indicated across each filter bank (pre-filter and final filter) in approved and easy readable location.
- .2 Mark each filter gauge with value of pressure drop for clean condition and manufacturer's recommended replacement (dirty) value.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation for piping and fittings used in HVAC heat exchangers.
 - .2 Sustainable requirements for construction and verification:

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME Boiler and Pressure Vessel Code.
 - .1 BPVC-VIII B-2004, BPVC Section VIII - Rules for Construction of Pressure Vessels Division 1.
 - .2 BPVC-VIII-2 B-2004, BPVC Section VIII - Rules for Construction of Pressure Vessels Division 2 - Alternative Rules.
 - .3 BPVC-VIII-3 B-2004, BPVC Section VIII - Rules for Construction of Pressure Vessels Division 3 - Alternative Rules High Press Vessels.
- .2 Canadian Standards Association (CSA International)
 - .1 CSA B51-03, Boiler, Pressure Vessel, and Pressure Piping Code.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet for heat exchangers.
 - .2 Submit WHMIS MSDS in accordance with Section 02 61 33 - Hazardous Materials. Indicate VOC's for adhesive and solvents during application and curing.
- .3 Shop Drawings:
 - .1 Submit shop drawings to indicate project layout including layout, dimensions of heat exchangers and system. Indicate following information:
 - .1 Manufacturer's recommended clearances for tube withdrawal and manipulation of tube cleaning tools.
 - .2 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
 - .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .4 Instructions: submit manufacturer's installation instructions.
 - .5 Manufacturer's Field Reports: manufacturer's field reports specified.

- .6 Closeout Submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout.

1.4 QUALITY ASSURANCE

- .1 Pre-Installation Meeting:
 - .1 Convene pre-installation meeting one week prior to beginning work of this Section and on-site installations in accordance with Section 01 32 18 - Construction Progress Schedules - Bar (GANTT) Chart.
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.
 - .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

1.5 MAINTENANCE

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

Part 2 Products

2.1 PLATE HEAT EXCHANGER

- .1 General:
 - .1 Glycol water to water as indicated.
 - .2 Designed, constructed and tested in with accordance ASME Boiler and Pressure Vessel Code, Section VIII, CSA B51 and provincial pressure vessel regulations.
- .2 Frames: carbon steel with baked epoxy enamel paint, stainless steel side bolts and shroud.
- .3 Plates: type AISI 304 gasketed stainless steel.
- .4 Gaskets: as recommended by manufacturer to suit fluid temperature and composition.
- .5 Nozzles: 1034 kPa, ASA rubber rated flange type.
- .6 Supports: mounting legs.
- .7 Piping connections: as indicated or required to suit piping.

- .8 Capacity: as indicated on equipment schedule.
- .9 Dimensions: as indicated on equipment schedule and drawing.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 General: install level and firmly anchored to supports as indicated and in accordance with manufacturer's recommendations.
- .2 Plate exchangers: install in accordance with manufacturer's recommendations; ensure installation permits removal panels without disturbing installed equipment or piping.

3.3 APPURTENANCES

- .1 Water Side: Install with valves as indicated on Schematic including safety relief valve piped to drain.

3.4 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Have manufacturer of products supplied under this Section review work involved in handling, installation/application, protection and cleaning of its products, and submit written reports, in acceptable format, to verify compliance of work with Contract.
 - .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 at stages listed:
 - .1 After delivery and storage of products, and when preparatory work on which work of this Section depends is complete, but before installation begins.
 - .2 Twice during progress of work at 25% and 60% complete.
- .2 Upon completion of work, after cleaning is carried out.
- .3 Obtain reports within 3 days of review and submit immediately to Departmental Representative.
- .4 Start-up:
 - .1 General: perform start-up operations in accordance with manufacturer's requirements and as specified herein.
 - .2 Check heater for cleanliness on primary and secondary sides.

- .3 Check water treatment system is complete, operational and correct treatment is being applied.
- .4 Check installation, settings, operation of relief valves and safety valves.
- .5 Check installation, location, settings and operation of operating, limit and safety controls.
- .6 Check supports, seismic restraint systems.

- .5 Performance Verification:
 - .1 General: perform performance verification in accordance with manufacturer's requirements, supplemented as specified.
 - .2 Timing: only after TAB of hydronic systems have been successfully completed.
 - .3 Primary side:
 - .1 Measure flow rate, pressure drop, and either one steam pressure and temperature at heater inlet or two water temperature at heater inlet and outlet.
 - .2 Verify operation of steam traps. Measure temperature of condensate return at trap outlet.
 - .4 Control valve: verify proper operation without binding, slack in components. Measure either steam pressure and temperature at control valve inlet or if control is three-port type, pressure drop across inlet to common, bypass to common, inlet to bypass.
 - .5 Secondary side:
 - .1 Measure flow rate, pressure drop and water temperature at heater inlet and outlet.
 - .2 Verify installation and operation of air elimination devices.
 - .6 Calculate heat transfer from primary and secondary sides.
 - .7 Simulate heating water temperature schedule and repeat above procedures.
 - .8 Verify settings, operation, safe discharge from safety valves and relief valves.
 - .9 Verify settings, operation of operating, limit and safety controls and alarms.
 - .10 Reports:
 - .1 Manufacturers start-up reports, supplemented as specified herein.

3.5 DEMONSTRATION

- .1 Training: provide training in accordance with Section 20 02 00 - General Mechanical Provisions, supplemented as specified.

3.6 CLEANING

- .1 Perform cleaning operations and in accordance with manufacturer's recommendations.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Mechanical louvers; intakes; vents; and reinforcement and bracing for air vents, intakes and gooseneck hoods.
 - .2 Sustainable requirements for construction and verification.

1.2 SECTION INCLUDES

- .1 Packaged air conditioning units.

1.2 SUBMITTALS

- .1 Submit shop drawings to requirements of Section 01 33 00.
- .2 Indicate water, drain, electrical, and duct rough-in connections.
- .3 Submit manufacturer's installation instructions to Section 01 33 00.
- .4 Provide detailed wiring diagram and complete description of controls.

1.3 SUBMITTALS FOR INFORMATION

- .1 Sections 01 33 00 and 01 78 00: Submission procedures.
- .2 Manufacturer's Certificate: Certify that specified products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- .1 Section 01 33 00: Submission procedures.

1.5 OPERATION AND MAINTENANCE DATA

- .1 Submit operation and maintenance data to requirements of Section 01 78 00.
- .2 Include manufacturers descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.

1.7 WARRANTY

- .1 Provide a 5 year warranty to Section 01 78 00 and CCDC 2 General Conditions.
- .2 Warranty: Include coverage of refrigerant compressors,.

2 Products

2.1 DEDICATED ROOM AIR CONDITIONING UNITS

- .1 Integrated package: to CAN/CSA-C656.
- .2 System type:
 - .1 Air flow arrangement: as noted on equipment schedule
 - .2 Cooling: direct expansion.
 - .3 Condensing: air cooled.
- .3 Cooling capacity, with fan heat extracted: based on 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.
- .4 Unit capacity: as indicated:
- .5 Cabinet:
 - .1 Wall mounted, 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 selected by Engineer.
 - .2 Cabinet to house: cooling coil, fans, filters, unit environmental control system, motor starters or contactors and electrical disconnect switch.
 - .3 Provide adequate access to components for servicing.
 - .4 Corrosion protected welded structural steel floor stand having adjustable feet and locking device on corners, vibration isolators and compatible with raised floor system.
 - .5 Fans: DWDI centrifugal, statically and dynamically balanced, direct drive, with self-aligning, permanently lubricated, 100,000 hours minimum life ball or roller bearings.
 - .6 Fan Motors: Drip-proof permanently lubricated bearings for continuous duty, 40 degrees C maximum rise and variable pitch sheaves on belt driven systems.
 - .7 Provide hail guards over fins.
- .6 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 (variable speed compressor)

- .7 Condenser:
 - .1 Outdoor Air cooled: free standing, welded steel unit construction, corrosion protected.
 - .1 Circuited to provide separate refrigerant circuit for each compressor/evaporator combination.
 - .2 Aluminum fins, mechanically bonded to copper tubes, tested to 3.1 MPa.
 - .3 Propeller or centrifugal type fans. Direct drive.
 - .4 Electrical and control components housed in weather-tight access panels with electrical disconnect switch and control cable for control interconnection and designed for year round operation.
 - .5 Vibration isolation: providing at least 95% isolation efficiency.
 - .6 Capacity: to heat rejection capacity of 35 degrees C.
 - .7 Variable speed compressor for capacity control.

- .8 Filters:
 - .1 Prefilters: Cleanable.
 - .2 Mounting: in corrosion resistant racks with service access.

- .9 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.

- .10 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 Alarm silencing switch for each alarm point.
 - .4 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 head pressure.

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

.12 Capacity and Line Sizing

- .1 Manufacturer and Mechanical Contractor shall ensure that system will operate at capacities indicated in equipment schedule despite distance from condensing units to indoor units and elevation change.
- .2 Contractor shall ensure refrigerant liquid and suction lines are sized in accordance with manufacturers requirements for elevation change and distance between indoor and outdoor unit.
- .3 Pipe distance is assumed to be 40m (131 ft) with an elevation change of 13.7m (45 ft). Elevation change is included in pipe distance.

3 Execution

3.1 INSTALLATION

- .1 Install in accordance with manufacturer's installation instructions.
- .2 Coordinate installation of units with architectural, mechanical, and electrical work.
- .3 Provide initial start-up and shut-down during first year of operation, including routine servicing and check-out.
- .4 Mount condensing units at ground level in courtyard. Mount on raised metal stand to ensure minimum of 610mm clearance above ground with stand on concrete pads as indicated by Architect. Mechanical to provide stand.
- .5 Supply units fully charged with refrigerant and filled with oil.
- .6 Provide shut-off valves in condenser water inlet and outlet piping.
- .7 Pipe drain pan condensate to nearest floor drain or mop sink as indicated on drawings.
- .8 Mount on raised metal stand to ensure minimum of 610mm clearance above ground.
- .9 Mechanical to pipe from condensing unit to wall along ground.

END OF SECTION

1 General

1.1 SECTION INCLUDES

- .1 Baseboard radiation.
- .2 Finned tube radiation.
- .3 Convectors.
- .4 Unit heaters.
- .5 Cabinet unit heaters.
- .6 Fan-coil units.
- .7 Unit ventilators.
- .8 Induction Units.
- .9 Radiant heaters.
- .10 Electric heaters.

1.2 SUBMITTALS FOR REVIEW

- .1 Section 01 33 00: Procedures for submittals.
- .2 Product Data: Provide typical catalogue of information including arrangements.
- .3 Shop Drawings:
 - .1 Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations.
 - .2 Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.
 - .3 Indicate mechanical and electrical service locations and requirements.
- .4 Samples: Submit one sample of each radiation cabinet detailed.

1.3 SUBMITTALS FOR INFORMATION

- .1 Section 01 33 00: Submittals for information.
- .2 Manufacturer's Instructions: Indicate installation instructions and recommendations.

1.4 SUBMITTALS AT PROJECT CLOSEOUT

- .1 Section 01 78 10: Submittals for project closeout.
- .2 Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access or valving.
- .3 Operation and Maintenance Data: Include manufacturers descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.
- .4 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owners name and registered with manufacturer.

1.5 QUALITY ASSURANCE

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.6 REGULATORY REQUIREMENTS

- .1 Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.7 WARRANTY

- .1 Section 01 78 10: Submittals for project closeout.
- .2 Provide five year manufacturers warranty for fan-coil unit motors.

2 Products

2.1 RADIATION CONVECTOR CABINETS

- .1 Heating Elements: Reuse existing unless specifically noted otherwise on drawings. Clean and comb reused fins. New fins to be 32 mm ID seamless copper tubing, 3mm (1/8") minimum wall thickness mechanically expanded into evenly spaced aluminum fins sized 100 x 100 mm, suitable for soldered fittings.
- .2 Cabinet: sloped top, 2.0 mm (14 gauge) steel front and top, 2.0 mm (14 gauge) steel back and ends; exposed corners rounded; easily secured removable front panels, adequately braced and reinforced for stiffness.
- .3 Finish: Factory applied baked enamel custom colour unless specifically noted otherwise in equipment schedule.
- .4 Access Doors: For otherwise inaccessible valves, provide factory-made permanently hinged access doors, 150 x 175 mm minimum size, integral with cabinet.

2.2 FAN-COIL UNITS

- .1 Units shall include a chassis, chilled water coil, fan deck with blower(s) / blower housing and motor(s). Steel parts exposed to moisture shall be galvanized and insulated to prevent condensation. The complete fan assembly shall be easily removable for service and maintenance. A quick-connect motor electric plug shall be provided.
- .2 Unit shall be supplied with return plenum complete with filter frame and filter. The plenum shall be fabricated of 18 gauge galvanized steel. The inside plenum surface shall be insulated with ½" matte-face fiberglass insulation . Plenum insulation shall meet minimum K value of 0.24 (BTU-in)/(hr-ft²-°F) and rated for maximum air velocity of 5000 fpm. Fiberglass insulation conforms to ASTM C1071 (including C665) UL 181 for erosion 25/50 rating for flame spread/smoke developed per ASTM E-84,UL 723 and NFPA 90A

- .3 Supply Fan:
 - .1 Supply fans shall be a DWDI forward-curved type. Fan assemblies including fan, motor and sheaves shall be dynamically balanced by the manufacturer on all three planes at all bearing supports. Manufacturer must ensure maximum fan RPM is below the first critical speed
 - .2 The complete fan assembly, including motor and main drain pan shall be easily removable
 - .3 Units shall be certified in accordance with the Room Fan Coil Unit certification program that is based on ARI Standard 440.

- .4 Electrical:
 - .1 Supply fans shall be driven by Electronically-Commutated motor(s). The ECM motor shall have five selectable constant-torque setting controlled by 24VAC input with fully integrated connector and be run-tested in the assembled unit. The motor to have 6 kV surge protection.
 - .2 Motor wires shall include a quick-disconnect motor plug

- .5 Cooling:
 - .1 Cooling performance shall be as specified on schedules.
 - .2 Water coil fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Seamless copper tubes shall be mechanically expanded into the fins to provide a continuous primary-to-secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins. Coil casing shall be constructed of galvanized steel.
 - .3 Water coils shall be provided with headers of seamless copper tubing with intruded tube holes to permit expansion and contraction without creating undue stress or strain. Coil connections shall be copper sweat connections with connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain connections shall be furnished on the coil connection, external to the cabinet. Vent connections provided at the highest point to assure proper venting. Drain connections shall be provided at the lowest point.
 - .4 All steel parts exposed to moisture shall be galvanized.
 - .5 Unit shall include a noncorrosive, ABS main drain pan, positively sloped in every plane and insulated with closed-cell insulation.

- .7 Filters:
 - .1 Filters shall be 1" (25 mm) Merv 8 throwaway. They shall be concealed from sight and easily removable.

- .8 Controls:
 - .1 Unit shall be supplied with a low-voltage interface board.
 - .2 Interface board shall have three 24-volt relays with line-voltage contactors to operate the fan motor speeds (low, medium, high).
 - .3 DDC interface board shall have terminal connections for interfacing to:
 - .1 EMCS wall-mounted thermostat.
 - .2 Low-voltage valve actuators (note that actual valve shall be controlled from EMCS)
 - .3 A return air sensor.
 - .4 Condensate overflow switch.
 - .4 Interface board shall include a factory-wired and installed transformer.

3 Execution

3.1 INSTALLATION

- .1 Install to manufacturer's written instructions.
- .2 Install equipment exposed to finished areas after walls and ceiling are finished and painted. Avoid damage.
- .3 Protection: Provide finished cabinet units with protective covers during balance of construction.
- .4 Baseboard Radiation: Provide cabinets for existing steam radiation as shown on drawings. Field measure all cabinet prior to ordering. Coordinate cabinets with walls to ensure cabinets do not hinder integrity of walls.
- .5 Fan-Coil Units: Install as indicated. Coordinate locations with ceiling grids to ensure proper access for servicing, as indicated on drawings. Connect drain pan to condensate drain.
- .6 Hydronic Units: Refer to details for complete valving arrangements. Contractor is responsible to ensure valving is installed in accordance with installation requirements of valves purchased.

3.2 CLEANING

- .1 After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.
- .2 Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials provided by manufacturer.
- .3 Install new filters.

END OF SECTION