

1 General

1.1 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 78 00 - Closeout Submittals.
- .3 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .4 Section 01 91 13 - General Commissioning Requirements.

1.2 EQUIPMENT LIST

- .1 Complete list of equipment and materials to be used on this project and forming part of tender documents by adding manufacturer's name, model number and details of materials, and submit for approval.
- .2 Submit for approval at time of tender within 10 days after award of contract.

1.3 PROTECTION OF OPENINGS

- .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

1.4 PAINTING

- .1 Prime and touch up marred finished paintwork to match original.
- .2 Restore to new condition, finishes which have been damaged too extensively to be merely primed and touched up.

1.5 SPARE PARTS

- .1 Furnish spare parts in accordance with Section 01 78 00 - Closeout Submittals as follows:
 - .1 One set of packing for each pump.
 - .2 One casing joint gasket for each size pump.
 - .3 One head gasket set for each heat exchanger.
 - .4 One glass for each gauge glass.
 - .5 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.
 - .6 One set spare belts for each belt drive.

1.6 SPECIAL TOOLS

- .1 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.7 DEMONSTRATION AND OPERATING AND MAINTENANCE INSTRUCTIONS

- .1 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .2 Where specified elsewhere in Division 23, manufacturers to provide demonstrations and instructions.
- .3 Use operation and maintenance manual, as built drawings, audio visual aids, etc. as part of instruction materials.
- .4 Instruction duration time requirements as specified in appropriate sections.
- .5 Where deemed necessary, Engineer may record these demonstrations on video tape for future reference.

1.8 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 Closeout Submittals.
- .2 Operation and maintenance manual to be approved by, and final copies deposited with, Engineer before final inspection.
- .3 Operation data to include:
 - .1 Control schematics for each system including environmental controls.
 - .2 Description of each system and its controls.
 - .3 Description of operation of each system at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for each system and each component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.
- .4 Maintenance data shall include:
 - .1 Servicing, maintenance, operation and trouble shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
- .5 Performance data to include:
 - .1 Equipment manufacturer's performance data sheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified elsewhere.
 - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .6 Approvals:
 - .1 Submit 2 copies of draft Operation and Maintenance Manual to Engineer for approval. Submission of individual data will not be accepted unless so directed by Engineer Consultant.
 - .2 Make changes as required and re submit as directed by Engineer.
- .7 Additional data:
 - .1 Prepare and insert into operation and maintenance manual when need for same becomes apparent during demonstrations and instructions specified above.

1.9 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop drawings and product data shall show:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances. eg. access door swing spaces.
- .3 Shop drawings and product data shall be accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.
 - .3 Points of operation on performance curves.
 - .4 Manufacturer to certify as to current model production.
 - .5 Certification of compliance to applicable codes.
- .4 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.

1.10 CLEANING

- .1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units.

1.11 AS-BUILT DRAWINGS

- .1 Site records:
 - .1 Obtain 1 set of reproducible mechanical drawings from Printer. Provide sets of white prints as required for each phase of the work. Mark there on all changes as work progresses and as changes occur. This shall include changes to existing mechanical systems, control systems and low voltage control wiring.
 - .2 On a weekly basis, transfer information to reproducibles, revising reproducibles to show all work as actually installed.
 - .3 Use different colour waterproof ink for each service.
 - .4 Make available for reference purposes and inspection at all times.
- .2 As built drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing (TAB), finalize production of as built drawings.
 - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (date).
 - .3 Submit to Engineer Consultant for approval and make corrections as directed.
 - .4 TAB to be performed using as built drawings.
 - .5 Submit completed reproducible as built drawings with Operating and Maintenance Manuals.
- .3 Submit copies of as built drawings for inclusion in final TAB report.

1.12 COMMISSIONING

- .1 Provide commissioning services as called for in Sections 01 91 13 Commissioning General Requirements.

1.13 WASTE MANAGEMENT AND DISPOSAL

- .1 Collect and separate waste material and place in on site bin in accordance with Waste Management Plan.

End of Section

1 General

1.1 RELATED SECTIONS

- .1 Section 01 50 00 - Temporary Facilities.

1.2 USE OF SYSTEMS

- .1 Use of new permanent heating and ventilating systems for supplying temporary heat or ventilation is permitted on written permission from Engineer and only under the following conditions:
 - .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 from any cause.
 - .5 Supply ventilation systems are protected by 60 % filters, which shall be inspected daily, changed every 2 weeks or more frequently as required.
 - .6 Return systems have approved filters over all openings, inlets, outlets.
 - .7 All systems will be:
 - .1 operated as per manufacturer's recommendations or instructions.
 - .2 operated by Contractor.
 - .3 monitored continuously by Contractor.
 - .8 Warranties and guarantees are not thereby relaxed.
 - .9 Regular preventive and all other manufacturers recommended maintenance routines are performed by Contractor at his own expense and under supervision of Engineer.
 - .10 Before static completion, entire system to be refurbished, cleaned internally and externally, restored to "as new" condition, filters in air systems replaced.
- .2 Filters referred to herein are over and above those specified elsewhere in this specification.
- .3 Dedicated exhaust systems are not included in any approvals for temporary heating ventilation.

End of Section

1 General

1.1 RELATED SECTIONS

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

1.2 REFERENCES

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

3 Execution

3.1 CONNECTIONS TO EQUIPMENT

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

3.2 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 at low points in piping systems, at equipment and at section isolating valves.
- .3 Pipe each drain valve discharge separately to above floor drain. 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 air vents at high points in piping systems.
- .2 Install isolating valve at each automatic air valve.
- .3 Install drain piping to approved location and terminate where discharge is visible.
- .4 Use industrial capacity air vents at air separators and in boiler room.

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 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.
- .6 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .7 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .8 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- .9 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .10 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .11 Group piping wherever possible and as indicated. Provide pipe support racks where indicated. Ensure all piping is separately accessible and individually clamped.
- .12 Ream pipes, remove scale and other foreign material before assembly.
- .13 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .14 Provide for thermal expansion as indicated.
- .15 Valves:
 - .1 Install in accessible locations.
 - .2 Remove interior parts before soldering.
 - .3 Install with stems above horizontal position unless otherwise indicated.
 - .4 Valves accessible for maintenance without removing adjacent piping.
 - .5 Install globe valves in bypass around control valves.
 - .6 Use gate or ball valves at branch take offs for isolating purposes except where otherwise specified.
 - .7 Install butterfly valves between weld neck flanges to ensure full compression of liner.
 - .8 Install ball valves for glycol service.
 - .9 Use chain operators on valves NPS 2 1/2 and larger where installed more than 3m above floor in Mechanical Rooms.
- .16 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 and elsewhere as indicated.

3.7 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 25mm 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.
 - .5 Each trade is responsible for firestopping around service penetrations.

3.8 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.

3.9 PREPARATION FOR FIRESTOPPING

- .1 Provide ULC approved firestopping, material and installation for pipes, ducts, insulation and adjacent fire separation. Firestopping for Section 23 service penetrations shall be by Section 23 trades.
- .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.

3.10 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.
- .3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of strainers in piping systems.

3.11 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

- .1 Advise Engineer 48 hours minimum prior to performance of pressure tests.
- .2 Pipework: Test as specified in relevant sections of Division 23.
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant sections of Division 23.
- .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 Engineer.
- .6 Pay costs for repairs or replacement, retesting, and making good. Engineer to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after approval and certification of tests by Engineer.

End of Section

1 General

1.1 SCOPE

- .1 This specification addresses the mechanical and electrical design, electrical insulation system and testing requirements of **Premium Efficiency Inverter Duty** Totally Enclosed Fan Cooled (TEFC) electric motors.

1.2 REFERENCES

- .1 NEMA Publication MG 1-1993 Rev 1.
- .2 NEMA Publication MG 1-Part 31.
- .3 Testing per NEMA MG 1-12 (IEEE 112 Test Standard, Method B).
- .4 Class F Insulation is UL Safety Standard 1004 recognized.
- .5 Frame assignments as per NEMA MG 1-13.
- .6 Manufactured in an API, ISO 9001 and ISO 14000 facility.

1.3 WARRANTY

- .1 Five (5) year warranty.

2 Products

2.1 GENERAL DESCRIPTION

- .1 Construction Motors are suitable for continuous duty in ambient temperatures from -40°C to 40°C. Operating altitude is 3300 feet (1000 meters) or less.
- .2 All motors have a Service Factor of 1.15 at 40°C and 1.00 at 65°C on sine wave power and 1.00 on PWM (pulse width modulated) power.
- .3 All 2, 4, 6 & 8 pole motors are suitable for 10:1 speed range for Constant Torque and Zero to base speed for Variable Torque applications.
- .4 All motors are suitable for 1.5 times base speed operation, constant horsepower.
- .5 All Motors are in accordance with the latest revisions of NEMA Standard MG1 and comply or exceed the applicable portions of the National Electrical Code, the Canadian Standards Association and Underwriters Laboratory.

2.2 ELECTRICAL

- .1 All motors supplied are the manufacturer's **premium efficiency** design. The nominal efficiency and the minimum guaranteed efficiency are stamped on the nameplate of the motor. All efficiency testing and labeling are done in accordance with the NEMA MG1 standard.
- .2 All motors are capable of developing NEMA Design B locked rotor torque at 90% of rated voltage (SWP - Sine Wave Power).
- .3 Conductors have increased cross sectional area for increased efficiency. Low-loss electric grade silicon steel is used with interlamination insulation and an 8-stage stress relief annealing process.
- .4 All motors meet or exceed NEMA MG1, Part 31 for use on a PWM variable frequency drive.
- .5 The insulation system is rated to meet NEMA MG1- 1998 Part 31. A Class F non-hygroscopic insulation system, utilizing a chemically treated corona resistant magnet wire, with a Class B rise at 1.15 service factor is standard. Motors are triple dipped and baked in a polyester, Class H semi-rigid 55% solids varnish.

All motors have the following temperature rise:

**Sine Wave, 80°C at S.F. =1.15 PWM
105°C at S.F. =1.0 PWM**

- .6 Stator windings are copper. Motor leads are stranded copper, are permanently identified, and are brought out into the motor terminal box through a nipped neoprene gasket.
- .7 Nomex slot liners, separators and wedges are used exclusively.
- .8 Wye-Delta internal connection for 230/460V motors. Star internal connection for 575V motors.
- .9 The first winding coil is covered with silicon tube for protection against reflected voltage spikes.
- .10 Maximum PWM Inverter to motor cable lengths @ 3kHz carrier frequency 230V & 460V = Unlimited cable length 575V = 600 ft.

2.3 MECHANICAL

- .1 Stator frame and end brackets are composed of a high-grade cast iron.
- .2 The terminal box is larger than NEMA requirements and rotatable in 90° increments.
- .3 The terminal box is full cast iron construction.
- .4 External cooling fans are non-sparking corrosion resistant polypropylene material.
- .5 Drain holes (quantity of 2) are provided at the lowest point in the motor frame.
- .6 A forged shoulder eyebolt is provided for lifting (184T frame and larger).
- .7 A shaft slinger is supplied on the drive end.
- .8 Bearings are either ball bearings or cylindrical roller bearings.
- .9 Bearings are individually selected for each motor rating to provide optimal performance including an L-10 life of 100,000 hours (direct coupled) and B10 life of 50,000 hours (belt driven).
- .10 The motor nameplate is stamped on 304 stainless steel and fastened to the motor frame with four stainless steel drive pins.
- .11 All hardware is zinc plated.
- .12 All motors are painted with a marine duty corrosion resistant polyurethane finish.
- .13 All motors are dynamically balanced to exceed NEMA standards.
- .14 Vibration levels are typically half of NEMA standards.
- .15 All motors are capable of all positioning and mounting.
- .16 All motors can accept C faces and D Flanges (D flanges 320 frame and larger).
- .17 All motors can be modified for Severe and Chemical Duty applications.

End of Section

1 General

1.1 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 22 - Construction/Demolition Waste Management And Disposal.

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- .2 ASHRAE 90.1 01, Energy Code for Buildings Except Low Rise Residential Buildings.
- .3 Electrical Equipment Manufacturers' Advisory Council (EEMAC)

1.3 SECTION INCLUDES

- .1 Electrical work to conform to Division 26 including the following:
 - .1 Supplier and installer responsibility is indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.
 - .2 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 26. Refer to Division 26 for quality of materials and workmanship.

1.4 SHOP DRAWINGS

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

1.5 CLOSE OUT SUBMITTALS

- .1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 33 00 - Submittal Procedures.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Collect and separate waste material and place in on site bin in accordance with Waste Management Plan.

2 Products

2.1 GENERAL

- .1 Motors to be high efficiency, in accordance with local Hydro company standards and the requirements of ASHRAE 90.1.

2.2 MOTORS

- .1 Provide motors for mechanical equipment as specified.
- .2 If delivery of specified motor will delay delivery or installation of equipment, install motor approved by Engineer for temporary use. Final acceptance of equipment will not occur until specified motor is installed.
- .3 Motors under 373 W (1/2 HP) : speed as indicated, continuous duty, built in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.
- .4 Motors 373 W (1/2 HP) and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40°C, 3 phase, 575 V, unless otherwise specified or indicated.

2.3 TEMPORARY MOTORS

- .1 If delivery of specified motor will delay completion or commissioning work, install motor approved by Engineer 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 specified.
- .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 to be 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 23 05 01.

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 1.3mm thick sheet metal tops and bottoms.
 - .3 38mm dia holes on both shaft centres for insertion of tachometer.
 - .4 Removable for servicing.
- .3 Provide means to permit lubrication and use of test instruments with guards in place.
- .4 Install belt guards to allow movement of motors for adjusting belt tension.
- .5 Guard for flexible coupling:
 - .1 "U" shaped, minimum 1.5mm 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, 19mm mesh.
 - .2 Net free area of guard: not less than 80% of fan openings.
 - .3 Securely fasten in place.
 - .4 Removable for servicing.

3 Execution

3.1 INSTALLATION

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

End of Section

1 General

1.1 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with 01 33 00 - Submittal Procedures.
- .2 Indicate on manufacturers catalogue literature the following:
 - .1 Thermometers.
 - .2 Pressure gauges.
 - .3 Mini ball valves.
 - .4 Siphons.
 - .5 Wells.

1.2 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Provide NIST Certificate with each gauge

2 Products

2.1 GENERAL

- .1 Thermometers and pressure gauges to operate at mid point of scale or range.
- .2 Provide NIST Certificate with each thermometer and gauge.

2.2 DIRECT READING THERMOMETERS

- .1 Industrial, metal casing variable angle type, liquid filled, 125mm scale length: to CAN/CGSB 14-GP-2A:
 - .1 Thermometers shall read temperatures in both Fahrenheit and Celsius.

2.3 REMOTE READING THERMOMETERS

- .1 100mm mercury activated dial type: to CAN/CGSB-14.5, stainless steel bourdon tube, accuracy within one scale division, dual scale (metric and English), brass movement, stainless steel capillary, stainless steel spiral armour, stainless steel bulb and polished brass case for wall mounting.

2.4 THERMOMETER WELLS

- .1 For copper pipe use copper or bronze. For steel pipe use stainless steel.

2.5 PRESSURE GAUGES

- .1 100mm metal casing, dual scale (psi & kpa) dial type: CGSB 91-GP-3, having 1/2 of 1% accuracy unless otherwise specified.
- .2 Provide mini ball valves and:
 - .1 Snubber for pulsating operation.
 - .2 Diaphragm for corrosive service.

2.6 MAGNEHELIC PRESSURE GAUGE

- .1 Flash mounted kit, 100mm metal casing, dual scale (in Wg and Pa), dial type for providing clean room positive pressurization indication, $\pm 2\%$ accuracy on full scale.

3 Execution

3.1 GENERAL

- .1 Install so they can be easily read from floor or platform. If this cannot be accomplished, install remote reading thermometers and gauges.
- .2 Install engraved lamicoid nameplates as specified in Section 23 05 54 - Mechanical Identification.

3.2 THERMOMETERS

- .1 Install in wells on all piping. Provide heat conductive material for inside of well.
- .2 Install in locations as indicated and on inlet and outlet of:
 - .1 DHW tanks.
 - .2 Inlet and outlet on all three way control valves.
 - .3 Inlet & outlet of heating coils.
 - .4 Inlet and outlet of heat exchangers.
 - .5 Other locations as noted.
- .3 Use extensions where thermometers are installed through insulation.

3.3 PRESSURE GAUGES

- .1 Install in following locations:
 - .1 Suction and discharge of pumps.
 - .2 Upstream and downstream of mixing valves and control valves.
 - .3 Inlet and outlet of heating coils.
 - .4 DHW tanks.
 - .5 Water meter and backflow preventer.
 - .6 Sprinkler systems
 - .7 Boilers
 - .8 In other locations as indicated.
- .2 Use extensions where pressure gauges are installed through insulation.

3.4 MAGNEHELIC PRESSURE GAUGES

- .1 Install in following locations:
 - .1 Across AHU filter banks.
 - .2 At entrance / exit to each sub-divided clean room space.

End of Section

1 General

1.1 REFERENCES

- .1 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME).
 - .1 ANSI/ASME B1.20.1-[1983(R1992)], Pipe Threads, General Purpose (Inch).
- .2 American Society for Testing and Materials (ASTM).
 - .1 ASTM A276-[98b1], Specification for Stainless and Heat Resisting Steel Bars and Shapes.
 - .2 ASTM B62-[93], Specification for Composition Bronze or Ounce Metal Castings.
 - .3 ASTM B283-[91], Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
 - .4 ASTM B505-[96], Specification for Copper-Base Alloy Continuous Castings.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
 - .1 SP-25-1998, Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 SP-80-1999, Bronze Gate Globe, Angle and Check Valves.

1.2 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit data for all valves specified in this section.

1.3 CLOSEOUT SUBMITTALS

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

1.4 EXTRA MATERIALS

- .1 Furnish following spare parts:
 - .1 Valve seats: one for every 10 valves each size, minimum 1.
 - .2 Discs: one for every 10 valves, each size. Minimum 1.
 - .3 Stem packing: one for every 10 valves, each size. Minimum 1.
 - .4 Valve handles: 2 of each size.
 - .5 Gaskets for flanges: one for every 10 flanged joints.

2 Products

2.1 GENERAL

- .1 Except for specialty valves, to be single manufacturer.
- .2 All products to have CRN registration numbers.

2.2 END CONNECTIONS

- .1 Connection into adjacent piping/tubing:
 - .1 Steel pipe systems: Screwed ends.
 - .2 Copper tube systems: Solder ends.

2.3 LOCKSHIELD KEYS

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

2.4 GATE VALVES

- .1 Requirements common to all gate valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: with hex. Shoulders.
 - .3 Connections: with hex. Shoulders.
 - .4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - .5 Packing: high grade non-asbestos packing.
 - .6 Handwheel: non-ferrous. 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 WP = 1380Kpa WOG.
 - .3 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 WP = 2068 Kpa WOG.
 - .3 Operator: Handwheel.
- .4 NPS 2 and under, rising stem, split wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 WP = 1380 Kpa WOG.
 - .3 Disc: split wedge, bronze to ASTM B283, loosely secured to stem.
 - .4 Operator: Handwheel.
- .5 NPS 2 and under, rising stem, solid wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 WP = 1380 Kpa WOG.
 - .3 Operator: Handwheel.
- .6 NPS 2 and under, rising stem, solid wedge disc, Class 150:
 - .1 Body: with long disc guides, [screwed] [union] bonnet.
 - .2 WP = 2068 Kpa WOG.
 - .3 Operator: Handwheel.

2.5 GLOBE VALVES

- .1 Requirements common to all globe valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: with hex shoulders.
 - .3 Connections: with hex 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. Nut: bronze to ASTM B62
- .2 NPS 2 and under, composition disc, Class 125:
 - .1 Body and bonnet: screwed bonnet.
 - .2 WP = 1380 Kpa WOG.
 - .3 Disc and seat: renewable rotating [PTFE] disc [composition to suit service conditions], regrindable seat, loosely secured to bronze stem to ASTM B505.
 - .4 Operator: Handwheel.
- .3 NPS 2 and under, composition disc, Class 150:
 - .1 Body and bonnet: union bonnet.
 - .2 WP = 2068 Kpa WOG.
 - .3 Disc and seat: renewable rotating [PTFE] disc in easily removable disc holder, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
 - .4 Operator: Handwheel.
- .4 NPS 2 and under, plug disc, Class 150, screwed ends:
 - .1 Body and bonnet: union bonnet.

- .2 WP = 2068 Kpa WOG.
- .3 Disc and seat ring: tapered plug type with disc stem ring of AISI S420 stainless steel to ASTM A276, loosely secured to stem.
- .4 Operator: Handwheel.
- .5 Angle valve, NPS 2 and under, composition disc, Class 150:
 - .1 Body and bonnet: union bonnet.
 - .2 WP = 2068 Kpa WOG.
 - .3 Disc and seat: renewable rotating PTFE disc in slip-on easily removable disc holder having integral guides, regrindable bronze seat, loosely secured to stem.
 - .4 Operator: Handwheel.

2.6 CHECK VALVES

- .1 Requirements common to all check valves, unless specified otherwise.
 - .1 Standard specification: MSS SP-80
 - .2 Connections: with hex. Shoulders.
- .2 NPS 2 and under, swing type, bronze disc, Class 125:
 - .1 Body: Y-pattern with integral seat at 45°, screw-in cap with hex head.
 - .2 WP= 1380 Kpa WOG.
 - .3 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°, screw-in cap with hex head.
 - .2 Class 150, WP = 2068 Kpa WOG.
 - .3 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°, screw-in cap with hex head. WP = 1380 Kpa cold water.
 - .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. WP = 1.03 2068 Kpa WOG.
 - .2 Disc: renewable PTFE rotating disc in disc holder having guides top and bottom, of bronze to ASTM B62.
 - .3 NPS 2 and under, vertical lift type, bronze disc, Class 125:
 - .1 Body: with integral seat. WP = 1380 Kpa WOG.
 - .2 Disc: rotating disc having guides top and bottom, disc guides, retaining rings.

2.7 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, WP = 1380 Kpa WOG.
 - .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.

2.8 BALL VALVES

- .1 NPS 2 and under:
 - .1 Body and cap: cast high tensile bronze to ASTM B62.
 - .2 Pressure rating: Class 125, 1380 Kpa WOG.
 - .3 Connections: Screwed ends to ANSI B1.20.1 and with hex shoulders, solder

- ends to ANSI.
- .4 Stem: tamperproof ball drive.
- .5 Stem packing nut: external to body.
- .6 Ball and seat: replaceable stainless steel solid ball and teflon seats.
- .7 Stem seal: TFE with external packing nut.
- .8 Operator: removable lever handle.

3 Execution

3.1 INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Remove internal parts before soldering.

End of Section

1 General

1.1 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, Class 25, 125, 250, and 800.
- .2 American Society for Testing and Materials (ASTM).
 - .1 ASTM A49-[95], Specification for Heat-Treated Carbon Steel Joint Bars.
 - .2 ASTM A126-[95e1], 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-[99], Specification for Aluminum-Alloy Die Castings.
 - .6 ASTM B209-[99], Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

1.2 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit data for valves specified in this section.

1.3 CLOSEOUT SUBMITTALS

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

1.4 EXTRA MATERIALS

- .1 Furnish following spare parts:
 - .1 Valve seats: one for every 10 valves each size, minimum 1.
 - .2 Discs: one for every 10 valves, each size, minimum 1.
 - .3 Stem packing: one for every 10 valves, each size, minimum 1.
 - .4 Valve handles: 2 of each size.
 - .5 Gaskets for flanges: one for every 10 flanged joints.

2 Products

2.1 GENERAL

- .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 plain face with 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°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 ½ - 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 125, WP = 1380 Kpa CWP
 - .2 Disc: solid offset taper wedge, bronze to ASTM B62 up to and including NPS 3, bronze rings rolled into cast iron disc on other sizes, secured to bronze stem 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.
 - .9 Bypass: complete with union and globe valve as per paragraph 2.4.
- .2 NPS 2 ½-8, 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 125, WP = 1380 Kpa CWP.
 - .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 Item: 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 Pressure-lubricated operating mechanism.
 - .8 Operator: Handwheel.

2.3 UNDERWRITERS APPROVED GATE VALVE

- .1 NPS 2 ½ - 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: 1723 Kpa CWP
- .12 Operator: Handwheel.

2.4 GLOBE VALVES

- .1 NPS 2 ½ - 10, OSY:
 - .1 Body: with multiple-bolted bonnet.
 - .2 WP: 1380 Kpa 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 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 8'- 0" above floor in mechanical equipment rooms.

2.6 CHECK VALVES

- .1 Swing check valves, Class 125:
 - .1 Body and bolted cover: with tapped and plugged opening on each side for hinge pin. Flanged ends: plain faced with smooth finish.
 - .1 Up to NPS 16: cast iron to ASTM A126 Class B
 - .2 Ratings:
 - .1 NPS 2 ½ - 12: 860 kPa steam; 1380 Kpa CWP.
 - .3 Disc: Rotating for extended life.
 - .1 Up to NPS 6: bronze to ASTM B62.
 - .4 Seat rings: renewable bronze to ASTM B62 screwed onto body.
 - .5 Hinge pin, bushings: renewable bronze to ASTM B62.
 - .6 Disc: A126 Class B, secured to stem, rotating for extended life.
 - .7 Seat: cast iron, integral with body.
 - .8 Hinge pin: exelloy, bushings: malleable iron.
 - .9 Identification tag: fastened to cover.
 - .10 Hinge: galvanized malleable iron.
- .2 Swing check valves, NPS 2 ½ - 8 Class 250.
 - .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: raised face with serrated finish.
 - .3 Rating: 3450 Kpa 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.

2.7 SILENT CHECK VALVES

- .1 Construction:
 - .1 Body: ductile iron with integral seat.
 - .2 Pressure rating: Class 125, WP = 360 Kpa
 - .3 Connections: grooved ends.
 - .4 Disc: bronze renewable rotating disc.
 - .5 Seat: renewable, EPDM.
 - .6 Stainless steel spring, heavy duty.

3 Execution

3.1 INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.

End of Section

1 General

1.1 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with 01 33 00 - Submittal Procedures.
- .2 Indicate on manufacturers catalogue literature the following:
 - .1 Upper attachment.
 - .2 Middle attachment.
 - .3 Pipe attachment.
 - .4 Riser clamps.
 - .5 Shields and saddles.
 - .6 Sway braces.

1.2 MAINTENANCE DATA

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

2 Products

2.1 GENERAL

- .1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS SP58.
- .2 Support from top of structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.

2.2 UPPER ATTACHMENTS

- .1 Concrete:
 - .1 Inserts for cast in place concrete: galvanized steel wedge to MSS SP58, type 18. ULC listed for pipe NPS 3/4 through NPS 8.
 - .2 Carbon steel plate with clevis, for surface mount: malleable iron socket and expansion case and bolt. Minimum two expansion cases and bolts for each hanger.
- .2 Steel beam (bottom flange):
 - .1 Cold piping 2" and under: malleable iron C clamp to MSS SP58, type 19. ULC listed.
 - .2 Cold piping NPS 2 1/2 and larger and all hot piping: malleable iron beam clamp to MSS SP58, type 28 or 29. ULC listed.
- .3 Steel beam (top):
 - .1 Cold piping NPS 2 and under: malleable iron "top of beam" C clamp to MSS SP58, type 19. ULC listed.
 - .2 Cold piping NPS 2 1/2 and larger and all hot piping: steel jaw, hook rod with nut, spring washer and plain washer, to MSS SP58, type 25. ULC listed.
- .4 Steel joist:
 - .1 Cold piping 2" and under: steel washer plate with double locking nuts.
 - .2 Cold piping NPS 2 1/2 and larger and all hot piping: steel washer plates with double locking nut, carbon steel clevis and malleable iron socket.
- .5 Steel channel or angle (bottom):
 - .1 Cold piping NPS 2 and under; malleable iron C clamp to MSS SP58, type 23. ULC listed.
 - .2 Cold piping NPS 2 1/2 and larger and all hot piping; universal channel clamp. ULC listed.
- .6 Steel channel or angle (top):
 - .1 Cold piping 2" and under; malleable iron "top of beam" C clamp to MSS SP58, type 19. ULC listed.
 - .2 Cold piping NPS 2 1/2 and larger and all hot piping: steel jaw, hook rod with nut, spring washer and plain washer, to MSS SP58, type 25. ULC listed.

2.3 MIDDLE ATTACHMENT

- .1 Carbon steel threaded rod black electro-galvanized for mechanical rooms finish.

2.4 PIPE ATTACHMENT

- .1 Cold piping, steel or cast iron: hot piping steel, with less than 25mm horizontal movement; hot piping, steel, with more than 300mm middle attachment (rod) length: adjustable clevis to MSS SP58, type 1. ULC listed.
- .2 Cold copper piping; hot copper piping with less than 25mm horizontal movement; hot copper piping with more than 300mm middle attachment (rod) length: adjustable clevis to MSS SP58, type 1. Copper plated.
- .3 Suspended hot piping, steel and copper, with horizontal movement in excess of 25mm; hot steel piping with middle attachment (rod) 300mm or less; pipe roller to MSS SP58, type 43.
- .4 Bottom supported hot piping, steel and copper: pipe roller stand to MSS SP58, type 45.

2.5 RISER CLAMPS

- .1 Steel or cast iron pipe: galvanized black carbon steel to MSS SP58, type 42. ULC listed.
- .2 Copper pipe: carbon steel copper finished to MSS SP58, type 42.

2.6 SADDLES AND SHIELDS

- .1 Cold piping NPS 1-1/4" and over: protection shield with high density insulation under shield with uninterrupted vapour barrier.
- .2 Hot piping NPS 1 1/4 and over: protective saddle with insulation under saddle. Saddle to be tack welded to pipe.

2.7 GUIDES AND ANCHORS

- .1 Guides: Provide factory-built guide lines to permit axial movement only and to restrain lateral and angular movement. Guides must be designed to withstand a minimum of 15 percent of the axial force which will be imposed on the expansion joints and anchors. Field-built guides may be used if detailed on the contract drawings.
- .2 Anchors and Guides: Provide type, quantity and spacing as recommended by manufacturer of expansion joint and as shown. A professional engineer shall verify in writing that anchors and guides are properly designed for forces and moments which will be imposed

3 Execution

3.1 HANGER SPACING

- .1 Spacing and middle attachment (rod) diameter as specified in paragraphs below or as in table below, whichever is more stringent.
 - .1 Plumbing piping: most stringent requirements of Canadian Plumbing Code, Provincial Code, or authority having jurisdiction.
- .2 Copper piping: up to NPS 1/2: every 1.5m
- .3 Flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.
- .4 Within 12" of each horizontal elbow.

Pipe Size: NPS	Rod Diameter	Maximum Spacing Steel	Maximum Spacing Copper
up to 1 1/4	9mm	21m	1.8m
1 1/2	9mm	2.7m	2.4m
2	9mm	3m	2.7m

2 1/2	13mm	3.6m	3m
3	13mm	3.6m	3m
3 1/2	13mm	3.9m	3.3m
4	16mm	4.2m	3.6m
5	16mm	4.8m	
6	22mm	5.1m	
8	22mm	5.8m	
10	22mm	6.7m	
12	22mm	7m	

3.2 HANGER INSTALLATION

- .1 Offset hanger so that rod is vertical in operating position.
- .2 Adjust hangers to equalize load.

End of Section

1 General

1.1 GENERAL CONDITIONS

- .1 Division 1, General Requirements, is a part of this Section and shall apply as if repeated here.

1.2 SCOPE OF WORK

- .1 Furnish and install vibration control devices, materials, and related items. Perform all work as shown on the drawings and as specified herein to provide complete vibration isolation systems in proper working order.

1.3 MATERIALS AND EQUIPMENT

- .1 All vibration mounts shall be supplied by one of the following approved manufacturers:
 - .1 Mason Industries Inc. - M.I.
 - .2 Kinetics Noise Control In. - K.N.C.
 - .3 Vibration Mountings & Control Inc. - V.M.&C.
 - .4 Vibron.
- .2 Unless otherwise specified, supply only new equipment, parts and materials.
- .3 Substitutions of equal equipment beyond the alternatives listed will be permitted only with the written permission of the Architect. Accompany each request for acceptance of substitute equipment with manufacturer's certified data proving the equivalence of the proposed substitute in quality and performance. The Architect shall be the final judge of the validity of the data submitted.

1.4 QUALITY ASSURANCE

- .1 Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pads.
- .2 Provide vibration isolators of the appropriate sizes and proper loading to meet the specified deflection requirements.
- .3 Supply and install any incidental materials needed to meet the requirements stated herein, even if not expressly specified or shown on the drawings, with claim for additional payment.
- .4 Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.

1.5 SUBMITTALS

- .1 The manufacturer of vibration isolation shall provide submittals for products as follows:
 - .1 Descriptive Data:
 - .1 Schedules of flexibly mounted equipment, referencing drawings by number.
 - .2 Catalogue cuts or data sheets on vibration isolators.
 - .2 Shop Drawings:
 - .1 Submit details of equipment bases including dimensions, structural member sizes and support point locations.
 - .2 Submit details of isolation hangers for ceiling hung equipment, piping and ductwork.
 - .3 Submit details of mounting for floor supported equipment, piping and ductwork.
 - .4 All hanger, mounting or pad drawing shall indicate deflections and model numbers as well as any other requirements in the specifications.
 - .5 Spring diameters, rated loads and deflections, heights at rated load and closed height shall be provided for all springs shown in the submittals in tabular form.
 - .6 Complete flexible connector details.

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1.6 REQUESTS FOR CHANGE

- .1 Any requests for changes to the specifications must be submitted in writing at least ten(10) days prior to bid closing. Approval will be given through a written addendum.

2 Products

2.1 VIBRATION ISOLATION

- .1 General Mount Types
 - .1 All metal parts of vibration isolation units installed out-of-doors shall be cold-dip galvanized, cadmium-plated, or neoprene coated after fabrication. Galvanizing shall meet ASTM Salt Spray Test Standards and Federal Test Standard No. 14.
 - .2 Isolator types are scheduled to establish minimum standards. At the Contractor's option, labour-saving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevations during installation and initial system filling operations, and similar installation advantages. Accessories must not degrade the vibration isolation system.
 - .3 Static deflection of isolators shall be as specified and as shown on the drawings. All static deflection stated are the minimum acceptable deflection for the mounts under actual load. Isolators selected on the basis of rated deflection are not acceptable and will be disapproved.
- .2 Type SH (Hanger Spring)
 - .1 Vibration isolation hangers shall consist of a free standing laterally stable steel spring set into a neoprene cup, contained within a steel housing. The neoprene cup shall be manufactured with a grommet (or other element) to prevent the hanger rod from contacting the hanger housing. A steel washer shall be provided in the neoprene cup to evenly distribute load onto the neoprene. Spring diameter and hanger housing lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 arc before contacting the housing. Spring elements shall have a minimum additional travel deflection.
- .3 Type SHR (Hanger Spring and Neoprene)
 - .1 Vibration isolation hangers shall consist of a free standing laterally stable steel spring and a neoprene or a glass fiber element in series, contained within a steel housing. A neoprene neck bushing (or other element) shall be provided where the hanger rod passes through the hanger housing to prevent the rod from contacting the hanger housing. Spring diameter and hanger housing lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 arc before contacting the housing. Spring elements shall have a minimum additional travel to solid equal to 50% of the actual deflection. The neoprene element shall be designed to have a 3" minimum static deflection.

2.2 SPRING ISOLATORS

- .1 Type SH Spring Isolators
 - .1 Free standing and laterally stable without any housing. All mounts shall have levelling bolts. Spring diameter shall not be less than 0.8 compressed height of the spring at rated load. Each isolator shall be mounted on a double layer of 5/16" thick ribbed or waffle neoprene separated by a 16 ga. Stainless steel plate. A square bearing plate shall be provided to load the pad uniformly in the range of 40 to 50 psi.
- .2 Type SLR Spring Isolators:
 - .1 Open, stable pair of steel springs and include vertical travel limit stops to control extension when weight is removed. The housing of the spring unit shall serve as a blocking during erection of equipment. Unit isolator base plate shall be complete with two layers of 8mm thick ribbed or waffle pattern neoprene pads separated by a 16 ga. Stainless steel plate. Base plate shall be sized to load the pad uniformly in the range of 40 to 50 psi.
- .3 Type NSN Pads:

- .1 Double layer of 12mm thick 50 durometer neoprene separated by 6mm thick steel plate.
- .4 Type S Steel Base:
 - .1 Frame of the base shall consist of structural steel sections, sized, spaced and connected to form a rigid base which will not twist, rack, deform or deflect in any manner that will negatively affect the operation of the supported equipment or performance of the vibration isolation mounts. Frames shall include side mounting brackets for attachment to Type SL or SLR spring isolators. The clearance between the underside of the base and top of the floor shall be at least 50mm

3 Execution

3.1 APPLICATION

- .1 General
 - .1 Refer to Section 2 - PRODUCTS of this specification for vibration isolation devices identified on the drawings or specified herein.
 - .2 The static deflection of all isolators specified herein are the minimum acceptable deflections for the mounts under actual load. Isolators selected on the basis of rated deflection are not acceptable and will be disapproved.

End of Section

1 General

1.1 REFERENCES

- .1 Do Identification work in accordance with CGSB 24 GP 3a, Identification and Classification of Piping Systems.
- .2 Provide ULC and CSA registration plates as required by respective agency.

1.2 SAMPLES

- .1 Submit samples in accordance with 01 33 00 - Submittal Procedures.
- .2 Submit samples and lists of proposed wording for approval before engraving.

2 Products

2.1 MANUFACTURERS NAMEPLATES

- .1 Each piece of equipment shall have a metal nameplate mechanically fastened to equipment, with raised or recessed letters. Nameplates to be located so that they are easily read. Do not insulate or paint over plates.
- .2 Include registration plates (eg. Pressure vessel, Underwriters' Laboratories and CSA approval) as required by respective agency and as specified. The supplier shall indicate size, equipment model, manufacturer=s name, serial number, voltage, cycle, phase and power of motors.

2.2 SYSTEM NAMEPLATES

- .1 Major equipment to be identified with laminated plastic plates with black face and white centre (lettering) of minimum size 875mm x 38mm x 2mm nominal thickness, engraved with 1/2" high lettering.
- .2 Nameplates to be fastened securely with pop rivets or screws in conspicuous place. Where nameplates cannot be mounted, such as on cool surfaces, provide standoffs.
- .3 Equipment type, number and service or areas or zone of building it serves to be identified.

2.3 EQUIPMENT CONCEALED BY CEILING

- .1 At valves, plumbing air vents and drains, and other similar pieces of equipment located above T-bar ceilings or access doors, provide circular 18mm diameter self adhesive identification discs on the underside of the ceiling, located as near as possible to where the item is located.
- .2 Discs shall be coloured as scheduled in this specification.
- .3 Where the item has a primary and secondary colour, provide a 18mm diameter primary color disc with a 18mm diameter secondary color disc centred on the primary disc.
- .4 For backflow preventors, fire dampers, air terminal units, exhaust fans, reheat coils and other similar pieces of equipment located above T-bar ceilings or access doors, provide laminated plastic plates as noted for System nameplates above. A second identical plate shall be installed on the underside of the ceiling grid or access door opening frame, as close as possible to the location of the equipment.

2.4 PIPE IDENTIFICATION

- .1 Medium in piping to be identified as indicated below showing name and service, including temperature and pressure as indicated below, and directional flow arrows where relevant.
- .2 Colour Bands, Arrows and Wrap mark
 - .1 Plastic coated cloth material with protective over coating and waterproof contact adhesive undercoating, suitable for continuous operating temperature of 148°C and intermittent temperature of 204°C
 - .2 50mm wide tape single wrap around pipe or pipe covering with ends overlapping one pipe

- .3 diameter but not less than 25mm for colour bands. Tape is to be cut, not torn.
- .3 Block capital letters 50mm high for pipes of 75mm nominal and larger o.d. including insulation and not less than 18mm high for smaller diameters to be used.
- .4 Direction arrows 150mm long by 50mm wide for piping of 75mm nominal or larger o.d. including insulation and 100mm long by 18mm wide for smaller diameters to be used. Double headed arrows to be used where direction of flow is reversible.
- .5 Waterproof and heat resistant plastic marker tags to be used for pipes and tubing of 3/4" nominal and smaller o.d.
- .6 Use black pipe marker letters and direction arrows. Use white on red background for fire protection pipe markers.
- .7 Use wrap mark in lieu of colour band, arrows and stencils.
- .3 Stenciled Identification
 - .1 Provide stenciled identification using a first quality environmentally friendly paint and colour bands. Letters shall be a minimum of 50mm
- .4 Location Identification
 - .1 Markers and classifying colours on piping systems to be located so they can be seen from floor or platform.
 - .2 Piping runs to be identified at least once in each room.
 - .3 Do not exceed 10m between identification in open areas.
 - .4 Both sides where piping passes through walls, partitions and floors to be identified.
 - .5 Where piping is concealed in pipe chase or other confined space, point of entry and leaving, and at each access opening to be identified.
 - .6 Piping to be identified at starting and ending points of runs and at each piece of equipment.
 - .7 Identify branch, equipment or building served after each valve. (ie, heating zones are to be identified in Boiler Rooms).
 - .8 Provide primary and secondary colour banding.

Pipe Marker Legend	Valve Tag Legend	Primary Colour	Second Colour
Domestic Cold Water	DCW	Green	None
Domestic Hot Water Supp.	D.H.W.S.	Green	None
Domestic Hot Water Recirc.	D.H.W.R.	Green	None
Storm Sewer	S.S.	Green	None
San. Sewer	San. S.	Green	None
Fire Protection Water	F.P.	Red	White
Vent (Plumbing)	V.P.	Green	None
Hot Water Heating Supply	H.W.H.S.	Yellow	Black
Hot Water Heating Return	H.W.H.R.	Yellow	Black
Chilled Water Supply	C.H.W.S.	Yellow	Black
Chilled Water Return	C.H.W.R.	Yellow	Black
Refrigerant Suction (Include Refrig No.)	REF. S. (No)	Yellow	Black
High Pressure Steam	HPS 9 (MPa)	Yellow	Black
High Pressure Condensate	HCR	Yellow	Black
Low Pressure Steam	LPS (MPa)	Yellow	Black
Low Pressure Condensate Return	LCR	Yellow	Black
Pumped Condensate Return	PCR	Yellow	Black
Humidification Steam	LPS(H)	Yellow	Black
Steam Vent	V.S.	Yellow	Black

- .5 Valves:
 - .1 38mm laminated plastic plates (tags) with corner hole shall be provided for all valves and installed with nonferrous chains, AS@ hooks or heavy duty plastic tie wraps. Tags shall have horizontal 12mm letters accurately aligned and machine engraved into the core. Required for all valves and operating controllers.

- .2 Provide one valve chart for each Operations and Maintenance Manual and one chart framed and wall mounted.
- .3 Valves in systems to be numbered consecutively.
- .6 Buried Pipe Identification
 - .1 Use detectable Identoline underground warning tape colour coded to pipe service for full length of pipe.
 - .2 Bury to manufacturers recommendations.
 - .3 Identify all systems, equipment, components, controls and sensors. Inscription to identify function.
- .7 Duct Identification
 - .1 50mm high black stenciled letters to be used, i.e., "Supply", "Return", "Sanitary Exhaust", with directional flow arrow and Fan System No.
 - .2 Maximum distance between markings not to exceed 15m
 - .3 Locate identification on long straight runs in boiler and equipment rooms so that at least one is clearly visible from any one viewpoint in usual operating areas or walking aisles, adjacent to all changes in direction, at least once in each room, on both sides of visible obstructions, on both sides of walls, floors and partitions, at each piece of equipment and beside each access door.
 - .4 Stencil over final finish only.
 - .5 Identify system to include air handling unit number.
- .8 Controls Equipment Identification
 - .1 Electrically fed equipment supplied by Division 23 (excluding that noted in .2, below) shall be identified as per Division 26 identification requirements.
 - .2 Intermediate and end control devices including sensors, controllers, monitoring devices, etc., shall be identified with laminated plastic plates as noted for System nameplates above. The plates shall be fastened securely with pop rivets or screws. Where rivets or screws are not feasible, provide heavy duty plastic tie wraps. As a minimum control device identification shall correspond to descriptors provided in the approved shop drawings with respect to panel designation or DDC point name.

3 Execution

3.1 GENERAL

- .1 Do identification work in accordance with CGSB 24 GP 3a except where specified otherwise.

3.2 LOCATION OF NAMEPLATES

- .1 In conspicuous location to facilitate easy reading from operating floor and to properly identify equipment and/or system.
- .2 Provide stand offs for nameplates on hot surfaces and insulated surfaces.
- .3 Do not insulate or paint over plates.

3.3 PIPING

- .1 Locations:
 - .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, and tunnels so that at least one is clearly visible from any one viewpoint in operating areas or walking aisles and not at more than 10m intervals.
 - .2 Adjacent to all changes in direction.
 - .3 At least once in each small room through which piping passes.
 - .4 On both sides of visual obstruction or where run is difficult to follow.
 - .5 On both sides of any separation such as walls, floors and partitions.
 - .6 Where piping is concealed in pipe chase, ceiling space, gallery or other confined space, at entry and leaving points and adjacent to each access opening.

- .7 At beginning and end points of each run and at each piece of equipment in run.
- .8 At point immediately upstream of major manually operated or automatically controlled valves. Where this is not possible, place identification as close to valve as possible, preferably on upstream side.
- .9 Legend to be easily and accurately readable from usual operating areas and all readily accessible points.
- .10 Plane of legend to be approximately at right angles to most convenient line of sight with consideration of operating positions, lighting conditions, reduced visibility of colour or legends caused by dust and dirt and risk of physical damage.

3.4 DUCTWORK

- .1 Stencil over final finish only.
- .2 Locations of ductwork identification:
 - .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, and tunnels so that at least one is clearly visible from any one viewpoint in operating areas or walking isles and not at more than 15m intervals.
 - .2 Adjacent to all changes in direction.
 - .3 At least once in each small room through which ductwork passes.
 - .4 On both sides of visual obstruction or where run is difficult to follow.
 - .5 On both sides of any separation such as walls, floors and partitions.
 - .6 Where ductwork is concealed in duct chase, gallery or other confined space, at entry and leaving points and adjacent to each access opening.
 - .7 At beginning and end points of each run and at each piece of equipment in run.
 - .8 At point immediately upstream of major manually operated or automatically controlled dampers. Where this is not possible, place identification as close to damper as possible, preferably on upstream side.
 - .9 Legend to be easily and accurately readable from usual operating areas and all readily accessible points.
 - .10 Plane of legend to be approximately at right angles to most convenient line of sight with consideration of operating positions, lighting conditions, reduced visibility of colour or legends caused by dust and dirt and risk of physical damage.
 - .11 Beside each access door.

3.5 VALVES AND CONTROLLERS

- .1 Secure tags with non-ferrous chains or closed "S" hooks for valves and operating controllers.
- .2 Install one (1) copy of flow diagram and valve schedule mounted in frame with non glare glass where directed by Engineer. Provide one copy in each operating and maintenance instruction manual.
- .3 Consecutively number valves in system.

3.6 CEILING IDENTIFICATION TABS

- .1 Provide circular 18mm dia. self-adhesive valve identification tabs on the underside of suspended ceiling systems, attached to the suspension grid, located below all heating and domestic water isolation valves.
- .2 Colours:
 - .1 Domestic Water - 18mm Green
 - .2 Hot Water Heating - 10mm Yellow self-adhesive tab w/ 10mm Black insert
 - .3 Reheat boxes - 10mm Blue

3.7 BURIED PIPE IDENTIFICATION

- .1 Use Detectable Identoline underground warning tape colour coded to pipe service for full length of pipe.
- .2 Bury to manufacturer's recommendations.

End of Section

1 General

1.1 GENERAL

- .1 TAB: means to test, adjust and balance all systems, including equipment, to perform in accordance with Contract Documents.
- .2 Follow start-up procedures as recommended by manufacturer unless otherwise specified.
- .3 Special start-up procedures may be specified elsewhere. Make allowances of 3 days to assist in measurements as required for HVAC Commissioning.
- .4 TAB shall be carried out by an independent agency. TAB shall be carried out to AABC Standards.
- .5 TAB to apply to the following systems and equipment:
 - .1 Ventilation systems including all supply air, return air and exhaust air systems.
 - .2 TAB shall review the ductwork shop drawings to ensure installation of all the volume dampers required for air balancing and as per specifications and review the piping layouts to ensure the installation of circuit setters required for water balancing.
 - .3 Hydronic heating.
 - .4 Domestic hot water recirculation.
 - .5 TAB shall advise control trade, Mechanical Contractor and the Architect of any adjustments, changes or additions required to systems.
 - .6 Reheat Boxes: Measure and record the entering and leaving air temperatures with the control valve fully open and a damper in controlled minimum position.
 - .7 Domestic Hot Water.
- .6 Reference Standards:
 - .1 Do TAB of complete mechanical systems over entire operating range in accordance with most stringent conditions of selected standard:
 - .1 AABC (Associated Air Balance Council).
 - .2 Specifications herein or elsewhere in contract documents.
- .7 Start TAB only when building is essentially completed, including:
 - .1 Installation of ceilings, doors, windows and other construction affecting TAB.
 - .2 Application of sealing, caulking and weather-stripping.
 - .3 Normal operation of mechanical and associated electrical and control systems affecting TAB including, but not limited to, the following:
 - .1 Proper thermal overload protection in place for electrical equipment.
 - .2 Air Systems:
 - .1 Filters clean and in place.
 - .2 Duct systems clean of debris.
 - .3 Correct fan rotation.
 - .4 Fire and volume dampers in place and open.
 - .5 Coil fins cleaned and combed.
 - .6 Access doors closed and duct end caps in place.
 - .7 All outlets installed and connected.
 - .8 Duct systems leakage test complete.
 - .3 Liquid Systems:
 - .1 Flushed, filled and vented.
 - .2 Correct pump rotation.
 - .3 Proper strainer baskets clean and in place.
 - .4 Service and balance valves open.
 - .5 Liquid treatment system operable.
- .8 Accuracy:
 - .1 Do TAB to within plus 5% or minus 5% of design values.
 - .2 Pressure relationships to be maintained as per design.
 - .3 Measurements to be accurate to within plus or minus 2% of actual values.
- .9 Instrument Calibration: to be in accordance with TAB referenced standard, but within 3 months of

- commencement of TAB.
- .1 Provide proof of calibration to the Architect.
- .10 Report:
 - .1 Format to be in accordance with TAB referenced standard, but using units shown in contract documents.
 - .2 Report to include "As-Built" full system schematics showing results of TAB.
 - .3 Submit six (6) copies of TAB reports, each in "D" ring binders, complete with index tabs for verification and approval of the Architect.
- .11 Verification:
 - .1 Reported measurements shall be subject to verification by the Architect. Provide instrumentation and manpower to verify results of up to 30% of all reported measurements. Number and location of verified measurements to be at discretion of the Architect. If the verification of air and water balancing shows variance of more than 5% between the actual readings and the results of the air balancing report, the systems reporting the unacceptable variance shall be retested.
 - .2 Bear costs to repeat TAB, as required, to satisfaction of the Architect.
- .12 Settings: lock and permanently mark settings as required by reference standard.
- .13 Completion: TAB to be considered complete only when final reports are approved by the Architect.

1.2 AIR MOVING SYSTEMS

- .1 General: measurements as required by referenced standards, including, but not limited to, the following:
 - .1 Measurements:
 - .1 Air velocity.
 - .2 Static pressure.
 - .3 Velocity pressure.
 - .4 Temperature:
 - .2 Wet bulb.
 - .3 Dry bulb.
 - .1 Cross sectional area.
 - .2 RPM.
 - .3 Electrical power:
 - .1 Voltage.
 - .2 Current draw.
- .2 Location of equipment measurements:
 - .1 Inlet and outlet of each:
 - .1 Fan.
 - .2 Coil.
 - .3 Filter.
 - .4 Damper.
 - .5 Other auxiliary equipment.
- .3 Location of system measurements at:
 - .1 Main ducts.
 - .2 Main branch ducts.
 - .3 Sub-branch ducts.
 - .4 Each supply, exhaust and return air inlet and outlet.
 - .5 Other auxiliary equipment.
 - .6 All areas served by system.
- .4 All locations for systems measurements shall be identified as per paragraph 7.1 of this Section and be readily accessible for future testing agencies.

1.3 HYDRONIC SYSTEMS

- .1 General: measurements as required by referenced standards, including, but not limited to, following:
 - .1 Measurements:
 - .1 Flow.
 - .2 Pressure.
 - .1 Location of equipment measurements:
 - .2 Flow rates for each circuit setter.
 - .3 Location of system measurements at:
 - .1 Supply and return of each primary and secondary loop of following hydronic systems:
 - .1 Heating water.

1.4 SCHEDULING OF AIR BALANCING

- .1 The final air balancing report must be submitted a minimum of three (3) weeks before the substantial completion date.

1.5 IDENTIFICATION OF DUCT TRAVERSE LOCATIONS

- .1 Locations where duct traverses are taken shall be marked and identified on the ductwork and the ceilings to enable the location of existing holes in the ductwork for future airflow measurements.

1.6 COMMISSIONING

- .1 Assist the Engineer in HVAC systems commissioning as may be required. Allow for 3 days.
- .2 Engineer may require random check of TAB report of up to 1/3 (33%) of reported measurements. Provide instruments and staff to complete these measurements in the presence of the Engineer. Make good any deficiencies. If more than 10% of measurements deviate from report then repeat TAB for all systems.

End of Section

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 Related Sections:
 - .1 Section 01 33 00 - Submittal Procedures.
 - .2 Section 01 35 29 - Health and Safety Requirements.
 - .3 Section 01 45 00 - Testing and Quality Control.
 - .4 Section 01 78 00 - Closeout Submittals.
 - .5 Section 01 91 13 - General Commissioning Requirements.

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 certified test reports from approved independent testing laboratories 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 Consultant for approval at least one month before proposed date of first series of tests. Do not start tests until approval received in writing from Consultant.
 - .2 Prepare report of results and submit to Consultant within 24 hours 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 (CFM) for test sites.
 - .6 Witnessed certification of results.
 - .3 Include test reports in final TAB report and Building Management Manual
 - .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 on-site installations
 - .1 Verify project requirements.
 - .2 Review installation conditions.
 - .3 Co-ordination with other building sub trades.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

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 Consultant at least one month before anticipated start date.

2.2 LEAKAGE TOLERANCES

- .1 Ductwork leakage: 2 % (excluding Reheat Boxes).

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 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.
- .3 Repeat tests until specified 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.

3.3 SITE TOLERANCES

- .1 System leakage tolerances specified are stated as percentage of total flow rate handled by system. Pro-rate specified system leakage tolerances. Leakage for sections of duct systems: not to exceed total allowable leakage.
- .2 Leakage tests on following systems not to exceed specified leakage rates.
 - .1 Small duct systems up to 250 Pa: leakage 10%.
 - .2 HP duct systems up to 1000 Pa pressure classification, including upstream side of Reheat boxes: leakage 5%.
- .3 Evaluation of test results to use surface area of duct and pressure in duct as basic parameters.

3.4 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 Flexible connections to VAV boxes.

3.5 FIELD QUALITY CONTROL

- .1 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 product[s] and submit written reports, in acceptable format, to verify compliance of Work with Contract.
 - .2 Manufacturer's Field Services: 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:
 - .4 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.
 - .5 Upon completion of the Work, after cleaning is carried out.
 - .6 Obtain reports, within 5 days of review, and submit, immediately, to Consultant.

3.6 CLEANING

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

End of Section

1 General

1.1 REFERENCE STANDARDS

- .1 Meet NFPA 90A-1985. Maximum flame spread rating of 25 and maximum smoke developed rating of 50 in accordance with NFPA 255-1984 and CAN4-S102-M83 for all components of insulation system. Materials tested in accordance with ASTM C411-82.

1.2 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 pipe, fittings, valves and jointing recommendations.

1.3 SAMPLES SUBMITTALS

- .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 samples on 12mm plywood board. Affix typewritten label sample indicating service.

1.4 DEFINITIONS

- .1 For Purposes of this Section:
 - .1 "CONCEALED"- insulated mechanical services and equipment in hung ceilings and non-accessible chases and furred spaces.
 - .2 "EXPOSED"- will mean "not concealed" as defined herein.

2 Products

2.1 D-1 DUCT INSULATION WITH VAPOUR BARRIER

- .1 Application: Ductwork up to 760mm for the following:
 - .1 All supply ductwork.
 - .2 Fresh air intake ductwork.
 - .3 Exhaust air ducting from exterior penetration to motorized damper.
- .2 Material:
 - .1 CGSB 51-GP-11M+Amdt-Apr-78 mineral glass fiber blanket. CGSB-51-GP-52 for vapour barrier.
- .3 Thickness:
 - .1 Supply Air Ductwork - 37mm
 - .2 Fresh Air Intakes and Exhaust Plenums - 50mm
 - .3 Exhaust Air Duct - 25mm
 - .4 Exterior Supply Air Ducting 50mm.

2.2 D-2 FIBER GLASS RIGID WITH VAPOUR BARRIER

- .1 Application: Ductwork over 780mm for the following:
 - .1 All supply air ductwork.
 - .2 Exhaust air ductwork from fan or damper to exhaust louver.
 - .3 Exterior Ductwork
- .2 Material:
 - .1 CGSB 51-GP-10M, rigid mineral fiber board; CGSB 51-GP-52M vapour barrier, jacket and

- facing material.
- .3 Thickness:
 - .1 Supply Air Ductwork - 38mm
 - .2 Fresh Air Intakes and Exhaust Plenums - 50mm
 - .3 Exhaust Air Duct - 25mm

2.3 FASTENINGS

- .1 Tape: self adhesive, 100mm wide, rated under 25 for flame spread and under 50 for smoke development.
- .2 Contact Adhesive: Quick-setting, non flammable fire resistive to adhere fibrous glass to ducts. Flame spread 15, smoke development 0.
- .3 Lap Seal Adhesive: Quick-setting for joints and lap sealing of vapour barriers.
- .4 For Canvas:
 - .1 Washable adhesive for cementing canvas lagging cloth to duct insulation.
- .5 Pins:
 - .1 Weld pins 4mm diameter with 38mm diameter head of installation through the insulation. Length of suit thickness of insulation.
 - .2 Weld pins 2mm diameter, for installation prior to applying insulation. Length to suit thickness of insulation. Nylon retain clips 32mm square.

2.4 JACKETS

- .1 Canvas:
 - .1 Apply in exposed areas: ULC listed plain weave, cotton fabric at 0.19 Kg/mm²
- .2 Exterior Ductwork:
 - .1 Application exterior supply and exhaust ductwork as required.
 - .2 To ASTM B209 with moisture barrier as scheduled in Part 3 of this section.
 - .3 Thickness: Aluminum 0.50mm sheet.
 - .4 Finish: Corrugated.
 - .5 Jacket banding and mechanical seals: 12mm wide, 0.5mm thick stainless steel.
 - .6 An acceptable alternative to the above mentioned is Alumaguard 60 self-adhesive foil faced membrane.

2.5 FIRE BLANKET

- .1 ULC listed non-combustible duct fire protection system with 2-hour fire rating and the following characteristics:
 - .1 Flame Spread - 0
 - .2 Smoke Developed - 0
 - .3 Fuel Contributed - 0
- .2 Thickness of the fire blanket to be as required to provide a 2-hour fire rating. The fire blanket to have service range of 93°C to 1260°C and thermal resistance of 4.12 per inch.
- .3 The fire blanket to have encapsulated ULC approved jacket.
- .4 Ducts covered with fire blanket do not need to be insulated.
- .5 To be applied as per manufacturers recommendations.

3 Execution

3.1 APPLICATION

- .1 Apply insulation after required tests have been completed and approved by the Architect. Insulation and surfaces to be clean and dry when installed and during application of any finish.

- Apply insulation materials, accessories and finishes to manufacturer's recommendations and as specified.
- .2 Vapour barriers and insulation to be unbroken over full length of duct or surface, without penetration for hangers, standing duct seams and without interruption at sleeves.
- .3 Use stand-offs for all duct mounted control accessories.
- .4 Ductwork covered with fire blanket is not to be insulated.

3.2 INSTALLATION

- .1 General:
 - .1 Adhere and seal vapour barrier using vapour seal adhesives.
 - .2 Stagger longitudinal and horizontal joints on multi-layered insulation.
- .2 Mechanical Fastenings:
 - .1 On rectangular ducts, use 50% coverage of insulating cement and weld pins at not more than 200mm centers, but not less than 2 rows per side and bottom.
- .3 On round ducts use 100% coverage of insulating cement and self adhesive tape on joints.

3.3 CANVAS

- .1 Provide fire retardant coating on canvas jackets.
- .2 Fire retardant coating shall be U.L. approved.
- .3 Coat canvas covering exposed in finished spaces with diluted coat of lagging adhesive. Provide two coats of lagging adhesive. Dilution of lagging adhesive as per manufacturer's recommendations for painting.

End of Section

1 General

1.1 REFERENCE STANDARDS

- .1 Meet NFPA 90A-1985. Maximum flame spread rating of 25 and maximum smoke developed rating of 50 in accordance with NFPA 255-1984 and CAN4-S102-M83 for all components of insulation system. Materials tested in accordance with ASTM C411-82.

1.2 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 pipe, fittings, valves and jointing recommendations.

1.3 SAMPLES SUBMITTALS

- .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 samples on 1/2" plywood board. Affix typewritten label sample indicating service.

1.4 DEFINITIONS

- .1 For Purposes of this Section:
 - .1 "CONCEALED"- insulated mechanical services and equipment in hung ceilings and non-accessible chases and furred spaces.
 - .2 "EXPOSED"- will mean "not concealed" as defined herein.

1.5 GENERAL

- .1 No unjacketed insulation to be installed in manufacturing space.

2 Products

2.1 P-1 FORMED MINERAL FIBER TO 200°F

- .1 Application: for piping, valves and fittings on:
 - .1 Domestic hot water.
 - .2 Domestic hot water recirculation.
 - .3 Hot water heating
 - .4 All other hot piping systems.
 - .5 Steam Piping.
- .2 Material:
 - .1 CGSB-51-GP-9M, rigid mineral fibre sleeving for piping and CGSB-51-GP-52M, vapour jacket and facing material.
- .3 Thickness:

	NPS	NPS 1 1/4 to 2	NPS 2 1/2 to 4	NPS and up
High Pressure Steam and Condensate	2"	2 1/2"	2 1/2"	3 1/2"
Low Pressure Steam and Condensate	1 1/2"	1 1/2"	2"	2"
Hot Water Heating	1"	1"	1 1/2"	1 1/2"
Chilled Water Supply	1/2"	1"	1"	1"
Chilled Water Return	1/2"	1"	1"	1"

2.2 P-2 FORMED MINERAL FIBER WITH VAPOUR BARRIER TO 85°F

- .1 Application: for piping, valves and fittings on:
 - .1 Domestic cold water.
 - .2 Rainwater Piping.
 - .3 Chilled water Piping
- .2 Material:
 - .1 CGSB 51-GP-9M, rigid mineral fibre sleeving for piping and CGSB 51-GP-52M, vapour barrier jacket and facing material.
- .3 Thickness:
 - .1 All hot and cold piping: 1"

2.3 DOMESTIC HOT & COLD WATER PIPING IN WALLS

- .1 Insulation thickness on 12mm domestic hot and cold water drops located in drywall partitions will be 12mm.

2.4 FASTENINGS

- .1 For Insulation Systems P-1 and P-2:
 - .1 Tape: self adhesive.
 - .2 Lap seal adhesive: quick-setting for joints and lap sealing of vapour barriers with 100% coverage.
 - .3 Lagging adhesive: fire retardant coating.
- .2 For vapour barriers:
 - .1 Quick-setting adhesive for joints and lap sealing of vapour barriers. Flame spread 10, smoke development 0.
- .3 All adhesives shall be U.L. listed and suitable for application as per insulation manufacturers' recommendations.

2.5 JACKETS

- .1 Canvas:
 - .1 Apply in all exposed areas inside the building except those listed in 2.5.2. ULC listed plain weave, cotton fabric at 0.04 lbs/ft².
 - .2 Polyvinyl Chloride (PVC) - [Alternate Pricing Option]
 - .1 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.
 - .2 Colours: to match adjacent finish paint. Confirm colour with Owner's Representative.
 - .3 Minimum service temperature: -20°C.
 - .4 Maximum service temperature: 65°C.
 - .5 Moisture vapour transmission: 0.02 perm.
 - .6 Thickness: 0.55mm.
 - .3 Special requirements:
 - .1 Indoor: flame spread rating 25, smoke developed rating 50.
 - .2 Outdoor: UV rated material at least 0.5mm thick.
- .2 Aluminum
 - .1 Apply On all outdoor piping
 - .2 To ASTM B209
 - .3 Thickness 26 ga. sheet
 - .4 Finish: smooth
 - .5 Joining: longitudinal and circumferential slip joints with 2" laps
 - .6 Fittings 26 ga die-shaped fitting covers with factory-attached protective liner.

- .7 Metal jacket banding and mechanical seals stainless steel. 3/4" wide. 26 ga. 12" spacing.
- .3 An acceptable alternative to the above mentioned is Alumaguard 60 self-adhesive foil faced membrane.

2.6 REMOVABLE PREFABRICATED INSULATION AND ENCLOSURES

- .1 Application: Expansion joints, valves, orifice plates, strainers and unions.
- .2 Design: To permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.
- .3 Insulation:
 - .1 Flexible or preformed to fit components.
 - .2 Thickness to match application.
 - .3 Chilled Water Systems: provide vapour barrier.
 - .4 Enclosure: aluminum or stainless steel 0.05" thick to match adjacent pipe insulation. Insulation pads will be acceptable on hot piping system.

3 Execution

3.1 APPLICATION

- .1 Apply insulation after required tests have been completed and approved by Architect. Insulation and surfaces shall be clean and dry when installed and during application of any finish. Apply insulation materials, accessories and finishes in accordance with manufacturer's recommendations and as specified herein.
- .2 On piping with insulation and vapour barrier, install high density insulation under hanger shield. Maintain integrity of vapour barrier over full length of pipe without interruption at sleeves, fittings and supports.
- .3 Apply insulation materials, accessories and finished in accordance with manufacturers' recommendations.

3.2 INSTALLATION

- .1 Preformed: Sectional up to 12", sectional or curved segmented above 300mm
- .2 Expansion Joints in Insulation: Terminate single layer and each layer of multiple layers in straight cut at intervals recommended by manufacturer. Leave 1" void between terminations. Pack void tightly with mineral fibre.
- .3 Seal and finish exposed ends and other terminations with insulating cement.
- .4 Expansion Joints In Piping: Provide for adequate movement without damage to insulation or finishes.
- .5 Orifice Plate Mounting Flanges, Flanges & Unions at Equipment, Expansion Joints, Valves, Other Components Requiring Regular Maintenance: Install insulation and finish to permit easy disassembly and replacement without damage to adjacent insulation and finishes.
- .6 Insulation is not required for:
 - .1 Chromeplated piping, valves and fittings.
 - .2 Heating pipe connection between floor and the underside of heating unit for up fed units when the unit is 100mm above the floor.

3.3 FASTENINGS

- .1 Secure pipe insulation by tape at each end and centre of each section, but not greater than 450mm on centres.

3.4 CANVAS

- .1 Provide fire retardant coating on canvas jackets.
- .2 Fire retardant coating shall be U.L. approved.
- .3 Coat canvas covering exposed in finished spaces with diluted coat of lagging adhesive. Provide a total of two coats of lagging adhesive. Provide a total of two coats of lagging adhesive. Dilution of lagging adhesive as per manufacturer's recommendations for priming.

3.5 HANGERS

- .1 Hot Piping:
 - .1 For pipes up to 2", provide proper covering shields sized to suit the insulated pipe, between the pipe insulation and the pipe hanger or support.
- .2 Where roller hangers and supports are used for hot piping 2" diameter and larger, steel protection saddles shall be supplied and installed as part of the piping work. Pack the saddle voids with fiberglass insulation.

3.6 DEMOUNTABLE INSULATION

- .1 Insulation on valves, flanges and orifice plates for steam flow measurements and other fittings requiring access for servicing shall be demountable.

3.7 REFRIGERANT PIPING

- .1 Insulation shall fit in snug contact with pipe and be installed in accordance with Manufacturer's recommendations.
- .2 Stagger joints on layered insulation.
- .3 Slip insulation on tubing before tubing sections and fittings are assembled keeping slitting of insulation to a minimum.
- .4 Seal joints in insulation.
- .5 Insulate flexible pipe connectors.
- .6 Provide 6" long, 20 ga. galvanized steel sleeve around pipe insulation at each support.
- .7 Extend insulation through pipe support clamps.
- .8 Insulation shall have "slit" joint seams placed on bottom of pipe. Use manufacturer's recommended adhesive to seal joints.
- .9 Insulate fittings with sheet insulation and as recommended by manufacturer.

End of Section

1 General

1.1 REFERENCES

- .1 American Society for Testing and Materials International (ASTM).

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.

1.3 HYDRONIC SYSTEMS-PERFORMANCE VERIFICATION (PV)

- .1 Perform hydronic systems performance verification after cleaning is completed and system is in full operation. To Section 01 91 13 - General Commissioning Requirements.
- .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 & auto switchover to stand-by.
 - .2 Maximum heating demand.
 - .3 Outdoor reset. Re check mixing valve output supply temperature at 100% and 50% reset, maximum water temperature. Verify reset curve.

1.4 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 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 Heating system capacity test:
 - .1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:
 - .1 Increasing OA flow rates through heating coils (in this case, monitor heating coil discharge temperatures to ensure that coils are not subjected to freezing conditions) or
 - .2 Reducing space temperature by turning of heating system for sufficient period of time before starting testing.
 - .2 Test procedures:
 - .1 Open fully heating coil and radiation control valves.
 - .2 With boilers on full firing and hot water heating supply temperature stabilized, record flow rates and supply and return temperatures simultaneously.
 - .3 Conduct flue gas analysis test on boilers at full load and at low fire conditions. Combustion efficiency test is not sufficient.

1.5 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.
- .5 Verify start-up of fire pump and operation of auto transfer switch. Conduct flow test for fire pump.

1.6 REPORTS

- .1 In accordance with Section 01 91 13 - General Commissioning Requirements:

1.7 TRAINING

- .1 In accordance with Section 01 91 13 - General Commissioning Requirements:

End of Section

1 General

1.1 RELATED SECTIONS

- .1 Section 23 05 93 - Testing Adjusting and Balancing for HVAC.

1.2 REFERENCES

- .1 American Society for Testing and Materials

2 Products

2.1 CLEANING SOLUTIONS

- .1 Low foaming detergent at all temperatures.
- .2 No PH neutralization required.
- .3 Designed for use on most metals including aluminum.
- .4 Biodegradable
- .5 Phosphate free.
- .6 Nitric free.

3 Execution

3.1 CLEANING HYDRONIC AND STEAM SYSTEMS

- .1 Timing
 - .1 Systems to be operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.
- .2 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete.
- .3 Cleaning procedures:
 - .1 Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:
 - .1 Cleaning procedures, flow rates, elapsed time.
 - .2 Chemicals and concentrations to be 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 to be used to ensure water will not damage systems or equipment.
- .4 Conditions at time of cleaning of systems
 - .1 Systems to be free from construction debris, dirt and other foreign material.
 - .2 Control valves to be operational, fully open to ensure that terminal units can be cleaned properly.
 - .3 Strainers to be 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.
- .5 Report on Completion of Cleaning
 - .1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.

End of Section

1 General

1.1 REFERENCES

- .1 ASME Section VIII for Unfired Pressure Vessels, 1983.
- .2 ASTM A47M 84, Specification for Ferritic Malleable Iron Castings.
- .3 ASTM A278M 85, Specification for Gray Iron Castings for Pressure Containing Parts for Temperatures up to 345EC.
- .4 ASTM A516/516M 86, Specification for Pressure Vessel Plates, Carbon Steel, for Moderate and Lower Temperature Service.
- .5 ASTM A536 84, Specification for Ductile Iron Castings.
- .6 ASTM B62 86, Specification for Composition Bronze or Ounce Metal Castings.
- .7 CSA B51 M1986, Boiler, Pressure Vessel, and Pressure Piping Code.

1.2 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with 01 33 00 - Submittal Procedures.
- .2 Indicate on manufacturers catalogue literature: expansion tanks air vents separators valves and strainers.

1.3 MAINTENANCE DATA

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

2 Products

2.1 PIPE LINE STRAINER

- .1 NPS 1/2" to NPS 2": bronze body to ASTM B62, solder screwed connections.
- .2 NPS 2 1/2" to 12": cast steel body to ASTM A278, Class 30, flanged connections.
- .3 NPS 2" to 12": T type with ductile iron body to ASTM A536 grooved ends.
- .4 Sizes: as indicated.
- .5 Blowdown connection: NPS 1
- .6 Screen: stainless steel brass with perforated size of 1.6mm
- .7 Working pressure: 860 Kpa

2.2 AUTOMATIC AIR VENT

- .1 Standard Float Vent: Brass body and 3 mm connection and rated at 690 KPa working pressure.
- .2 Industrial Float Vent: Cast iron body and 12 mm connection and rated at 860 KPa working pressure.

3 Execution

3.1 GENERAL

- .1 Install as indicated and to manufacturer's recommendations.
- .2 Pipe drains and blow off connections to nearest drain.
- .3 Maintain proper clearance to permit service and maintenance.
- .4 Should deviations beyond allowable clearances arise, request and follow Engineer's directive.
- .5 Refer to manufacturer's installation drawings.
- .6 Check that all openings for appurtenances and equipment operating weight conform to shop drawings.

3.2 STRAINERS

- .1 Install in horizontal or down flow lines.
- .2 Ensure clearance for removal of basket.
- .3 Install ahead of each pump.

3.3 AIR VENTS

- .1 Install at high points of systems.
- .2 Install mini ball valves on automatic air vent inlet. Run discharge to nearest drain.

3.4 PRESSURE SAFETY RELIEF VALVES

- .1 Pipe discharge to nearest drain.

3.5 SUCTION DIFFUSERS

- .1 Install on inlet to pumps.

End of Section

1 General

1.1 APPLICATIONS

- .1 This section intended for hot water heating, temperature range 4.4°C to 120°C and 860 Kpa. working pressure.

1.2 REFERENCES

- .1 ANSI B16.1 1975, Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800.
- .2 ANSI B16.5 1981, Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and other Special Alloys.
- .3 ASTM A53 87b, Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless.

1.3 SHOP DRAWINGS

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

1.4 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Provide maintenance data for incorporation into manual specified in 01 33 00 - Submittal Procedures.

2 Products

2.1 PIPE

- .1 Steel pipe: Schedule 40 to ASTM A53, Grade B, ASTM A120.
- .2 Schedule 10 with roll groove joints for NPS 2-1/2 and larger.

2.2 PIPE JOINTS

- .1 NPS 2 and under: screwed fittings with teflon tape.
- .2 NPS 2 1/2 and over: welding fittings and flanges to CSA W47.1.
- .3 Flanges: plain or raised face.
- .4 Orifice flanges: slip on raised face, 2068 Kpa
- .5 Flange gaskets: to ANSI B16.21 or ANSI B16.20.
- .6 Pipe thread taper.
- .7 Bolts and nuts: to ANSI B18.2.1.
- .8 Mechanical roll grooved coupling with gaskets rated for 200°F continuous use. Products shall have current CRN numbers from the Province of Prince Edward Island. Grooved coupling shall conform to CSA-B242.05. All grooved products shall be of one manufacturer.

2.3 FITTINGS

- .1 Cast iron pipe flanges: Class 125 to ANSI B16.1.
- .2 Screwed fittings: malleable iron, Class 150.
- .3 Pipe flanges and flanged fittings:
 - .1 Steel: to ANSI B16.5.
 - .2 Steel butt welding fittings.
- .6 Unions: malleable iron, to ASTM A47M.
- .7 Mechanical roll grooved piping.
 - .1 NPS 2 to 8: Rigid roll grooved couplings.
- .8 Fittings for roll grooved piping: malleable: iron to ASTM A47M094, ductile iron to ASTM A536-84.

3 Execution

3.1 PIPING INSTALLATION

- .1 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.
- .2 Install concealed pipes close to building structure to keep furring space to minimum. Install to conserve headroom and space. Run exposed piping parallel to walls. Group piping wherever practical.
- .3 Slope piping in direction of drainage and for positive venting.
- .4 Use eccentric reducers at pipe size change installed to provide positive drainage or positive venting.
- .5 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.
- .6 Ream pipes, clean scale and dirt, inside and outside, before and after assembly.
- .7 Assemble piping using fittings manufactured to ANSI standards.
- .8 Saddle type branch fittings may be used on mains if branch line is no larger than half the size of main. Hole saw or drill and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .9 Piping:
 - .1 Connect equipment as per manufacturer's installation literature and as instructed.
 - .2 Provide flexible connections at moving equipment.
 - .3 Route piping in orderly manner and maintain proper grades. 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.
 - .4 Slope water piping up in direction of flow 1:700 and drain at low points.
 - .5 On all closed systems, equip low points with 3/4" drain valves and hose nipples. Provide, at high points on lines and on equipment connections, collecting chambers and high capacity float operated automatic air vents.
 - .6 Make reductions in water pipe sizes with eccentric reducing fittings.
 - .7 Provide clearance for installation of insulation and for access to strainers, valves, air vents, drains, cleanouts, unions, expansion joints, flex connectors and trap assemblies.
 - .8 Ream pipes and tubes. Clean scale and dirt, inside and outside, before and after assembly.
 - .9 The use of "main sized saddle type branch connections" or "directly connecting branch lines to mains" in steel piping will be permitted if: for all water systems and low pressure steam systems, main is at least two pipe sizes larger than the branch up to NPS 6 mains; and if main is at least two pipe sizes larger than branch for NPS 8 and larger mains. Where reducing tees of proper size are not available, use available tees with an eccentric reducer. Tees with increasers shall not be acceptable.
 - .10 Make all connections to equipment with unions, or flanges.
 - .11 Provide non-conducting type connections wherever joining dissimilar metals. Brass adapters flanges and valves are acceptable.

3.2 TESTING

- .1 Test system in accordance with Section 23 05 01 - Common Work Results - Mechanical.

End of Section

1 General

1.1 SECTION INCLUDES

- .1 Materials and installation of steel piping valves, fittings for steam and condensate building services piping.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 35 29 - Health and Safety Requirements.
- .3 Section 01 78 00 - Closeout Submittals.
- .4 Section 01 91 13 - General Commissioning Requirements.
- .5 Section 23 05 01 - Common Work Results for Mechanical.
- .6 Section 23 08 02 - Cleaning and Start up of Mechanical Piping Systems.
- .7 Section 23 05 22 - Valves - Bronze.
- .8 Section 23 05 23 - Valves - Cast Iron.
- .9 Section 23 84 13 - Humidifiers.
- .10 Section 23 08 01 - Performance Verification of Mechanical Piping Systems.

1.3 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], Butt welding 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 Butt welding 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.

1.4 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit product data and include manufacturer's literature data sheets.
- .3 Submit shop drawings: As per Section 01 33 00 - Submittal Procedures.
- .4 Submit operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 HEALTH AND SAFETY

- .1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

1.6 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.

2 Products

2.1 GENERAL

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

2.2 LOW PRESSURE STEAM (0 TO 15 PSI) AND CONDENSATE RETURN UP TO 15 PSI

- .1 Piping:
 - .1 To ASTM A53/A53M, Grade B or ASTM A106/A106M.
 - .2 Steam:
 - .1 NPS 1/2 to 1-1/2: Sch. 40, seamless.
 - .2 NPS 2 to 10: Sch.40-ERW, bevel ends.
 - .3 Condensate Return Schedule 80, ERW screwed or plain end.
- .2 Fittings:
 - .1 NPS 1/2 to 1-1/2: Class 800, forged steel, socket weld ends, to ASTM A105/A105M, ASME B16.11.
 - .2 NPS 2 to 12: Sch. 40, bevel ends, to ASTM A234/A234M, Grade WPB.
- .3 Couplings, caps, plugs:
 - .1 NPS 1/2 to 1-1/2: Class 800, screwed, to ASTM A105/A105M.
- .4 Nipples for drains, vents, pressure gauges, similar items:
 - .1 NPS 1/2 to 1-1/2: Sch. 80, seamless, screwed, to ASTM A53/A53M, Grade A.
- .5 Unions:
 - .1 NPS 1/2 to 1-1/2: Class 800, screwed ends, steel-to-steel ground joints to ASTM A105/A105M, ASME B16.11.
- .6 Flanges:
 - .1 NPS 1/2 to 1-1/2: Class 125, full faced screwed to ASTM A105/A105M. ASME B16.5
 - .2 NPS 2 and over: Class 125, full faced, slip-on, bored to suit pipe, to ASTM A105/A105M. ASME B16.5.
- .7 Studs, bolts and nuts:
 - .1 Studs, bolts: With heavy hex heads, alloy steel to ASTM A193/A193M, grade B7.
 - .2 Nuts: Semi-finished heavy hex., to ASTM A194/A194M, grade 2H.
- .8 Gaskets:
 - .1 Steel flex, 1.6 mm thick, full face, rated for temperature and pressure of system.
- .9 Gate valves for steam systems:
 - .1 NPS 1/2 to 1-1/2: Class 800, screwed ends, forged steel body, union bonnet, solid wedge disc, rising stem.
 - .2 NPS2 to 12: Class 125, full faced flanged ends, cast steel body, hardened stainless steel trim, OS&Y, wedge disc.
- .10 Gate valves for pumped condensate return:
 - .1 NPS 1/2 to 1-1/2: Class 800, screwed ends, forged steel body, union bonnet, solid

- wedge disc, rising stem.
- .2 NPS2 to 12: Class 125, full faced flanged ends, cast steel body, hardened stainless steel trim, OS&Y, wedge disc.
- .11 Valves in external bypass around gate valves, NPS 8 and over:
 - .1 NPS 3/4 gate as specified above.
- .12 Check Valves:
 - NPS 1/2 to 1-1/2: Class 800, forged steel body, swing type, Y pattern, screwed ends, rotating PTFE disc.
- .13 Drain valves:
 - .1 Gate valves, NPS 3/4, as specified above.
- .14 Strainers for steam systems:
 - .1 NPS 1/2 to 1-1/2: Class 800, Y-type, screwed ends, body of forged steel, screen of monel or 304 stainless steel.
 - .1 Screen:
 - .1 Exposed area: 4 times cross-sectional area of pipe.
 - .2 Mesh: 100 mesh (0.15mm)
 - .2 NPS 2 and over: Class 125, Y-type, flanged ends, body of ASTM A216/A216M cast steel, screen of monel or 304 stainless steel.
 - .1 Screen:
 - .1 Exposed area: 4 times cross-sectional area of pipe.
 - .2 Mesh: 100 mesh (0.15mm)

2.3 ANCHORS, GUIDES, SLIDES

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

2.4 EXPANSION LOOPS

- .1 Expansion loops in accordance with stress limits set out in ANSI/ASME B31.1M.
- .2 Provide as indicated, using distribution piping and fittings.

2.5 BASES, HANGERS AND SUPPORTS

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

2.6 THERMOMETERS

- .1 Thermometer:
 - .1 Bi-metallic, self-indicating, 90 mm diameter, mercury-free dial type, variable angle, to CAN/CGSB-14.5

- .2 Accuracy: 0.5% over full range.
- .3 Range: maximum 1.5 times maximum operating temperature.
- .2 Thermowell: separable stainless steel.

2.7 PRESSURE GAUGES

- .1 Dial type, 90 mm diameter, self-indicating.
- .2 Accuracy: 0.5% over full range.
- .3 Range: 1.5 times operating pressure.
- .4 Accessories:
 - .1 Shut-off valve: class 300 steel ball.
 - .2 Syphon (for steam service).
 - .3 Liquid pulsating service: provide liquid-filled pressure gauges.
 - .4 Diaphragm (for corrosive service).

2.8 FABRICATIONS

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

3 Execution

3.1 WELDING

- .1 Perform welding in accordance with PEI Department of Community, Cultural Affairs and Labour - Boiler and Pressure Vessel, Plumbing and Propane Inspection, supplemented as specified herein.
- .2 Notwithstanding the requirements of referenced section, the following shall apply:
 - .1 Welding to be in accordance with ASME B31.1M.
 - .2 Welding to be executed by certified pipe welders.
 - .3 Pipe fitting to be executed by certified pipe fitters.

3.2 INSTALLATION

- .1 Installation to be performed by certified steam fitters.
- .2 Install pipework in accordance with Section 23 05 05 - Installation of Pipework, as specified herein.
- .3 Clearances:
 - .1 Maintain clearance around systems, equipment and components and between pipes and structures for O&M as indicated for greater of:
 - .1 Observation of operation, inspection, servicing, maintenance.
 - .2 Disassembly, removal of equipment and components without interrupting operation of other system, equipment, components.
 - .2 Except where indicated, install to permit separate thermal insulation of pipes.
- .4 Provide drip legs, dirt pockets as specified.
- .5 Flanges: use suitable graphite lubricant on bolts and nuts.
- .6 Manual Air Vents.

- .1 Install at high points in piping systems and elsewhere as indicated.
- .2 To consist of full size tee, pipe extension and accumulator, cap and shut off valve, discharge pipe to floor drains with visible termination.
- .7 Butterfly valves: install between weld-neck flanges.
- .8 Drain valves:
 - .1 Install at low points in piping systems, at equipment, at section isolating valves and elsewhere as required.
 - .2 Pipe drain valves discharge separately to above floor drain. Discharge to be visible.
 - .3 Weld couplings for drains into piping to ASME B31.1M.
- .9 Provide for pipe movement as indicated and in accordance with expansion joint manufacturer's
- .10 Branch take-offs:
 - .1 Use welding tees.
 - .2 Where reducing tees of proper size are unavailable, use available tees with reducers. Tees with increasers not acceptable.
 - .3 Weldolets may be used at drip legs only provided ratio of outlet size to pipe size is 0.5 or smaller.
- .11 Cap open ends of piping during installation. Remove foreign material from inside piping.
- .12 Grade nominally horizontal piping in direction of flow.
- .13 Flanges: tighten bolts evenly with torque wrench.
- .14 Revisions to location of piping require written approval of Consultant
- .15 Connections to equipment:
 - .1 Use flanged valves for isolation and ease of maintenance and assembly.
 - .2 Use double swing joints and swing joints when equipment mounted on vibration isolation and when piping subject to movement.
- .16 Expansion Joints:
 - .1 Install to manufacturer's recommendations.
 - .2 Install lubrication facilities in locations for ease of servicing.
- .17 Anchors and Guides:
 - .1 Locate anchors and guides as indicated.
 - .2 Align piping at expansion joints and guides to avoid damage by movement of piping against fixed structures.

3.3 COLD SPRINGING

- .1 Except where cold springing is indicated or specified, do not force pipes into position.
- .2 Cold springing and pre-compression requirements to be based upon ambient temperature during installation of 20 degrees C and maximum operating temperature.
- .3 Cold springing of expansion loops, offsets: as indicated and in presence of Consultant
- .4 Cold springing of expansion joints: to recommendation of manufacturer and in presence of Consultant
- .5 Pre-compress expansion joints in accordance with manufacturer's recommendations.

3.4 PIPE SUPPORTS

- .1 In accordance with Section 23 05 29 - Pipe Hangers and Supports, supplemented as specified herein.
- .2 Install to manufacturer's recommendations.
- .3 Expansion loops and expansion joints:
 - .1 Provide supports as indicated, to manufacturer's recommendations as required to maintain venting.

3.5 VALVES

- .1 Install isolating valves at branch take-offs, at pieces of equipment and elsewhere as indicated.
- .2 Install in accordance with manufacturer's recommendations.
- .3 Install silent check valves on pump discharge as indicated.
- .4 Install butterfly valves, where specified, between weld neck flanges to ensure full compression of liner.
- .5 Install in accessible locations.
- .6 Depending upon piping configuration and ease of operation, on horizontal pipes install with stem horizontal or above.
- .7 Valves to be accessible for maintenance without removing adjacent piping.

3.6 STRAINERS

- .1 Install in locations to allow easy access for removal of screen.

3.7 INSTALLATION OF THERMOWELLS

- .1 In general, to be installed in elbows.
 - .1 Minimize turbulence and resistance to flow.
 - .2 Install in direction of flow.
 - .3 Full length of thermowell to be in the fluid being measured.
 - .4 Increase size of piping to ensure velocity of fluid at thermowell is equal to flow rate in adjacent piping.

3.8 FIELD QUALITY CONTROL

- .1 Inspections.
 - .1 Leave joints in piping systems uncovered until tests are completed and system inspected as directed by Consultant.
 - .2 Radiographic inspections:
 - .1 As required by applicable Codes and Authorities Having Jurisdiction.
 - .3 Consultant to inspect new piping prior to hydrostatic pressure tests for compliance with approved drawings and specifications.
 - .4 Where Province has approved the drawings, Provincial certified boiler inspector to inspect installation.
 - .5 Obtain from Consultant requirements for inspection and testing of system modifications, design changes and repairs performed in-house.
 - .6 Pay costs for inspections.
- .2 Hydrostatic Pressure Tests.
 - .1 Pressure tests are required to verify quality assurance.
 - .2 Give Consultant minimum of 48 hours notice of intention to perform pressure tests.
 - .3 After installation and before concealing, subject piping to hydrostatic pressure tests to 1.5 times maximum working pressure and maintain test pressure without loss for 24 hours.
 - .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or test media.
 - .5 Provide additional supports to steam piping as required and remove after testing is successfully completed.
 - .6 Conduct tests in presence of Consultant and as required by the certified boiler inspector of insurance company under contract to the owner.
 - .7 Bear costs for tests, for repairs or replacement, retesting, making good.
 - .8 Insulate or conceal work after approval and certification of tests by Consultant
- .3 Verification Requirements:
 - .1 Verification requirements in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal (Short Form), include:
 - .1 Materials and resources.

- .2 Storage and collection of recyclables.
- .3 Construction waste management.
- .4 Resource reuse.
- .5 Local/regional materials.
- .6 Low-emitting materials.

3.9 PAINTING

- .1 Paint hangers, supports, exposed steelwork with 2 coats of rust inhibitive primer after construction and prior to beginning of insulation.

3.10 FLUSHING AND CLEANING

- .1 Timing:
 - .1 Systems to be operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.
 - .2 System to remain uninsulated, with the exception of penetrations and safety areas until after cleaning is complete.
- .2 Install instrumentation including flow meters, orifice plates, Pitot tubes, flow metering valves pressure reducing valves only after cleaning is certified as complete by water treatment specialist.
- .3 Conditions at time of cleaning:
 - .1 Systems to be free from construction debris, dirt and other foreign material.
 - .2 Control valves to be operational, fully open to ensure that terminal units can be cleaned properly.
 - .3 Strainers to be 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 Steam lines with spring hangers to be blocked for support
- .4 Cleaning procedures:
 - .1 Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:
 - .1 Cleaning procedures, flow rates, elapsed time.
 - .2 Chemicals and concentrations to be 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 to be used. This is to ensure water being used will not damage systems or equipment.
- .5 Clean system in accordance with Section 23 08 02 - Cleaning and Start Up of Mechanical Piping Systems.
- .6 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.

3.11 IDENTIFICATION

- .1 In accordance with Section 23 05 54 - Mechanical Identification, supplemented as specified herein.
- .2 In addition, identify piping at building entry.

3.12 DEMONSTRATIONS

- .1 Operate at design temperatures, pressures, flow rates for consecutive period of 48 hours to demonstrate compliance with design criteria and design intents.
- .2 Demonstrations also to show completeness of O&M personnel training.

3.13 CERTIFICATES

- .1 Obtain data form for new pressure vessels, including heat exchangers, chillers, boilers, tanks from manufacture and submit data form and fee at own expense to authority having jurisdiction for certificate for pressure vessels.

End of Section

1 General

1.1 SECTION INCLUDES

- .1 Materials and installation of steel piping valves, fittings for steam and condensate building services piping.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 35 29 - Health and Safety Requirements.
- .3 Section 01 78 00 - Closeout Submittals.
- .4 Section 23 08 01 - Performance Verification of Mechanical Piping Systems.

1.3 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 degrees 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.

1.4 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 Safety relief valves.
- .3 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 HEALTH AND SAFETY

- .1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

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

- .1 Application: for modulating steam service on heating coils and steam converters and as indicated.
- .2 Materials: body cast iron; valve stainless steel with stainless steel seat; float and mechanisms stainless steel; air vent stainless steel thermostatic type.
- .3 Capacity: as indicated.
- .4 Acceptable Materials:
 - .1 See Schedule.

2.3 INVERTED BUCKET STEAM TRAP 0 1000 KPA

- .1 Application: for non modulating steam services on end of line drips humidifiers and as indicated.
- .2 Materials: body cast iron; valve stainless steel; bucket stainless steel, with bimetal air vent.
- .3 Capacity: as indicated.
- .4 Acceptable Materials:
 - .1 See Schedule.

2.4 VACUUM BREAKERS

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

2.5 PIPE LINE STRAINERS UP TO NPS 2

- .1 Application: ahead of condensate pumps, steam traps, control valves and elsewhere as indicated.
- .2 Body: bronze. For General Service, stainless steel for humidification service.
- .3 Connections: screwed.
- .4 Screen: stainless steel with 100 mesh (0.15mm)

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

- .1 Application: ahead of condensate pumps, steam traps, control valves as indicated.
- .2 Body: cast iron, for general service and stainless steel for humidification service.
- .3 Connections: flanged.
- .4 Blowdown connection: NPS 1 1/4 complete with gate valve and cap.
- .5 Screen: stainless steel with 100 mesh (0.15mm)

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.

3.5 PRESSURE REDUCING VALVES

- .1 Install on 3 valve bypass with strainer on inlet.
- .2 Pipe as indicated. Follow manufacturer's installation instructions.

3.6 FLASH TANKS

- .1 Pipe arrangement as indicated.

3.7 PERFORMANCE VERIFICATION

- .1 In accordance with Section 23 08 01 - Performance Verification of Mechanical Piping Systems and Section 01 91 13 - General Commissioning Requirements.

End of Section

1 General

1.1 SHOP DRAWINGS

- .1 Submit shop drawings and technical information in accordance with Section 01 33 00 - Submittal Procedures.

1.2 GENERAL

- .1 This section is applicable to ductwork up to 750 Pa.

2 Products

2.1 LOW PRESSURE DUCTWORK

- .1 All supply ductwork up to the terminal units to be constructed for 750Pa operating pressure. Ductwork designed for 500Pa operating pressure shall be constructed as per Table 2-4m, SMACNA HVAC Duct Construction Standards.
- .2 All supply ductwork downstream of terminal units, all return air ductwork and all exhaust air ductwork shall be constructed for 500Pa operating pressure. Ductwork designed for 500Pa operating pressure shall be constructed as per Table 2-3m, SMACNA HVAC Duct Construction Standards.

2.2 GALVANIZED STEEL DUCTWORK

- .1 Ducts: Lock forming quality steel with G90 designation zinc coating to ASTM A525-79. Gauge of ducts shall be in accordance with SMACNA HVAC Duct Construction Standards and ASHRAE Guide Book.
- .2 Fabrication: ducts and fittings configuration in accordance with recommendation of SMACNA and ASHRAE.
- .3 Joints: to ASHRAE. Class A seal. All transverse joints, longitudinal seams and duct wall penetrations to be sealed.
- .4 Ductwork shall be reinforced to ensure that there are no ductwork sounds on fan start-up and shutdown.

2.3 ALTERNATE TRANSVERSE DUCT JOINT SYSTEM

- .1 Alternate transverse duct joint system shall be as developed by a manufacturer and shall include angles, corners, metal cleats closed cell neoprene gaskets, corner clips and integral mastic sealant.
- .2 Alternate transverse duct joint system shall be installed as per manufacturer's recommendations.
- .3 When the gasket is applied around the corner of the alternate transverse duct joint system, reverse direction twice in order to apply three layers of the gasket at each corner.
- .4 Use bolts at the corners or "no-bolt" corner clips.
- .5 Use metal drive cleats on all four sides of the joints. Cleats to be 6" long and 18" on centres.
- .6 Alternate transverse duct joint system shall not be permitted as an alternate for welded ductwork.
- .7 Ductwork to be reinforced to ensure that there are no ductwork sounds on fan start-up and shut down.

2.4 HANGERS AND SUPPORTS

- .1 Hangers and Supports:
 - .1 Fabricate strap hangers to same material as duct. Hanger configuration to SMACNA

- details.
- .2 Rod and angle hangers: galvanized steel to SMACNA details with cadmium plated black iron rods to SMACNA details.
- .3 Hanger attachments: manufactured concrete inserts, expansion shields and bolted steel clamps. Do not weld rods to steel decks or use power actuated fasteners.

2.5 STAINLESS STEEL DUCTWORK

- .1 Stainless Steel:
 - .1 Ducts type 304 stainless steel to ASTM A480-79. Gauge of ducts to be in accordance with recommendations of ASHRAE, but not less than 20 ga.
 - .2 Fabrication: ducts and fittings configuration to be in accordance with recommendations of SMACNA and ASHRAE.
 - .3 Joints: to be continuous inert gas welded, liquid tight external joints.
 - .4 Application: fume hood exhaust ductwork.
 - .5 The ductwork shall be reinforced adequately to ensure that there are no ductwork noises on fan start-up and shut-down.

3 Execution

3.1 DUCT INSTALLATION

- .1 Install steel duct in accordance with SMACNA standards.
- .2 Do not break continuity of insulation vapour barrier by hangers or rods.
- .3 Ground across flexible connector with No. 2/0 braided copper strap.
- .4 Install balancing dampers at all branch ducts and as indicated.
- .5 Anchor all risers.
- .6 Install fire dampers to NFPA 90A.
- .7 Make plenums at outside air intake and exhaust louvres watertight. Fit drain connections on bottom with minimum NPS 1-1/4 pipe to nearest funnel drain.
- .8 Duct sides that are 19" and over and are 20 ga. or less with more than 10 sq. ft. of unbraced panel area shall be cross-braced or beaded.
- .9 Hangers shall be galvanized steel angles with supporting rods, locking nuts and washers to the following table:

Duct Size	Angle Size	Rod Size	Spacing
Up to 750	25 x 25 x 3	6mm	3m
751 to 1050	38 x 38 x 3	6mm	3m
1051 to 1500	38 x 38 x 3	9mm	3m
1525 to 2100	50 x 50 x 3	9mm	2.4m
2125 to 2400	50 x 50 x 5	9mm	2.4m
2425 and Over	50 x 50 x 6	9mm	2.4m

- .10 Use of round prefabricated spiral duct as branch duct for smaller sizes will be acceptable.

3.2 WATERTIGHT DUCT

- .1 Provide watertight ductwork for:
 - .1 Plenums at outside air intake and exhaust air louvres.
 - .2 All exterior ductwork located on the roof.
- .2 Form bottom of duct without longitudinal seams. Solder or weld joints of bottom sheets and 150mm up sides. Solder or weld transverse joint and caulk.

3.3 FRESH AIR AND EXHAUST OPENINGS

- .1 Install to SMACNA details.
- .2 Reinforce and brace air outlets and intakes for wind speed as per NBC for location.
- .3 Provide air inlet openings with 0.06" thick 6mm and air outlet openings with 12mm mesh screwed aluminum birdscreens.

3.4 INSTRUMENT AND TEST HOLES

- .1 Install 25mm test plugs with chain and cap, where required to accommodate testing and balancing instruments.

3.5 JOINT SEALING

- .1 Seal all duct joints with specified liquid tight sealant in accordance with SMACNA HVAC Duct Standards.

3.6 PROTECTION OF DUCT OPENINGS

- .1 Seal and protect all open ends of ductwork during construction. Existing ducts at the point of connection shall be sealed with sheet metal blank plates and kept sealed until the time of connection after installation of the new ductwork.

End of Section

1 General

1.1 SHOP DRAWINGS

- .1 Submit shop drawings and technical information in accordance with Section 01 33 00 - Submittal Procedures.

1.2 SAMPLES

- .1 Submit duplicate samples in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Samples are required for the following:
 - .1 Flexible connections.
 - .2 Duct tape.
 - .3 Access doors.

1.3 MANUFACTURED ITEMS

- .1 Flexible duct connections shall be factory fabricated.
- .2 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or those obtained by him from independent testing agency signifying adherence to Codes and standards in force.

1.4 MAINTENANCE MATERIALS

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

2 Products

2.1 SEALANTS AND TAPES

- .1 Duct sealer to be flame retardant in wet or dry state and shall not contain any toxic or flammable solvent. Liquid type duct sealer to be used in conjunction with open weave fiberglass cloth impregnated with PVC.

2.2 FLEXIBLE CONNECTIONS

- .1 General HVAC System:
 - .1 Provide where indicated, at fans and at air handling units, neoprene coated glass fabric, minimum density 1.22 Kg/m² factory fabricated, not more than 6" long between metal parts and installed with just sufficient slack to prevent vibration transmission. Allow 4" movement to high pressure fans and 50mm movement to low pressure fans.

2.3 DUCT ACCESS DOORS

- .1 Provide as indicated for access to fire or other dampers and for service or inspection, and for cleanouts where required on specialty systems, hinged type access doors, 400 x 500mm unless otherwise stated, complete with two sash locks.

2.4 TURNING VANES

- .1 Provide small arc air foil hollow vanes as indicated in duct elbow where center-line radius is less than 1-1/4 times turning dimension of duct.

3 Execution

3.1 INSTALLATION

- .1 Install flexible connections, sealants and tapes, duct access doors and turning vanes in accordance with manufacturer's recommendations.
- .2 Ground access flexible connector with No. 2/0 braided copper strap.
- .3 Provide access doors in ductwork for access to fire dampers, volume dampers, smoke dampers and other devices located in ductwork and as required for duct cleaning.

3.2 JOINT SEALING

- .1 Duct sealer and open weave tape to be applied strictly in accordance with the recommendations of the manufacturer.

End of Section

1 General

1.1 REFERENCES

- .1 Do work in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible 1985, except where specified otherwise.

1.2 PRODUCT DATA

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

2 Products

2.1 GENERAL

- .1 Manufacture to SMACNA standards.

2.2 SPLITTER DAMPERS

- .1 Of same material as duct but one sheet metal thickness heavier, with appropriate stiffening.
- .2 Single thickness construction.
- .3 Control rod with locking device and position indicator.
- .4 Rod configuration to prevent end from entering duct.
- .5 Pivot: piano hinge.
- .6 Folded leading edge.

2.3 SINGLE BLADE DAMPERS

- .1 Of same material as duct, but one sheet metal thickness heavier. V groove stiffened.
- .2 Size and configuration to recommendations of SMACNA, except maximum height 100mm.
- .3 Locking quadrant.
- .4 Inside and outside end bearings supported at each end.
- .5 Channel frame of same material as adjacent duct, complete with angle stop.

2.4 MULTI-BLADED DAMPERS

- .1 Factory manufactured of material compatible with duct.
- .2 Opposed blade: configuration to recommendations of SMACNA supported at both ends.
- .3 Maximum blade height: 100mm.
- .4 Bearings: pin in bronze bushings.
- .5 Linkage: shaft extension with locking quadrant.
- .6 Channel frame of same material as adjacent duct, complete with angle stop.

3 Execution

3.1 INSTALLATION

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .3 For supply, return and exhaust systems, balancing dampers are to be located in each branch duct, except for inlets to terminal units.
- .4 Each grille, register and diffuser connection to have balancing damper located as close as possible

- to main ducts.
- .5 Install splitter damper blade, pivot and control rod in rigid manner to prevent vibration. Use splitter damper only where no other means are available.

End of Section

1 General

1.1 GENERAL

- .1 This section applies to operating dampers.

1.2 PRODUCT DATA

- .1 Submit product data in accordance with 01 33 00 - Submittal Procedures.
- .2 Indicate the following:
 - .1 Performance data.

1.3 MAINTENANCE DATA

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

1.4 CERTIFICATION OF RATINGS

- .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency.

2 Products

2.1 BACK DRAFT DAMPERS

- .1 Automatic gravity operated, multi-leaf, steel construction with nylon bearings, centre pivoted spring assisted or counter-weighted, as indicated.

2.2 RELIEF DAMPERS

- .1 Automatic multi-leaf aluminum dampers with ball bearing centre pivoted and counter-weights set to open at 10 Pa static pressure.

2.3 DAMPER

- .1 Sizes:
 - .1 Blades maximum 150mm wide and 1200mm long.
 - .2 Modular maximum 1200mm wide x 2400mm high.
 - .3 Multiple sections with stiffening mullions and jack shafts.
- 2 Materials:
 - .1 Frame: 2.03mm extruded aluminum.
 - .2 Blades: two sheets 22 ga. thick or 16 ga. thick galvanized sheet steel, insulated.
 - .3 Bearings: oil impregnated sintered nylon. Provide additional thrust bearings for vertical blades.
 - .4 Linkage and shafts: zinc plated steel.
 - .5 Seals: replaceable neoprene seals or ss spring on side, top and bottom of frame and along all blade edges and blade ends.
 - .6 All operating dampers to be low leakage type.
- .3 Provide performance characteristics as follows:
 - .1 15 l/s per sq. metre allowable leakage against 0.25kPa static pressure.
 - .2 Temperature range -40°C to 93°C.

3 Execution

3.1 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 Upon system start-up, ensure that dampers operate properly.

End of Section

1 General

1.1 REFERENCES

- .1 ANSI/NFPA 90A 1985, Installation of Air Conditioning and Ventilating Systems.
- .2 CAN4 S112 M82(R1987), Fire Test of Fire Damper Assemblies, except specified otherwise.
- .3 CAN4 S112.2 M84, Fire Test of Ceiling Firestop Flap Assemblies.
- .4 ULC S505 1974, Fusible Links for Fire Protection Service.

1.2 PRODUCT DATA

- .1 Submit product data in accordance with 01 33 00 - Submittal Procedures.
- .2 Indicate the following:
 - .1 Fire dampers.
 - .2 Fire stop flaps.

1.3 MAINTENANCE DATA

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

1.4 MAINTENANCE MATERIALS

- .1 Provide following:
 - .1 6 fusible links of each type.

1.5 CERTIFICATION OF RATINGS

- .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

2 Products

2.1 FIRE DAMPERS

- .1 Fire dampers: listed and bear label of ULC, meet requirements of NFPA 90A.
- .2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
- .3 Top hinged: galvanized steel interlocking blades, guillotine type; sized to maintain full duct cross section.
- .4 Fusible link actuated, weighted to close and lock in closed position when released or having negator spring closing operator for horizontal position with vertical air flow.
- .5 40 X 40 X 3 retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.

3 Execution

3.1 INSTALLATION

- .1 Install in accordance with NFPA 90A and in accordance with conditions of ULC listing.
- .2 Fire damper assemblies to be fire tested in accordance with CAN4 S112.
- .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. See Section 23 33 00 - Air Duct Accessories.

- .6 Coordinate with installer of firestopping.
- .7 Use Type C fire dampers on round ductwork.

End of Section

1 General

1.1 SHOP DRAWINGS

- .1 Submit shop drawings and technical information in accordance with Section 01 33 00 - Submittal Procedures.

1.2 MANUFACTURED ITEMS

- .1 Flexible ductwork shall be factory fabricated.
- .2 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to Codes and standards in force.

2 Products

2.1 FLEXIBLE DUCTWORK

- .1 Comply with requirements of ULC "Standards for Safety, Air Ducts", ULC S110-1970, and NFPA 90A-1976.
- .2 Provide as indicated, unless otherwise noted. Unit must withstand 500 Pa. internal pressure.
- .3 Ductwork: 1-ply spiral wound flexible aluminum.
- .4 Thermally insulated ductwork: flexible glass fibre, nominal thickness of 25mm factory applied, unless otherwise specified, with PVC exterior vapour barrier.

3 Execution

3.1 DUCT INSTALLATION

- .1 Locate between air control boxes and all grilles, registers and diffusers.
- .2 Support flexible ducts at 1200mm O.C., minimum of two hangers per length.
- .3 Maximum length of flexible duct connections shall be 1800mm.
- .4 Connections between flexible duct and terminal devices to be made airtight with foil tape.

End of Section

1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Fans, motors, accessories and hardware for commercial use.

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, 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 300mm 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 Provinces of Nova Scotia.
- .3 Provide :
 - .1 Fan performance curves showing point of operation, BHP 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 and variable inlet vanes 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 Engineer Consultant 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 29 - 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.

2 Products

2.1 FANS GENERAL

- .1 Each fan shall be belt or direct driven in AMCA arrangements.
- .2 Fans to be equipped with lifting lugs.
- .3 Motor mounting plate / bearing mounting plate to be coated steel with a chemical resistant epoxy.
- .4 Fasteners to be stainless steel.

2.2 FAN HOUSING

- .1 Fan housing shall be of the bifurcated design, in which all impeller drive components are outside of the air stream.
- .2 Fan housing shall be manufactured from corrosion resistant resins, and reinforced with fiberglass for structural strength. Fastening bolts holding the casing to the support plate are to be encapsulated in FRP. No uncoated metal fan parts in the air stream will be tolerated.
- .3 Fans shall be supplied with a internal graphite liner and grounding strap to remove static electricity.
- .4 Fan inlet & outlet to be slip connections or flanged.
- .5 A housing access door shall be supplied for impeller inspection and service.
- .6 AXCL fans shall be supplied with horizontal or vertical mounting brackets, if stated and shown on the plans and specifications.

2.3 FAN IMPELLER

- .1 The impellers to be molded FRP, backward inclined. A metal backplate integral to the FRP impeller and encapsulated in resin shall have the hub extending to the outside of the fan housing. The shaft end in the housing to be covered by a tight fitting FRP cap.
- .2 The impellers shall be balanced dynamically Grade G6.3 per AMCA 204 Standard and conform to ASTM Standard D-4167.

2.4 FAN MOTORS AND DRIVES

- .1 Motors to be premium efficiency, standard NEMA frame, 1800 RPM (Belt Drive) or 900, 1200, or 1800 RPM (Direct Drive), TEFC with a 1.15 service factor.
- .2 A factory mounted NEMA 3R disconnect switch shall be provided for each fan.
- .3 Belt drive units shall have belts and sheaves sized for 150% of the fan operating brake horsepower, and shall be readily and easily accessible for service.
- .4 Drives up to 5 HP shall be provided with variable pitch sheave.
- .5 Shafts to be AISI -1045 carbon steel. The shaft shall not be in the corrosive air stream.
- .6 Belt driven AXCL fans shall have shaft bearings sized for a minimum life of L-10 100,000 hours. Bearings shall be ball or spherical pillow block type, sealed to retain lubricant and exclude dust and air. Due to the bifurcated fan housing design, bearing inspection and relubrication shall be accomplished without fan disassembly, and in clear view, without the use of extended lube lines.
- .7 Belt drive guards and motor covers shall be supplied, as indicated on the schedule.

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

1 General

1.1 PRODUCT DATA

- .1 Submit product data in accordance with 01 33 00 - Submittal Procedures.
- .2 Indicate the following:
 - .1 Capacity.
 - .2 Throw and terminal velocity.
 - .3 Noise criteria.

1.2 MAINTENANCE MATERIALS

- .1 Include:
 - .1 Keys for volume control adjustment.
- .2 Keys for air flow pattern adjustment.

1.3 MANUFACTURED ITEMS

- .1 Grilles, registers and diffusers shall be product of one manufacturer for generic type.

1.4 CERTIFICATION OF RATINGS

- .1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

2 Products

2.1 GENERAL

- .1 Standard product to meet capacity, throw, noise level, throat and outlet velocity as indicated.
- .2 Provide volume control dampers on all supply diffusers and concealed operators.
- .3 Sizes indicated are nominal. Provide correct standard product nearest to nominal for capacity throw, noise level, throat and outlet velocity.
- .4 Furnish factory prime coated steel frames for setting into fire protecting membrane. At aluminum diffusers, registers and grilles, provide 0.05" thick minimum steel collar up to fire damper or fire stop flap, for suspending from the basic structure independently of membrane pierced to maintain fire protection membrane integrity.
- .5 Where penetrating fire partitions, provide approved steel sleeve attached to structure and secured in accord with NFPA 90A-1978. Where penetrating fire walls provide 10 gage thick steel sleeve with angle iron perimeter frame to NFPA 90A-1978.
- .6 Frames:
 - .1 Steel: standard cold rolled steel with exposed joints welded and ground flush and completely closed.
 - .2 Aluminum: satin finish with mechanical fasteners and completely closed corners.
 - .3 Provide full perimeter sponge rubber gaskets.
 - .4 Provide plaster frames as plaster stops set into gypsum board at all locations.
 - .5 Provide concealed fasteners and operators.
- .7 Finish:
 - .1 Off white baked enamel unless otherwise indicated.
- .8 Capacities: See schedules on drawings.

2.2 SUPPLY DIFFUSERS

- .1 Type A Supply Diffusers:
 - .1 Square diffuser with round neck connection of steel construction and four cone arrangement.
 - .2 Diffuser to be 12" X 12" or 24" X 24" size with four (4) concentric cones as indicated in the schedule.
 - .3 Diffusers in areas with T-bar ceiling shall be suitable for lay-in application and diffusers in areas with drywall ceiling to be suitable for surface mounting. All 12" X 12" diffusers in the ceiling tiles will be surface mounted.
- .2 Type B Supply Diffusers:
 - .1 Diffusers to consist of a framing valving mechanism and perforated distribution plate. Distribution plate to be retained to the framing through the use of retaining chains with snaps after the removal of screws. Diffusers to be of stainless steel construction for procedure, endoscopy, cystoscopy and isolation rooms.
- .3 Type C Supply Diffusers:
 - .1 Linear slot diffusers, 1" slots, all aluminum construction.
- .4 Type LS-3 Linear Supply Diffusers:
 - .1 Bi-directional pattern diffusers with internal actuator mechanism.
 - .2 Curved extruded aluminum horizontal pattern controller.

2.3 EXHAUST AIR GRILLES/REGISTERS

- .1 Type A Return Air Grilles & Exhaust:
 - .1 Single deflection, 45° deflection, horizontal bar of extruded aluminum construction with 1-1/4" border.
- .2 Low Level Exhaust Grilles:
 - .1 Single deflection, 45° deflection 3/4" blade spacing, horizontal bar grille of stainless steel construction. 1-1/4" surface mount border. Removable grille with 90° quick release fasteners.

3 Execution

3.1 INSTALLATION

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

End of Section

1 General

1.1 DESCRIPTION

- .1 This section includes chemical (general purpose) hoods in designs and configurations specified hereunder.

1.2 DEFINITIONS

- .1 Chemical Or General-Purpose Hoods
 - .1 LOW-VELOCITY HOOD: A high-performance hood that yields energy savings by reducing the sash opening and the corresponding exhaust volume, while maintaining safe containment levels with the sash raised for set-up and face velocity as low as 60fpm.

1.3 PERFORMANCE REQUIREMENTS

- .1 Average Face Velocity for Low Velocity laboratory fume hoods can be as low as 60 fpm with sash located at the average Low Velocity hood sash stop height of 12 to 18 inches.
- .2 Containment: Furnish and install laboratory fume hoods that are tested according to ASHRAE 110 at a release rate of 4.0 L/min. (0.1 CFM)
 - .1 Face Velocity Variation: Allowable variation threshold is not more than +/-10% of average face velocity.
 - .2 Sash Position:
 - .1 For Vertical Sash units, test with sash fully open, and at typical sash stop height of 18".
- .3 Average Static-Pressure Loss: Not more than 93 Pa (3/8-inch wg) at 0.51-m/s (100-fpm) face velocity when tested according to SEFA 1.2.

1.4 QUALITY CONTROL

- .1 All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
- .2 Electrical Components and Devices: UL listed and labeled for intended use.

1.5 SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Manufacturer's Literature and Data: Include the following:
 - 1. Illustrations and descriptions of laboratory fume hoods and factory-installed devices for fume hoods.
 - 2. Catalog or model numbers for each item incorporated into the work.
 - 3. Static-pressure losses and exhaust volumes for fume hoods.
 - 4. Results of testing according to ASHRAE 110.
- .3 Shop Drawings: Show details of fabrication, installation, adjoining construction, coordination with mechanical and electrical work, anchorage, and other work required for complete installation.
- .4 Field Test Reports: Indicate dates and times of tests and certify test results.
- .5 Factory Test Reports: Provide manufacturer's QC checklist or other reports that indicate comprehensive factory testing has been performed, and the results of these tests have been certified.
- .6 Operating Instructions: Comply with requirements in Section 01 10 10 - General Instructions.

1.6 APPLICABLE PUBLICATIONS

- .1 The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- .2 American National Standards Institute / American Society of Heating, Refrigerating and Air-Conditioning Engineers (ANSI/ASHRAE): 110-1995 Method of Testing Performance of

- .3 Laboratory Fume Hoods
Scientific Equipment and Furniture Association (SEFA): 1-2005 Recommended Practices for Laboratory Fume Hoods 2-1999 Recommended Practices for Installation
- .4 National Fire Protection Association (NFPA): 45-2011 Standard on Fire Protection for Laboratories using Chemicals

2 Products

2.1 FUME HOODS, GENERAL

- .1 Furnish and install laboratory fume hoods that comply with recommendations in SEFA 1.
- .2 Confirm factory-installed service fixtures and electrical devices in locations shown on drawings.
- .3 Ductwork: All ductwork shall be stainless steel. Refer to Section 23 31 14 - Metal Ducts - Low Pressure to 750Pa.
- .4 Lighting Fixtures:
 - .1 Vapor proof Fixtures: 120-V 2-tube fluorescent.
- .5 Receptacles and Switches: Include junction box and cover plate. Refer to Section 26 27 26 - Wiring Devices
 - .1 Ground Fault Interrupter (GFI) Duplex Receptacles: Integral unit with 2-pole, 3-wire, 120-V, 20-A receptacle.
 - .2 Lighting Fixture Switches: Toggle, single pole, 120-277 V, 20 A.
 - .3 Switches with Receptacles: Single-pole switch to control lighting fixtures and 120-V, 15-A, 2-pole, 3-wire single receptacle.
- .6 See Schedule for additional details.

2.2 LOW VELOCITY FUME HOODS

- .1 Airflow Systems: Restricted Bypass.
- .2 Liners: Stainless steel, Type 304, or Equal.
- .3 Work Surfaces: Epoxy
- .4 Blowers: Remote; sized to create exhaust air volume that produces average face velocity indicated with sashes fully open (sized at the reduced average face velocity the hood is rated for). Refer to Section 23 34 00 - HVAC Fans.
- .5 Sashes: Vertical Type; fully tempered safety glass
 - 1. Accessories: Sash stops, installed at 18"
- .6 Bases: Cabinet.
- .7 See Schedule for additional details.

2.3 FLAMABLE AND COMBUSTIBLE LIQUID STORAGE CABINET

- .1 Cabinet to meet requirements of NFPA 30 and be ULC approved.
- .2 Cabinet to be provided with grounding wire connections.
- .3 Cabinet to be constructed of 18 gauge steel, double wall construction, with 50 mm thick fire proof insulating metal sandwiched between inner and outer walls.
- .4 Door sill to be raised 50 mm above bottom of cabinet to form liquid tight joint.
- .5 Cabinet to be supplied with four (4) adjustable leveling feet.
- .6 Cabinet to be double door style with three (3) point lock on door.
- .7 Cabinet to be provided with NPS 2 threaded vents one on each side at top and bottom of cabinet to enable continuous cabinet ventilation. Each vent to be covered internally with a fire baffle.
- .8 Cabinet to be supplied complete with adjustable satin coat galvanized shelves to permit storing of various sizes of containers.
- .9 Cabinet to be painted with yellow safety enamel with red letters, warning: "FLAMMABLE -KEEP FIRE AWAY" in English and French.
- .10 Cabinet to be individually cartoned.
- .11 Capacity and dimensions: as indicated.

3 Execution

3.1 INSTALLATION

- .1 Install laboratory fume hoods to comply with SEFA 2.
- .2 Locate unit away from fans, heating and air conditioning registers, laboratory hoods, high traffic areas and doors that could interfere with airflow patterns.

3.2 TESTS

- .1 Field test installed laboratory fume hoods according to ASHRAE 110 to verify compliance with performance requirements for containment.
 - .1 For units that fail testing, make adjustments and corrections to installation, or replace fume hoods, and repeat tests until fume hoods comply with requirements.

3.3 PROTECTING AND CLEANING

- .1 Protect equipment from dirt, water, and chemical or mechanical injury during the remainder of the construction period.
- .2 At the completion of work, clean equipment as required to produce ready-for-use condition.

3.4 INSTRUCTIONS

- .1 Instruct personnel and transmit operating instructions in accordance with requirements in Section 01 10 10 - General Instructions. Training must be provided by Manufacturer or Installer.

End of Section

1 General

1.1 DESCRIPTION

- .1 This section specifies Biological Safety Cabinets: Class II, Type A2.

1.2 DEFINITIONS

- .1 Class II Biological Safety Cabinet: A ventilated cabinet for exposure protection of personnel, product and the environment, suitable for work involving low to moderate risk agents (BSL 1,2, and 3). Cabinet air is exhausted through a HEPA filter either into the laboratory or to the outside. Class II cabinets are available as two types (A and B) based on construction, air flow velocities and patterns, and exhaust systems. Refer to Table 1.

1.3 RELATED WORK

- .1 Section 22 15 00 - Compressed Air Systems.
- .2 Section 22 11 18 - Domestic Water Piping Copper.
- .3 Section 22 13 19 - Drainage Waste and Vent Piping - Process Sanitary.
- .4 Section 22 62 00 - Vacuum.
- .5 Section 25 30 02 - EMCS: Field Control Devices.
- .6 Section 23 31 14 - Metal Ducts - Low Pressure to 750Pa.
- .7 Section 23 41 00 - HVAC Air Filtration.
- .8 Section 26 05 16 - Wires and Cables, 0-1000V.
- .9 Section 26 27 26 - Wiring Devices.

1.4 QUALITY CONTROL

- .1 Mechanical, electrical and associated systems shall be safe, reliable, efficient, durable, easily and safely operable, maintainable, and accessible.
- .2 Standard Products: Material and equipment shall be the standard products of the selected manufacturer, and they should be regularly engaged in the manufacture of such products for at least 3 years.
- .3 All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
- .4 NSF Compliance: Equipment bears NSF (National Sanitation Foundation) Certification Mark indicating compliance with NSF 49. This certification applies only to Class 1 and 2 Biological Safety Cabinets, not LAFW.
- .5 Electrical Components and Devices: UL listed and labeled for intended use.

1.5 SUBMITTALS

- .1 Submit in accordance with specification Section 01 33 00 - Submittal Procedures.
- .2 Manufacturer's Literature and Data: Include the following:
 - 1. Illustrations and descriptions of the unit and factory-installed devices associated with it.
 - 2. Catalog or model numbers for each item incorporated into the work.
 - 3. Utility requirements.
- .3 Shop Drawings: Show details of fabrication, installation, adjoining construction, coordination with mechanical and electrical work, anchorage, and other work required for complete installation.
- .4 Factory Testing: Provide manufacturer's QC checklist or other reports that indicate comprehensive factory testing has been performed, and the results of these tests.

1.6 APPLICABLE PUBLICATIONS

- .1 The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- .2 American National Standards Institute / National Electrical Manufacturers Association (ANSI/NEMA):
WD 6-2002 (R2008) Wiring Devices--Dimensional Specifications
- .3 National Sanitation Foundation International / American National Standards Institute (NSF/ANSI):
49-2009 Biosafety Cabinetry: Design, Construction, Performance and Field Certification
- .4 Scientific Equipment and Furniture Association (SEFA):
2-1999 Recommended Practices for Installation
7-2007 Recommended Practices for Fixtures
- .5 National Fire Protection Association (NFPA):
45-2011 Standard on Fire Protection for Laboratories using Chemicals

2 Products

2.1 BIOLOGICAL SAFETY CABINETS

- .1 General Specification for Biological Safety Cabinets. Furnish and install biological safety cabinets that have the following characteristics:
 - .1 Cabinet Exterior:
 - .1 Class II: Reinforced cold-rolled steel with acid-resistant painted finish.
 - .2 Cabinet Interior:
 - .1 Class II: stainless steel.
 - .3 View Screen: Hinged, 6-mm- (1/4-inch-) minimum thick, laminated safety glass.
 - .4 Motor/Blower System: To circulate filtered air into and/or through cabinet.
 - .5 HEPA Filtering: 99.99 percent effective on 0.3 microns for both recirculated and exhausted air.
 - .6 Lighting: Fluorescent lights producing a minimum of 1076 lux (100 fc) of non-glare illumination in the work area, and ultraviolet lamp electrically interlocked to be inoperable while fluorescent lighting is "on."
 - .7 Magnehelic Gauge: Located on the front of the cabinet to indicate cabinet interior pressure. Provide DDC sensor with remote indicator.
 - .8 Equip with listed hospital-grade duplex receptacles having drip proof covers, and control switch. Refer to Section 26 27 26 - Wiring Devices for additional requirements
 - .9 Equip with gas, vacuum, water, and air valves, as needed. See Schedule.
 - .10 Equip with the following controls:
 - .1 On/off switch and circuit breaker with pilot "on" light for blowers.
 - .2 On/off switch for // fluorescent // and ultraviolet lamps //.
 - .3 Circuit breaker and on/off switch for duplex outlets.
 - .4 On type A2 cabinets, provide an indirect canopy ("thimble") connection by the cabinet manufacturer.
 - .11 Locate HEPA filters and blower so that they are removable from the front without entry into workspace.
 - .12 Equip with a supportive work surface or base stand.
- .2 Class II Biological Safety Cabinet Types: Furnish and install Class II biological safety cabinets, according to the following table:

TYPE	AIRFLOW	MAXIMUM FACE VELOCITY	Biosafety Level	COMMENTS
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A2	30 percent indirect exhaust / 70 percent recirculated	0.51 m/s (100 fpm)	1,2,3	Contaminated plenums must be surrounded by negative pressure.
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2.2 MECHANICAL SERVICE FIXTURES

- .1 Valves, General Requirements:
 - .1 Comply with requirements in SEFA 7.
 - .2 Cast red brass alloy bodies with copper content not less than 81 percent, or drop forged brass alloy with high density and no porosity.
 - .3 Locate valves so that they are accessible for maintenance and repair of internal working parts.
 - .4 Equip valves with four-arm handles.
 - .5 Design valves to withstand 689 kPa (100 psig) without leakage.
- .2 Gas, Air, and Vacuum Valves:
 - .1 Provide floating needle valves with a replaceable cone and a replaceable valve seat.
 - .2 Provide bonnet with exterior packing nut and packing gland designed for valve to be repacked while under pressure.
- .3 Outlet Fittings: Fit each outlet with a 10 serrated hose connector.
- .4 Electrical System: 115 V, 1 phase, 60 Hz.
- .5 Identification: Code valves with full-view plastic index buttons as follows:

SERVICE	BUTTON COLOR	CODE	LETTER COLORS
Air	Orange	AIR	Black
Gas	Dark Blue	GAS	White
Vacuum	Yellow	VAC	Black
- .6 Finish:
 - .1 Fixtures, Handles, and Escutcheons: Polished chrome plate.
 - .2 Fixtures Inside Hoods: Acid- and solvent-resistant coating applied by fixture manufacturer.
- .7 Electrical Receptacles: Hospital-grade; ANSI/NEMA WD 6 Configuration 5-20R; duplex; with chrome-plated brass or stainless-steel cover plates; minimum 120 V, 20 A.

3 Execution

3.1 PREPARATION

- .1 Install equipment after installation of finish flooring in rooms to receive cabinets has been completed.

3.2 INSTALLATION

- .1 General:
 - .1 Install biohazard safety cabinets and LAFWs according to manufacturer's written instructions
 - .2 Coordinate installation with related mechanical and electrical work. Provide cutouts and openings for plumbing and electrical work as indicated or as required by trades involved.
 - .3 Install level, plumb, true, and straight without distortion.
 - .1 Shim cabinets using concealed shims.
 - .4 Adjust hardware so that doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended in writing by manufacturer.
 - .5 Locate unit away from fans, heating and air conditioning registers, laboratory hoods, high traffic areas and doors that could interfere with airflow patterns.

3.3 TESTING

- .1 Biological Safety Cabinets: After installation, an independent accredited service technician must test the biological safety cabinet according to NSF 49 and permanently attach certificate of compliance to equipment.

3.4 PROTECTING AND CLEANING

- .1 Protect equipment from dirt, water, and chemical or mechanical injury during the remainder of the construction period.
- .2 At the completion of work, clean equipment as required to produce ready-for-use condition.

3.5 INSTRUCTIONS

- .1 Instruct personnel and transmit operating instructions in accordance with requirements in specification.

End of Section

1 General

1.1 SHOP DRAWINGS

- .1 Submit shop drawings and technical information in accordance with Section 01 33 00 - Submittal Procedures..
- .2 Submit shop drawings of all filters, filter frames and housings. Show cfm vs P.D. at clean and dirty conditions.

1.2 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into maintenance manual specified in Section 01 33 00 - Submittal Procedures.

1.3 MAINTENANCE MATERIALS

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

1.4 MANUFACTURED ITEMS

- .1 Catalogue or published rating shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards in force.

2 Products

2.1 GENERAL

- .1 Provide filter media, frames, seals, gaskets per NFPA and ULC codes; and controls per CSA where applicable.
- .2 Use incombustible materials in fabrication of filter assembly.
- .3 Provide air filter gauges, one for each bank of filters. Gauge range to be two times the final pressure drop of the filter.
- .4 Acceptable Products: Magnehelic 2000 Series diaphragm actuated direct reading dial type.
- .5 Efficiency: ASHRAE Standard 52-76 Sect 3-16, Atmospheric dust spot efficiency. "Absolute Filter" efficiency shall be tested with 0.3 micrometre dioctyl phthalate (DOP) smoke.
- .6 Dust holding capacity: Air Filter Institute (AFI) Test.
- .7 Frames:
 - .1 Provide prefabricated filter frames and supporting structure of galvanized steel with gasketing between frames and walls. Holding frames: 16 ga. thick ("T" section construction).
- .8 Filters shall be suitable for air at 100% RH.
 - .1 Acceptable Products: American Air Filter of Canada Ltd. (AFF). Flanders. Farr Company Limited. These names indicate general approval of manufacturer's name only. All the products must meet the detailed specifications for each product included in this section.

2.2 PRE-FILTERS

- .1 Filter media to be made of non-woven cotton and synthetic fibers formed into a high loft mat in permanent metal filter frames. Filter frames shall be of galvanized steel construction. Filters to be 2" thick.

2.3 HIGH EFFICIENCY FILTER - RIGID TYPE

- .1 Filters shall be extended media separators type rigid filter with all metal construction. Filter media shall be of non-fiberglass construction. Filter pack shall be sealed into a 24 ga. steel frame with non-fiberglass sealant. Filters to be provided with gaskets for tight sealing in side access housing. Filters to be treated with anti-microbial coating.
- .2 Filters to be 12" deep and 90 - 95% efficiency. Final pressure drop not to exceed 1.5" w.g.

3 Execution

3.1 INSTALLATION

- .1 Install in accordance with manufacturer's recommendations.
- .2 Label clearly with the words "Contaminated Air" on exhaust ducts leading to the hepa filter housing.

3.2 FILTER REPLACEMENTS

- .1 Install a complete set of filters prior to the start of air balancing. Replace the filter, if required, during the air balancing and testing.
- .2 Replace all the filters three (3) days before the acceptance of the building by the Owner.
- .3 Furnish one complete set of filters as spare filters. If the filters used during the air balancing have not reached the final air resistance, do not replace these at the time of acceptance of building by the Owner and hand over two (2) complete sets of filters to the Owner. Allow for three (3) complete sets of filters.

End of Section

1 General

1.1 REFERENCES

- .1 American National Standards Institute/Air-Conditioning and Refrigeration Institute (ANSI/ARI)
 - .1 ANSI/ARI 430-99, Central Station Air Handling Units.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 1.181-99, Ready-Mixed Organic Zinc-Rich Coating.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate following: fan; include performance data.

1.3 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Include following: fan.

1.4 EXTRA MATERIALS

- .1 Provide one spare set of filters for each filter bank.
- .2 Provide list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.

2 Products

2.1 GENERAL

- .1 Factory assembled components to form unit supplying air at designed conditions, as indicated.
- .2 Certify ratings: to ARI 430 with ARI seal.
- .3 Horizontal type, as indicated, having air tight modular components, consisting of casing, fan section with motor and drive, filter section, dampers, chilled water coil, steam heating coil and face/bypass dampers.
- .4 Roof top units (RTU) shall be fabricated from insulated, solid double-wall galvanized steel without any perforations in draw-through configuration.
- .5 RTUs shall be fully assembled by the manufacturer in the factory in accordance with the arrangement shown on the drawings. The unit shall be assembled into the largest sections possible subject to shipping and rigging restrictions. The correct fit of all components and casing sections shall be verified in the factory for all units prior to shipment. All units shall be fully assembled, tested and then split to accommodate shipment and job site rigging. On units not shipped fully assembled, the manufacturer shall tag each section and include air flow direction to facilitate assembly at the job site. Lifting lugs or shipping skids shall be provided for each section to allow for field rigging and final placement of unit.
- .6 The RTU manufacturer shall provide the necessary gasketing, caulking, and all screws, nuts, and bolts required for assembly. The manufacturer shall provide a local representative at the job site to supervise the assembly and to assure the units are assembled to meet manufacturer's recommendations and requirements noted on the drawings. Provide documentation that this representative has provided this service on similar jobs to the Contracting Officer. If a local

- representative cannot be provided, the manufacturer shall provide a factory representative.
- .7 Gaskets: All door and casing and panel gaskets and gaskets between air handling unit components, if joined in the field, shall be high quality which seal air tight and retain their structural integrity and sealing capability after repeated assembly and disassembly of bolted panels and opening and closing of hinged components. Bolted sections may use a more permanent gasketing method provided they are not disassembled.

2.2 CASINGS

- .1 General: RTU casing shall be entirely double wall insulated panels, integral of or attached to a structural frame. Construction shall be such that removal of any panel shall not affect the structural integrity of the unit. All casing and panel sections shall be tightly butted and gasketed. No gaps of double wall construction will be allowed where panels bolt to air handling unit structural member. Structural members, not covered by the double wall panels, shall have equivalent insulated double wall construction.
- .2 Double wall galvanized steel panels, minimum 51 mm (2 inches) thick, constructed.
- .3 Blank-Off: Provide blank-offs as required to prevent air bypass between the AHU sections, around coils, and filters.
- .4 Insulation: Insulation shall be injected CFC free foam encased in double-wall casing between exterior and interior panels such that no insulation can erode to the air stream. Insulation shall be 50 mm (2 inch) thick, and 48 kg/m³ (3.0 lb/ft³) density with a total thermal resistance (R-value) of approximately 2.3 m.K/W (13.0 hr-ft² OF/BTU). Units with less than 50 mm (2 inch) of insulation in any part of the walls, floor, roof or drain pan shall not be acceptable. The insulation shall comply with NFPA 90-A for the flame and smoke generation requirements.
- .5 The thickness of insulation, mode of application, and thermal breaks shall be such that there is no visible condensation on the exterior panels of the AHU.
- .6 Casing panels shall be secured to the support structure with stainless steel or zinc-chromate plated screws and gaskets installed around the panel perimeter. Panels shall be completely removable to allow removal of fan, coils, and other internal components for future maintenance, repair, or modifications. Welded exterior panels are not acceptable.
- .7 Access Doors: Provide in each access section and where shown on drawings. Show single-sided and double-sided access doors with door swings on the floor plans. Doors shall be a minimum of 50 mm (2 inches) thick with same double wall construction as the unit casing. Doors shall be a minimum of 600 mm (24 inches) wide, unless shown of different size on drawings, and shall be the full casing height up to a maximum of 1850 mm (6 feet). Doors shall be gasketed, hinged, and latched to provide an airtight seal. The access doors for fan section, mixing box, coil section shall include a minimum 150 mm x 150 mm (6 inch x 6 inch) double thickness, with air space between glass panes tightly sealed, reinforced glass or Plexiglas window in a gasketed frame.
- .1 Hinges: Manufacturers standard, designed for door size, weight and pressure classifications. Hinges shall hold door completely rigid with minimum 45 kg (100 pound) weight hung on latch side of door.
- .2 Latches: Non-corrosive alloy construction, with operating levers for positive cam action, operable from either inside or outside. Doors that do not open against unit operating pressure shall allow the door to ajar and then require approximately 0.785 radian (45 degrees) further movement of the handle for complete opening. Latch shall be capable of restraining explosive opening of door with a force not less than 1991 Pa (8 inches water gage).
- .3 Gaskets: Neoprene, continuous around door, positioned for direct compression with no sliding action between the door and gasket. Secure with high quality mastic to eliminate possibility of gasket slipping or coming loose.
- .8 Provide sealed sleeves, metal or plastic escutcheons or grommets for penetrations through casing for power and temperature control wiring and pneumatic tubing. Coordinate with electrical and temperature control subcontractors for number and location of penetrations. Coordinate lights,

- switches, and duplex receptacles and disconnect switch location and mounting. All penetrations and equipment mounting may be provided in the factory or in the field. All field penetrations shall be performed neatly by drilling or saw cutting. No cutting by torches will be allowed. Neatly seal all openings airtight.
- .9 Roof of the unit shall be sloped to have a minimum pitch of 1/4 inch per foot. The roof shall overhang the side panels by a minimum of three inches to prevent precipitation drainage from streaming down the unit side panels.
- .10 Base:
- .1 Provide a heavy duty steel base for supporting all major RTU components. Bases shall be constructed of wide-flange steel I-beams, channels, or minimum 125 mm (5 inch) high 3.5 mm (10 Gauge) steel base rails. Welded or bolted cross members shall be provided as required for lateral stability. Contractor shall provide supplemental steel supports as required to obtain proper operation heights for cooling coil condensate drain trap and steam coil condensate return trap.
- .2 RTUs shall be completely self supporting for installation on roof curb or steel support pedestals.
- .3 The RTU bases not constructed of galvanized material shall be cleaned, primed with a rust inhibiting primer, and finished with rust inhibiting exterior enamel.
- .11 Unit floor shall be level without offset space or gap and designed to support a minimum of 488 kg/square meter (100 pounds per square foot) distributed load without permanent deformation or crushing of internal insulation. Provide adequate structural base members beneath floor in service access sections to support typical service foot traffic and to prevent damage to unit floor or internal insulation. Unit floors in casing sections, which may contain water or condensate, shall be watertight with drain pan.

2.3 ACOUSTIC LINER

- .1 Insulate internal surface of panels with 50 mm neoprene coated rigid duct liner of 24 kg/m (density.
- .1 Apply with 100% coverage of adhesive with clip pins.
- .2 Cover with 0.8 mm thick solid galvanized sheet metal.
- .3 Cover leading and trailing edges with sheet metal nosing and at edges around access doors and panels complete with 15 mm overlap.

2.4 DRAIN PANS

- .1 Condensate Drain Pan: Drain pan shall be designed to extend entire length of cooling coils including headers and return bends. Depth of drain pan shall be at least 43 mm (1.7 inches) and shall handle all condensate without overflowing. Drain pan shall be double wall construction, Type 304 stainless steel and have a minimum of 50 mm (2 inch) insulation, and shall be sloped to drain. Drain pan shall be continuous metal or welded watertight. No mastic sealing of joints exposed to water will be permitted. Drain pan shall be placed on top of casing floor or integrated into casing floor assembly. Drain pan shall be pitched in all directions to drain line.
- .1 An intermediate condensate drip pan shall be provided on stacked cooling coils and shall be constructed of type 304 stainless steel with copper downspouts factory piped to main condensate pan. Use of intermediate condensate drain channel on upper casing of lower coil is permissible provided it is readily cleanable. Design of intermediate condensate drain shall prevent upper coil condensate from flowing across face of lower coil.
- .2 Drain pan shall be piped to the exterior of the unit. Drain pan shall be readily cleanable.
- .3 Installation, including frame, shall be designed and sealed to prevent blow-by.

2.5 FANS

- .1 Housed Centrifugal Fan Sections:
 - .1 Fans shall be minimum Class II construction, double width, double inlet centrifugal, air foil or backward inclined or forward curved, factory balanced and rated in accordance with AMCA 210 or ASHRAE 51. Provide self-aligning, pillow block, regreasable ball-type bearings selected for a B(10) life of not less than 40,000 hours and an L(50) average fatigue life of 200,000 hours per AFBMA Standard 9. Extend bearing grease lines to motor and drive side of fan section. Fan shall be located in airstream to assure proper air flow.
 - .2 Provide internally vibration isolated fan, motor and drive, mounted on a common integral bolted or welded structural steel base with adjustable motor slide rail with locking device. Provide vibration isolators and flexible duct connections at fan discharge to completely isolate fan assembly.
 - .3 Fan Motor, Drive, and Mounting Assembly (Housed Centrifugal Fans):
 - .1 Fan Motor and Drive: Motors shall be premium energy efficient type, and suitable for use in variable frequency drive applications.
 - .2 Fan drive and belts shall be factory mounted with final alignment and belt adjustment to be made by the Contractor after installation.

2.6 VIBRATION ISOLATION

- .1 Flexible connections at inlet and outlet of fan section: to Section 23 33 00 - Air Duct Accessories.
- .2 Vibration isolators on fan section: Isolators shall be bolted to steel channel welded to unit floor which is welded to the structural frame of the unit. The isolators shall incorporate vertical spring type isolators with leveling bolts, bridge bearing waffled pads with minimum 1" (25 mm) static deflection designed to achieve high isolation efficiency.

2.7 FILTER BOX

- .1 Material to match casing. For V type filter arrangement: as indicated.
 - .1 Provide access to filter through hinged door with LeverLok handles.
- .2 Filter removal shall be from one side as noted on the drawings.
- .3 Provide 50 mm pleated panel pre-filters with non-woven cotton and synthetic fabric media with a metal support grid and rigid heavy-duty board enclosing frame with diagonal support members bonded to the air entering and air exiting side of each pleat. Each filter shall be in a permanent re-usable metal enclosing frame for added rigidity, as required for 100% outside air applications. The filter media shall have an efficiency of 25-30% on ASHRAE Standard 52.1-92, and minimum MERV 7 per ASHRAE 52.2.-1999. Filters shall slide into a formed metal track, sealing against metal spacers at each end of the track.
- .4 Rigid Style Support Media Box Filters: Final air filters shall be high performance. 12" deep pleated, totally rigid and disposable type. Each filter shall consist of media support grid, contour stabilizers and enclosing frame. Filters shall be classified by Underwriters Laboratories as Class 2. The minimum MERV when tested under ASHRAE 52.2 shall be no less than MERV 14. Initial resistance at 500 feet per minute approach velocity shall not exceed 0.60" w.g.
- .5 Provide Dwyer series 2000 magnehelic filter gauge mounted on exterior of the unit casing..

2.8 COILS

- .1 Capacity: as indicated on drawings.
- .2 Ratings: ARI certified.
- .3 Construction:
 - .1 Casings: 1.59 mm thick stainless steel.
 - .1 Supports of stainless steel, double angle frames.
 - .2 Blank-off plates. Insulated sandwich construction.

- .2 Chilled Water Coils:
 - .1 Tubes: 12mm O.D. Copper.
 - .2 Fins: Aluminum..
 - .3 Headers: Seamless Copper with steel connections.
 - .4 Pressure tests: ARI to 1723 kPa.
 - .5 Provide drains and vents extended to outside unit casing.
 - .6 Stacked coils shall have intermediate drain pan with down spouts to divert condensate to main drain pan.
 - .7 Cooling coils to be rated for water.
 - .8 Coils shall be circuited to provide free draining and venting. Coils shall be circuited with supply on bottom and return on top.
- .3 Steam Coils:
 - .1 Tubes: 12mm O.D. Copper.
 - .2 Fins: Aluminum.
 - .3 Headers: Seamless Copper tubing, silver brazed to tubes. Steel pipe thread connections.
 - .4 Steam coils c/w face bypass dampers.
 - .5 Steam coils rated for 690 kPa steam.
- .4 Coils: Coils shall be mounted on hot dipped galvanized steel supports to assure proper anchoring of coil and future maintenance. Coils shall be face or side removable for future replacement thru the access doors or removable panels. Each coil shall be removable without disturbing adjacent coil. Cooling coils shall be designed and installed to insure no condensate carry over. Provide factory installed extended supply, return, drain, and vent piping connections.
- .5 Integral Face and Bypass Steam Coils: Provide integral vertical face and bypass dampers. Electric damper operators shall be furnished and mounted by the RTU manufacturer at the factory.

2.9 HUMIDIFIER

- .1 Humidifier: When included in design, coordinate the humidification requirements with Section 23 84 13 - Humidifiers. Provide humidification section with stainless steel drain pan of adequate length to allow complete absorption of water vapor. Provide stainless steel dispersion panel or distributors as indicated, with stainless steel supports and hardware.

2.10 ELECTRICAL AND LIGHTING

- .1 Electrical and Lighting: Wiring and equipment specifications shall conform to Division 26, ELECTRICAL.
 - .1 Vapor-proof lights using cast aluminum base style with glass globe and cast aluminum guard shall be installed in access sections for fan, mixing box, humidifier and any section over 300mm (12 inch) wide. A switch shall control the lights in each compartment with pilot light mounted outside the respective compartment access door. Wiring between switches and lights shall be factory installed. All wiring shall run in neatly installed electrical conduits and terminate in a junction box for field connection to the building system. Provide single point 115 volt - one phase connection at junction box.
 - .2 Install compatible 100 watt bulb in each light fixture.
 - .3 Provide a convenience duplex, weatherproof receptacle next to the light switch.
 - .4 Disconnect switch and power wiring: Provide factory or field mounted disconnect switch. Coordinate with Division 26, ELECTRICAL.

3 Execution

3.1 INSTALLATION

- .1 Provide appropriate protection apparatus.
- .2 Install units in accordance with manufacturer's instructions and as indicated.
- .3 Design and provide support structure with full perimeter top and floor rails to evenly distribute the weight load to the floor structure.
- .4 Ensure adequate clearance for servicing and maintenance.
- .5 Install roof top unit in conformance with ARI 435.
- .6 Assemble roof top unit components following manufacturer's instructions for handling, testing and operation. Repair damaged galvanized areas with paint. Repair painted units by touch up of all scratches with finish paint material. Vacuum the interior of air-handling units clean prior to operation.
- .7 Seal and/or fill all openings between the casing and RTU components and utility connections to prevent air leakage or bypass.

3.2 FANS

- .1 Install fan sheaves required for final air balance.
- .2 Install flexible connections at fan inlet and fan outlets.
- .3 Install vibration isolators.

3.3 DRIP PANS

- .1 Install deep seal P-traps and trap seal primer on drip lines.
 - .1 Depth of water seal to be 1.5 times static pressure at this point.

3.4 STARTUP SERVICES

- .1 The air handling unit shall not be operated for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings are lubricated and fan has been test run under observation.
- .2 After the air handling unit is installed and tested, provide startup and operating instructions to Owner.
- .3 An authorized factory representative should start up, test and certify the final installation and application specific calibration of control components. Items to be verified include fan performance over entire operating range, noise and vibration testing, verification of proper alignment, overall inspection of the installation, Owner/Operator training, etc.

End of Section

1 General

1.1 SHOP DRAWINGS AND PRODUCT DATA

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

1.2 MAINTENANCE DATA

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

1.3 MAINTENANCE MATERIALS

- .1 Provide the following maintenance items:
 - .1 One (1) Spare cylinder for Electrode Type Humidifiers.

1.4 UNIT WARRANTY

- .1 Unit to be complete with two year warranty (Parts only).

2 Products

2.1 PACKAGED ELECTRODE STEAM GENERATING TYPE

- .1 Self-contained electronically controlled steam generating humidifier. ULC rated.
- .2 Unit shall be for use on 575/3/60 phase power.
- .3 Steam shall be generated using tap water in a factory sealed cylinder containing electrodes that do not require setting of spacing, cleaning or maintenance. Cylinder shall be of the disposable type.
- .4 Unit shall have an electronically controlled automatic drain cycle to maximize efficiency c/w integral drain water cooler. Only one water connection to unit shall be required.
- .5 Unit shall have overcurrent protection of the solid-state circuit board.
- .6 Detachable hinged locking door with interlock safety switch to disconnect power to steam generator when door is opened.
- .7 Unit shall include short absorption manifold for vertical duct mounting. Steam supply and condensate piping by this Contract..
- .8 Unit shall have a 25 mm air gap, strainer and flow regulating control on the water fill line.
- .9 Unit shall have an air gap fitting on the drain to isolate it from the external drain pipes.
- .10 The cabinet shall be constructed of 18 gauge steel with gray enamel finish.
- .11 Approximate external dimensions of air handling unit are 93" x 61".
- .12 Provide external drain cooler for air handling unit humidifier drains.
- .13 Capacity: Refer to schedule for capacity, quantity and type.
- .14 The unit shall be provided with the following manufacturer's controls:
 - .1 Duct mounted humidistat for proportional modulating control.
 - .2 High limit duct mounted humidistat.
 - .3 Pressure differential type air flow switch.

3 Execution

3.1 INSTALLATION

- .1 Install unit as per manufacturer's recommendations. Locate where indicated. Contractor to provide miscellaneous steel mounting frame as needed.
- .2 Ensure that door to unit opens without interference by or with adjacent equipment to facilitate

- maintenance ease of humidifier.
- .3 Install controls where indicated.
- .4 Control components supplied by humidifier unit manufacturer but installed by Contract #2.
- .5 Prior to shipment, manufacturer to ensure that bottles being supplied are compatible with the water chemistry found on site. Contractor responsible for all water tests as required.
- .6 Manufacturer's representative to be on site for commissioning of unit.

End of Section