DIVISION 23 - HEATING, VENTILATING, and AIR-CONDITIONING (HVAC)

Section 23 00 00 HVAC – General

1 Refer also to Facility Services Subgroups - General, for additional HVAC requirements and Common Work Results for mechanical systems.

2 Varying, or deviating from any item(s) indicated in this document must be approved by DTIR. DTIR will not grant a deviation from these requirements unless the deviation has been submitted in writing for review and approved prior to proceeding with the design.

3 Operating Dampers

4 Mechanical designer shall inspect all air handling units and air distribution systems for cleanliness prior to start-up of systems. No systems shall be started until they are cleaned to satisfaction of the designer and until filters (temporary or permanent) are in place. Air handling systems shall not be run until construction activities are complete and the building is clean and dust free (this is when testing and commissioning may commence).

5 Commissioning, Testing and Balancing shall be as per related Facility Services Subgroup-General (FSS-G) requirements.

Section 23 05 00 Common Work Results for HVAC

1 Roll Grooved Joints

1.1 General

1.1.1 References

1.1.1.1 American Water Works Association (AWWA)

1.1.1.1.1 ANSI/AWWA C111/A21.11-(00) (AWWA C111/A21.11-17), Rubber Gasket Joints for Ductile-Iron and Fittings.

1.1.1.1.1.1 CSA B242-M1980(R1998) (CSA B242-05 (R2016), Groove and Shoulder Type Mechanical Pipe Couplings.

1.1.2 Maintenance

1.1.2.1 Extra materials

1.1.2.1.1 Provide the following spare parts:

1.1.2.1.1.1 Gaskets for flanges: one for every ten flanges.

1.2 Products

1.2.1 Pipe Joints

1.2.1.1 Roll grooved: to CSA B242 (CSA B242-05 (R2016)).

1.2.1.2 Roll grooved: Joints to be rigid with angled bolt pads for rigidity and visual verification of sealed joint, except at expansion loops, elbows and pumps where flexible couplings shall be used.

1.2.1.3 Roll grooved products shall be of one manufacturer and have CRNS for Nova Scotia.

1.2.2 Fittings

1.2.2.1 Fittings for roll grooved piping malleable iron to ASTM A47/A47M (ASTM A47/A47M-99(2018)e1) on ductile iron to ASTM A536 (ASTM A536-84(2019)e1).

1.2.3 Gaskets

1.2.3.1 Roll grooved couplings gaskets: type EPDM

1.2.3.2 Gaskets shall be good for cold and hot water up to minimum 110deg C (230deg F)

1.2.3.3 Gaskets for other services require approval in writing from DTIR

1.2.4 Valves

1.2.4.1 Connections

1.2.4.1.1 DN 65 (NPS 2 ½) and larger:

1.2.4.1.1.1 Grooved ends: as specified.

1.2.4.2 Butterfly valves: Application: Isolating equipment:

1.2.4.2.1 DN 65 (NPS 2 ½) and larger:

1.2.4.2.1.1 Grooved ends: as specified.

1.2.4.3 Swing check Valves: to MSS-SP-71 (MSS SP-71-2018).

1.2.4.3.1 DN 65 (NPS 2 ½) and larger:

1.2.4.3.1.1 Grooved ends: as specified.

1.2.4.4 Silent check valves;

1.2.4.4.1 DN 65 (NPS 2 ½) and larger:

1.2.4.4.1.1 Grooved ends: as specified.

1.2.4.5 All valves shall be lead free.

Section 23 05 19 Meters and Gauges for HVAC Piping

1 Thermometers and Pressure Gauges

1.1 Thermometers

1.1.1 Adjustable type 23cm (9") graduated scale, metal casing, calibrated in degrees F and degrees C range to suit the normal operating temperature of the fluid.

1.1.2 Locate and install thermometers to facilitate reading.

1.1.3 For heating systems, provide thermometers at the inlet and outlet of all main heat exchange equipment (for exchangers/convertors in both primary and secondary piping), programmed water three way valves, heating coils and cooling coils and on the supply and return piping (in the boiler room and/or chiller room) for main heating and cooling zones.

1.2 Pressure Gauges

1.2.1 Gauges shall be 114mm (4½") diameter, cast aluminum, close type black finished ring and clear glass window, calibrated in both imperial and metric. Dials shall have white finish with jet black embossed figures and graduations.

1.2.2 Permanent legibility shall be ensured by a hot dip stamp process. The pointer shall be adjustable, black finish with red tip.

1.2.3 Movement shall be bronze with bronze bushing. The bourdon tube shall be phosphor bronze soldered to the socket and tip.

1.2.4 Accuracy to be 1% over middle half of scale range and 1½% over balance. All gauges to be complete with snubbers and mini ball valves. Gauges on steam systems shall be complete with mini ball valves and pipe siphon.

1.2.5 Locate and install pressure gauges to facilitate reading.

1.2.6 For heating systems, provide gauges for each pump over ½ hp, at the inlet and outlet of all main heat exchange equipment (for exchangers/convertors in both primary and secondary piping) including heating and cooling coils, and on both sides of water make- up assemblies.

Section 23 05 29 Hangers and Supports for HVAC Piping and Equipment

1 Duct hangers and supports shall follow the recommendations of the SMACNA Duct Manuals.

2 Provide all hangers required for the proper support of ducting. Hangers shall be galvanized or primed steel channel or angle sections. To adjust the duct height, provide cadmium plated threaded steel rods with nuts and washers. All hanger rod installations to be double nutted (top and bottom).

3 For ducts 500 mm (20") and smaller, 25 mm (1") wide strap hangers are acceptable.

4 In concrete construction, use self drilling inserts at proper centers securely anchored in concrete.

5 Beam clamps shall be used when hanging from any structural steel members. No drilling or welding of these members shall be permitted.

6 Do not break continuity of duct insulation vapour barrier with hangers or rods.

Section 23 05 48 Vibration and Seismic Controls for HVAC Piping and Equipment

1 Aim of noise and vibration control shall be to ensure that mechanical equipment and systems operate at the lowest sound and vibration level consistent with the functional requirements of the project.

2 Moving Machinery

3 Moving machinery shall be set on foundations isolated from the structure so as to minimize the transmission of noise and/or vibration.

4 Heavy reciprocating machinery shall be located on the lowest level of the building. Where it must be located on a framed floor, very careful attention shall be given to the proper balancing of the masses of the foundation and the supporting structure, and also to the design of the isolation equipment.

5 Major Equipment Isolation

6 Flexible pipe and duct connections shall be installed at all pipe and duct connections to vibration isolated equipment (not required if equipment internally isolated). Three (3) roll groved joints may be used in lieu of flexible pipe connectors. See Flexible Connections in Ductwork Accessories section for further information on flexible duct connections.

7 All fans and pumps shall be isolated from the building structure.

8 A/H units (not required if internally isolated), base mounted pumps, air compressors over 5 hp, and chillers shall be isolated from the building structure by means of spring isolators and an inertia base. Other types of isolation (in accordance with manufacturer's recommendations) may be considered but will be allowed only with written permission from DTIR.

9 Air compressors up to and including 5 hp shall be isolated from the building structure by means of spring isolators.

10 Electrical connections to vibration isolated equipment shall be flexible.

11 Isolators for equipment with bases shall be located on the sides of the bases which are parallel to the equipment shaft.

Section 23 05 53 Identification for HVAC Piping and Equipment

1 Manufacturers Nameplates

1.1 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.

1.2 Include registration plates (e.g. 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 System Nameplates

2.1 Major equipment to be identified with laminated plastic plates with white face and black center (lettering) of minimum size 89mm x 38mm x 2mm (3½" x 1½" x 3/32") nominal thickness, engraved with 13mm (½") high lettering.

2.2 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.

2.3 Unique mechanical identification tag shall follow naming system laid out on drawings and in specifications. Equipment type, number and service or areas or zone of building it serves to be identified.

3 Equipment Concealed by Ceiling

3.1 At valves, balancing dampers air vents and drains, and other similar pieces of mechanical equipment located above T-bar ceilings or access doors, install circular 19mm (¾") diameter self- adhesive identification discs on the underside of the ceiling, as close as possible to the location of the equipment.

3.2 Discs shall be coloured as scheduled in this section (see pipe primary and secondary colours table).

3.3 Where the item has a primary and secondary colour, provide a 19mm (¾") diameter primary colour disc with a 9.5mm (3/8") diameter secondary colour disc centered on the primary disc.

3.4 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 (with plates for fire dampers to have red face and white lettering). 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.

4 Pipe Identification

4.1 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.

4.2 Material shall be vinyl/plastic coated cloth with protective over coating and waterproof contact adhesive undercoating, suitable for continuous operating temperature of 149 deg. C (300 deg. F) and intermittent temperature of 204 deg. C (400 deg. F).

4.3 Tape shall be 51mm (2") wide single wrap around pipe or pipe covering with ends overlapping not less than 25mm (1"). Tape is to be cut, not torn.

4.4 Block capital letters 51mm (2") high for pipes of 76mm (3") nominal and larger o.d. including insulation and not less than 19mm (¾") high for smaller diameters shall be used.

4.5 Direction arrows 152mm (6") long by 51mm (2") wide for piping of 76mm (3") nominal or large o.d. including insulation and 102mm (4") long by 19mm (¾") wide for smaller diameters to be used. Double headed arrows to be used where direction of flow is reversible.

4.6 Waterproof and heat resistant plastic marker tags to be used for pipes and tubing of 19mm (¾") nominal and smaller o.d.

4.7 Use black pipe marker letters and direction arrows. Use white on red background for fire protection pipe markers.

4.8 Stenciled identification if used shall be from a first quality low VOC paint, with letters a minimum of 51mm (2"). Use stenciling on all purpose or canvas insulation jackets only.

5 A high quality pre-manufactured identification system may be used in lieu of the identification noted above. Submit proposed product(s) to DTIR and do not proceed until written approval received.

6 Location of Identification

7 Markers and classifying colours on piping systems to be located so they can be seen from floor or platform.

8 Piping runs to be identified at least once in each room, regardless of whether concealed or in open areas.

9 Do not exceed 1524cm (50'-0") between identification, regardless of whether concealed or in open areas.

10 In addition, where piping is concealed in pipe chase or other confined space, point of entry and leaving, and each access opening to be identified.

11 Both sides where piping passes through walls, partitions and floors to be identified.

12 Piping to be identified at starting and ending points of runs and at each piece of equipment.

13 Identify branch, equipment or building served after each valve. (ie. heating zones are to be identified in boiler rooms)

14 Provide primary and secondary colour banding.

15 Identification and colour coding shall be as per the following:

Pipe Marker	Valve Tag	Primary Colour	Second Colour
Glycol Supply	G.	Yellow	Black
Glycol Return	G.	Yellow	Black
Condenser Water Supply	CONDS.W	Green	None
Condenser Water Return	CONDS.W	Green	None
Chilled Water Supply	CH.W.S	Green	None
Chilled Water Return	CH.W.R	Green	None
Chilled Drinking Water Supply	D.W.S	Green	None
Hot Water Heating Supply (Up to 120 deg. C)	H.W.H.S	Yellow	Black
Hot Water Heating Return (Up to 120 deg. C)	H.W.H.R	Yellow	Black
Hi Temp Water Supply (Above 120 deg. C)	H.T.W.S.	Yellow	Black
Hi Temp Water Return (Above 120 deg. C)	H.T.W.R	Yellow	Black
Make Up Water	M.U.W	Yellow	Black
Boiler Feed Water	B.F.W	Yellow	Black
Condensate Return	C.	Yellow	Black
Blow Off	B.	Yellow	Black
Refrigerant Suction (Include Refrig No.)	REF.S (No.)	Yellow	Black
Refrigerant Liquid (Include Refrig No.)	REF.L (No.)	Yellow	Black
Refrigerant Hot Gas (Include Refrig No.)	REF.H.G.	Yellow	Black

Pipe Marker	Valve Tag	Primary Colour	Second Colour
Engine Exhaust		Yellow	Bla

Steam (Indicate Pressure)	S (PSI)	Yellow	Bla
Vent (Steam)	V	Yellow	Bla

16 Valves

16.1 38mm (1½") laminated plastic plates (tags) with corner hole shall be provided for all valves and installed with nonferrous chains, “S” hooks or heavy duty plastic tie wraps. Tags shall have horizontal 13mm (½") letters accurately aligned and machine engraved into the core. Required for all valves and operating controllers.

16.1.1 Provide one valve chart for each Operations and Maintenance manual and one chart framed and wall mounted.

16.1.2 Valves in systems to be numbered consecutively.

17 Buried Pipe Identification

17.1 Use detectable Identoline underground warning tape colour coded to pipe service for full length of pipe.

17.2 Bury to manufacturers recommendations.

17.3 Identify all systems, equipment, components, controls and sensors. Inscription to identify function.

18 Duct Identification

18.1 51mm (2") high black stenciled letters to be used, i.e. "Supply", "Return", "Exhaust", “Washroom Exhaust”, "Kitchen Exhaust", etc. with directional flow arrow and Fan System No.

18.2 Maximum distance between markings not to exceed 1524cm (50'-0").

18.3 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.

18.4 Stencil over final finish only.

18.5 Identify system to include air handling unit number.

Section 23 07 00 HVAC Insulation

1 Wire, Mesh and Straps

1.1 Materials

1.1.1 Stainless Steel Wire: 18 ga., Type 304, dead soft annealed.

1.1.2 Galvanized Wire: 15 ga., annealed.

1.1.3 Stainless Steel Mesh: Hexagonal mesh, 20 ga., Type 304.

1.1.4 Galvanized mesh: Hexagonal mesh, 15 ga., galvanized annealed.

1.1.5 Aluminum straps: 13mm (½") x 26 ga.

1.1.6 Stainless Steel Straps: 13mm (½") x 26 ga., Type 304, dead soft.

1.2 Where vapour barriers are used, wire, wire mesh and straps shall be stainless steel.

1.3 Where no vapour barrier is required, wire and wire mesh shall be galvanized steel. Straps may be galvanized steel or aluminum.

2 Pins; welded 4 mm diameter with 13mm (½") diameter head for installation through insulation. Length to suit thickness of insulation.

3 Canvas: ULC listed plain weave, cotton fabric, 8 oz. Finish all exposed insulation with canvas and two coats of lagging adhesive.

Section 23 07 13 Duct Insulation

1 Provide 1" thick duct insulation on the following:

1.1 Dual temperature and air conditioning supply duct.

1.2 Ducts which pass through unconditioned areas and ducts where the temperature difference between the space where the duct is located and the design air temperature of the air carried by the duct exceeds $9^{O}F$ ($5^{O}C$) Also to be insulated are ducts running outdoors, including those for dust collection systems. All duct insulation thicknesses to be in accordance with MNECB requirements.

1.2.1 Exhaust ducts (except kitchen exhaust) are to be insulated 305cm (10") back from their point of exit from the building.

2 Insulation shall be 51mm (2") thick on air handling unit outside air intake ducts and plenums and exhaust plenums, as well as outside air intakes for both boiler rooms and electrical rooms Also to have 51mm (2") insulation are exhaust ducts from air handling unit heat recovery devices which are to be insulated completely from the heat recovery devices to the exhaust plenum.

3 Duct Insulation type - Rigid / Flexible

4 Rigid duct insulation shall be used on exposed rectangular ducts. Flexible duct insulation may be used on rectangular ducts in concealed spaces, such as above ceilings and in wall cavities. Flexible duct insulation shall also be used on round ducts.

5 Rigid insulation shall be rigid mineral fibre board, having a minimum density of 96 kg/m3 (6 lbs./cu.ft) to CAN/CGSB-51.10 (CAN/CGSB-51.10-92).

5.1 Flexible insulation shall be flexible mineral fibre blanket to CAN/CGSB-51.11 (CAN/CGSB-51.11-92).

6 Jacketing on Duct Insulation

7 Factory applied foil-scrim-kraft facing consisting of aluminum foil reinforced with fibre glass yarn mesh and laminated to chemically treated fire resistant kraft is acceptable for duct insulation in concealed spaces.

8 Glass fiber reinforced kraft foil laminate, all service jacket is acceptable for concealed spaces.

9 Canvas jackets shall be ULC listed, fire retardant treated, applied with an approved lagging adhesive (two coats) and painted with a fire retardant paint with a flame spread rating not greater than 25. Where not in concealed spaces, duct insulation shall be canvas jacketed.

10 Jacketing on ducting installed outdoors shall be aluminum.

11 Installation

12 Insulation shall be applied with edges tightly butted and sealed with a 76 mm (3") wide strip of the vapour barrier material, applied with a compatible adhesive.

13 The insulation shall be impaled on stick clips or pins welded to the duct, and secured with speed washers. Maximum spacing of pins shall be 20 pins per sq. yd.

14 Penetrations of the vapour barrier shall be patched with a strip of vapour barrier material.

15 Duct insulation and vapour barrier, where applicable, shall be continuous through walls and floor openings, except at fire dampers or fire doors. Duct coverings shall also be interrupted at duct access doors, electrical resistance heaters and fuel burning heaters.

16 Where more than one thickness of insulation is required, stagger both longitudinal and horizontal joints.

17 Where voids or openings occur between insulation and duct sleeves void shall be filled

Section 23 07 16 HVAC Equipment Insulation

1 Insulate all equipment that operates at less than 15 ^{o}C (60^{o}F) and more than 40 ^{o}C (104^{o}F)

2 Equipment Insulation (above ambient temperature)

3 Insulate domestic hot water tanks, heat exchangers, condensate tanks, flash tanks, and air separators with 51 mm (2") thick sectional semi-rigid mineral fibre, 72 kg/m3 (4.5 lbs./cu. Ft). See also Division 21

4 Insulation for curved surfaces shall be 51 mm (2") flexible mineral fiber blanket to CAN/CGSB 51.11, or 51 mm (2") thick sectional semi-rigid, as noted above.

5 Hydrous calcium silicate or high temperature mineral fibre (51 mm (2") thick) shall be used on applications where temperatures are greater than 454 deg. C (850 deg. F), i.e.: breeching, diesel exhaust, etc. (to CAN/CGSB -51.2 (CAN/CGSB-51.2-95))

6 Hydrous calcium silicate insulation shall be 51 mm (2") thick, have a density of 208 kg/m3 (13 lbs./cu.ft.), and a maximum linear shrinkage of 2.2% after a 24 hour period at 649 deg. C (1200 deg). F.

7 Equipment Insulation (below ambient temperature)

8 Insulate chilled water system components and other similar pieces of equipment with 51 mm (2") thick sectional semi-rigid mineral fibre, 72 kg/m3 (4.5 lbs./cu. Ft), complete with vapour barrier jacket. See also Division 23.

9 Insulation for curved surfaces shall be 51 mm (2") flexible mineral fiber blanket to CAN/CGSB 51.11. (CAN/CGSB-51.11-92), or 51 mm (2") thick sectional semi-rigid, as noted above, complete with vapour barrier jacket.

10 On flat surfaces, mineral fibre insulation shall be applied by impaling the insulation on 9 ga. pins, spot welded, on maximum 30 cm (12") centers, and placed no closer than 102mm (4") from the edge of the board. Secure with 12mm (½") O.D. speed washers. Provide appropriate finish and canvas jacket.

11 On curved surfaces secure the mineral fibre insulation where indicated with galvanized steel wire or aluminum straps. Finish the insulation by applying 25mm (1") galvanized hexagonal mesh and 15 gauge galvanized annealed wire, with metal corner beads applied after the blocks are wired in place. Wire mesh shall be tightly stretched in place and secured with galvanized wire. Overlap mesh points and bind with galvanized wire. Apply one coat, not less than 6mm (¼") thick of hydraulic setting cement and trowel to a smooth finish. Cover with canvas neatly fitted and secured with lagging adhesive. Lap seams at least 51mm (2").

12 Calcium silicate insulation blocks shall be carefully fitted and applied with all blocks staggered. The blocks shall be secured with galvanized wire or aluminum straps.

13 Finish all exposed insulation with canvas jacket that is ULC listed, fire retardant treated, applied with an approved lagging adhesive and painted with a fire retardant paint with a flame spread rating not greater than 25 and smoke generation rating not greater than 50.

14 Diesel exhaust jacket shall be aluminum.

Section 23 10 00 Facility Fuel Systems

1 #2 Fuel Oil.

1.1 Fuel Oil Tank Systems Reference Standards

1.1.1 Supply and installation of dual wall oil storage tanks and accessories shall be in accordance with the following standards:

1.1.1.1 Most recent editions of CSA B139 (CSA B139 SERIES:19), CSA B139S1 (standard not found), ULC S601 (CAN/ULC S601-14), CAN4-S602 (CAN/ULC S602-14).

1.1.1.2 Nova Scotia Department of Environment (DOE) - Petroleum Storage Regulations and Construction Standards for Installation and Removal of Petroleum Storage Systems.

1.2 Installation Requirements

1.2.1 Fuel oil storage tank shall be installed by a certified tank installer (Class I License). Tank shall be registered as per DOE Petroleum Storage Tank Regulations. Copy of registration shall be forwarded to DTIR.

1.3 Piping

1.3.1 Installed and protected as per CAN 4-S603.1M (CAN/ULC S603.1), latest edition, Appendix B.

1.3.2 Above Grade.

1.3.2.1 Above grade oil lines shall be Schedule 40 black steel pipe, ASTM A53 (ASTM A53/A53M-18) with socket weld fittings or Type L hard copper with silfos joints. Provide fusible link shut-off valve on suction lines at burner. Provide normally closed solenoid valves on each supply line to the boilers where applicable. Provide check valves on return lines only. Return oil lines to be terminated at top of tank. Do not pipe to bottom of tank. Provide ball valve shutoffs on suction lines upstream of fusible links and filters.

1.3.2.2 Above grade black steel pipe located outdoors shall be primed and painted with corrosion resistant coatings. The final connection to the burner shall be with flexible braided stainless steel hose.

1.3.3 Provide individual suction lines from the bottom of the tank(s) to each boiler. Provide normally closed solenoid valves on each line.

1.3.4 A separate pump set and dedicated circulation loop for the boilers may be provided in lieu of individual suction lines and normally closed solenoid valves.

1.3.5 Below Grade

1.3.5.1 Buried pipe shall be double wall, continuous polyethylene piping consisting of a ULC listed flexible inner primary pipe encased within a ULC listed flexible outer containment pipe.

1.4 Accessories

1.4.1 Vent shall be fitted with a screened elbow and Vent-A-Larm.

1.4.2 Fuel oil filter shall be heavy duty type, simplex filters at pump suction.

1.4.3 Float activated fill limiting valve (overfill preventer valve) to be installed in the tank to back flow up the fill pipe when the tank is 95% full. Provide necessary coupler/adaptor for fuel delivery.

1.4.4 Provide a distant reading fuel gauge (Levelometer) with installation in the Boiler Room.

1.5 Tanks

1.5.1 General

1.5.1.1 Provide a CSA certified above ground exterior oil tank. Size tank for minimum one week oil storage capacity at design winter temperature.

1.5.1.2 Dual wall construction, with tank saddles continuous welded to tank shell.

1.5.1.3 Tank to be coated, at factory, with one coat of corothane zinc primer and two coats of white corothane II moisture cured urethane finish (or two coats of heavy duty marine type paint which requires approval in writing from DTIR). Provide one pint of touch- up paint.

1.5.1.4 Fill service platform shall be 91cm (36") x 61cm (24") with stairs (ships ladder not acceptable). Platform/stairs to be 100% galvanized including railings and be complete with non- slip treads.

1.5.1.5 All hinges, bolts and bung fittings to be galvanized or stainless steel.

1.5.1.6 Tank to have a 25 litre lockable spill containment box. Locate vacuum monitor gauge in box. Fill box shall be pre-drilled, at high level, for tank monitor conduit, at factory.

1.5.2 Concrete Work

1.5.2.1 Concrete tank pad (above/below grade) shall be minimum 12" thick, length and width extending 18" beyond tank dimensions.

1.5.2.2 Pad shall be structurally reinforced.

1.5.2.3 Concrete to be a minimum 4000 lb. test.

1.5.3 Fencing

1.5.3.1 Provide chain-link fencing (minimum height 244cm (8'-0")) around the tank c/w lockable access gate. Also provide concrete filled metal bollards to protect tank from vehicles.

2 Propane / Natural Gas System

3 Provide a complete propane distribution system including connection to exterior propane tank(s). Coordinate tank installation (size of tank(s), location etc.) with DTIR/building operator and their propane service contractor.

4 System shall be in accordance with applicable codes and authorities having jurisdiction. Installation shall be carried out by a licensed propane installer.

5 Above grade pipe shall be Schedule 40 black steel with socket welded joints or Type K copper with silfos joints. As noted elsewhere, under the subject of Pipe Identification, paint the entire propane or natural gas piping system yellow and ensure proper stenciled identification is used.

6 Pipe supports and hangers shall be as per authorities having jurisdiction or the DC350, whichever is more stringent. Pipes running outside on roofs to be mechanically fastened to the roof structure (e.g. Thaler anchors). Supporting the pipe on wood sleepers placed on top of the roof is not permitted.

7 Provide a reinforced cast-in-place structural concrete slab base for the tank(s) and chain-link fencing (minimum height 8'-0'') around the tank(s) c/w lockable access gate. Also provide concrete filled metal bollards to protect tank(s) from vehicles.

8 Gas outlets shall be provided with pins, lugs etc. secured to the mounting benches to prevent tampering with the system and release of propane gas

Section 23 20 00 HVAC Piping and Pumps

1 Pipe and Fittings

1.1 Hot water heating, chilled water, condenser water, glycol, diesel cooling, diesel exhaust and steam piping (excluding steam piping in boiler plant and steam vent piping) shall be as follows.

1.1.1 Pipe

1.1.1.1 51mm (2") and Smaller: BW steel, Sch. 40 ASTM A53 (ASTM A53/A53M-18), Grade B.

1.1.1.2 64mm (2½") and Larger: ERW steel, Sch. 40, ASTM A53 (ASTM A53/A53M-18), Grade B.

1.1.1.3 Copper Tube: Type L hard drawn.

1.1.2 Joints:

1.1.2.1 51mm (2") and Smaller: Screwed

1.1.2.2 64mm (2½") and Larger: Welded, Flanged

1.1.2.3 Copper Joints: Solder, lead free.

1.1.2.4 Roll grooved joints are also acceptable for hot water heating, chilled water, glycol, condenser water and diesel radiator piping.

1.1.2.4.1 Roll groved coupling, complete with EPDM gaskets at elbows only.

1.1.2.4.2 Roll groved coupling, complete with EPDM gaskets at straight run of pipe.

1.1.3 Fittings

1.1.3.1 51mm (2") and Smaller: Standard Malleable Iron, Banded Threaded, 57kg (125 lb.) class.

1.1.3.2 64mm (2½") and Larger: Sch. 40 Steel Butt Welded ASTM A234 (ASTM A234/A234M-18a), Grade A, Weld-0-Lets or equal.

1.1.3.3 Copper Fittings: Wrought copper.

1.1.3.4 Roll grooved fittings and tees.

1.1.3.5 Unions: 51mm (2") and Smaller: Class 150 malleable iron, brass to iron seats.

1.1.3.6 Flanges

1.1.3.6.1 All: Class 150 steel slip-on or weld neck type, raised face, ASTM A181 (ASTM A181/A181M-14).

1.1.3.6.2 Bolts: Stud bolts, carbon steel, heavy hex nuts.

1.1.3.6.3 Gaskets: All – 1.6mm (1/16") thick Cranite or approved equal.

1.2 Headers shall consist of the required length and size of pipe with each take-off welded into the pipe. Roll grooved couplings also permitted for take-offs. Ends of all headers shall be finished with welding caps or grooved couplings.

1.3 Branch connections shall be made using pipe cut into the main and/or weld-o-lets where the main is twice the diameter of the branch, otherwise welding tees shall be used. Alternatively, use an approved hole cut mechanical tee piping system.

1.4 If roll groove piping system is used, all couplings and fittings shall be of the same manufacturer.

1.5 Piping Installation

1.5.1 Arrange and install piping approximately as indicated, straight, plumb, and as direct as possible. Form right angles or parallel lines to building walls.

1.5.2 Locate groups of pipe parallel to each other spaced at a distance to permit applying full insulation and access for servicing valves.

1.5.3 Grade forced water piping 25mm (1") per 1829cm (60'-0") so that when the system is filled, the air in the mains and risers shall be carried to venting high points and drains at low points.

1.5.4 Forced water return and supply piping shall be taken off main at 45º angle vertically from each main or branch main. Runouts shall be made with four (4) joints to permit expansion and avoid strain on equipment.

1.5.5 Provide air vents at all high points in the piping system. Air vents shall be installed at an accessible place in order to facilitate maintenance.

1.5.6 Valved by-passes shall be provided for equipment requiring disconnection for repair or replacement, including, but not limited to 3-way valves, water make-ups, PRVs, steam traps, steam and condensate meters.

1.5.7 Unions shall be provided in the by-passes and shall be located between the shut-off and the equipment. Do not conceal unions in walls, partitions or ceilings.

1.5.8 Provide shut-off valves in risers and main branches at point of takeoff from the supply or return main, individual equipment units at inlets and outlets to permit removal for repairs without interfering with remainder of the system, and in equipment by-passes.

1.5.9 Keep piping free from scale and dirt. Protect open pipe and whenever work is suspended during construction, to prevent foreign bodies entering or lodging, using temporary plugs, burlap or other approved materials for protection.

1.5.10 Expansion Loops and Anchors

1.5.10.1 Control the direction and extent of pipe movement in mains and risers by the use of loops, bends, offsets, guides and anchors. Compensators will also be considered where space does not permit loops or bends (obtain specific written permission from DTIR).

1.5.10.2 All expansion loops or bends shall be half cold spring, and/or branch connections shall have strain, on when cold, off when hot.

1.5.10.3 Anchors shall be fabricated from angle iron sections and fastened to the building structure.

1.5.10.4 Provide roll groved couplings on expansion loops where roll groove joints are used.

1.5.11 All elbows shall be long radius.

2 Valves

3 Each valve type to be of one manufacturer and shall have the manufacturer's name and pressure rating clearly marked on the outside of the body.

4 The metals used in the bodies, bonnets, yokes, and discs of all the bronze valves shall conform to ASTM B62. In iron body valves, the cast iron shall conform to ASTM A126 (ASTM A126-04(2014)) Class B.

5 Composition discs on all valves shall be suitable for the service and shall be as recommended by the manufacturer.

6 Use globe valves for by-passes that are the same size as control valves and pressure reducing stations. Use ball valves for pipe 51mm (2") and smaller.

7 Balancing Valves

8 Provide circuit balancing valves on returns from force flow heaters, unit heaters, heating coils and wall mounted radiators. Also provide circuit balancing valves on main and branch supplies/returns for easy balancing of the system and on each boiler return to ensure even flow. Triple duty valves (with memory stop) may be used in lieu of gate valve, balancing valve and check valve, at pump discharges.

9 Provide a memory stop balancing valve in conjunction with a flow measuring fitting on in-floor heating manifold returns and radiant ceiling panel manifold returns. Circuit balancing valves (circuit setters) are also acceptable.

10 Locate valves for easy access. Do not locate stems below horizontal.

11 Balancing shall be sized according to flow and NOT line size only.

Section 23 21 00 Hydronic Piping and Pumps

1 Hydronic Specialities

1.1 Air Vents

1.1.1 At every high point in piping system, provide automatic air eliminators in order to avoid air pockets in the system. Air vents shall be installed at an accessible place with the aid of necessary piping in order to facilitate maintenance.

1.1.2 Provide manual air vents at high points of the system and return bends to permit draining.

1.1.3 Use automatic float type vents at difficult to get at points only and provide drip point. A collecting standpipe is recommended at any high point which might cause air binding.

1.1.4 Provide a mini ball valve for shut-off and servicing of the vent.

1.1.5 Provide automatic type air vents on all upfeed radiation.

1.1.6 For shell and tube steam convertors, provide automatic air purging.

1.1.7 All air vents where possible are to be complete with collecting chambers.

1.1.8 Arrange the piping so that the air purging will follow the direction of water flow in branches and risers.

1.2 Drains/Sediment Faucets

1.2.1 Provide sediment faucets at the low points of piping and on radiation.

1.2.2 On mains, risers and equipment provide 19mm (3/4") straight-through ball valves with hose end male thread and cap with chain.

1.2.3 All small drains from each piece of equipment shall be brought over to a funnel floor drain and shall terminate 51mm (2") above the funnel. These shall include small surface drains from boilers, heating system main drain outlets, etc. and shall be run in steel piping to nearest floor drain or hopper. No drain or over flow line shall be left so that liquid or vapour will spill on equipment or floors. Cut drain pipes at 45º angle to drain top.

1.3 Air Separator / Purger

1.3.1 Working pressure 862 kpa (125 psi).

1.3.2 Provide centrifugal type with galvanized steel 5 mm perforated strainer, perforated stainless steel air collector tube and drain connection. Provide on suction side of system circulation pump and connect to expansion tank.

1.4 Safety and Relief Valves

1.4.1 Provide ASME rated direct spring loaded type, lever operated non-adjustable factory set discharge pressure as indicated. Provide relief valves on pressure tanks, low pressure side of reducing valves, heating convertors and where indicated. Drain relief valve discharge to nearest floor drain. System relief valve capacity shall equal make-up pressure reducing valve capacity. Equipment relief valve capacity shall exceed input rating of connected equipment. Where one line vents several relief valves, cross sectional area shall equal the sum of individual vent areas and must be vented to prevent the discharge going back to one of the other relief valves.

1.4.2 Locate and install so that they can be taken apart without breaking piping connections.

1.4.3 Provide safety valves at all heat exchangers and as otherwise required.

1.4.4 Provide relief valves in piping between isolation valves and heat exchangers.

1.5 Strainers

1.5.1 "Y" pattern, full size of pipe.

1.5.2 2" and smaller shall be threaded; 64mm (2½") and larger shall be flanged.

1.5.3 Strainers shall have stainless steel or monel perforated screens. Install strainers at the inlet of all pumps, reducing valves, flow regulators, etc.

1.5.4 Install strainers in vertical lines with downward flow or in horizontal lines. Do not install in vertical lines with upward flow.

1.6 Expansion Tank

1.6.1 Provide diaphragm type for acceptance volume up to 132 litres (35 US gallons), and bladder type for acceptance volume over 132 litres (35 US gallons).

1.6.2 Pre-charged expansion tank shall be complete with air control fitting and water make-up accessories, from the same manufacturer.

1.6.3 The tank system connection shall be at or near the pump suction.

1.6.4 Use 19mm (3/4") minimum pipe size for tank connection to system. Minimize length of horizontal piping.

1.6.5 Provide lockshield isolation valves at expansion tanks.

1.7 Water Make-up System

1.7.1 Water make-up connection must have an approved and certified backflow device.

1.7.2 Provide pressure gauge complete with mini ball valve, on both sides of the make-up assembly. Also provide valved bypass piping around make-up assembly.

1.7.3 Locate water make-up feed connection at the point of no pressure change.

2 System Pressurization

3 The fill pressure at the system pump intake shall be the saturation pressure of water -9 deg. C (15 deg. F) above the system design operating temperature.

4 This minimum pressure shall ensure at least 27 kpa (4 psig) at the top of the system.

5 Locate the boilers and a system relief valve on the suction side of the pump.

6 Standard pressure settings of 241 kpa (35 psig) for relief valve and 83kpa (12 psig) for automatic fill valve are suitable for water temperatures up to 110 deg. C (230 deg. F) and static heads up to 549cm (18 feet).

Section 23 22 00 Steam and Condensate Piping and Pumps

1 Steam piping between boilers and main header, condensate, boiler blowdown, and boiler feed piping.

1.1 Pipe: Extra strong black steel, Sch. 80, ERW or seamless ASTM A53 (ASTM A53/A53M-18), Grade B.

1.2 Joints: Screwed or welded up to 51mm (2"), welded 64mm (2½") and larger.

1.3 Fittings: 51mm (2") and smaller, 2068 kpa (300) psi malleable iron banded screwed; 64mm (2½") and larger, 2068 kpa (300) psi steel butt welded.

1.4 Unions: 2068 kpa (300) psi malleable iron, ground joint.

1.5 Flanges: 2068 kpa (300) psi steel slip-on type ASTM A181 (ASTM A181/A181M-14), Grade 1 with 1.6 mm (1/16”) Cranite gaskets. (or Lamons Flexatalic, SS 316)

2 Untreated steam and condensate piping for humidification (for steam to steam type systems)

3 Pipe: Schedule 40 stainless steel to ASTM A213 (ASTM A213/A213M-18b) Grade 316.

4 Joints: Socket weld to schedule 40 pipe size. Grade 316 stainless steel.

5 Fittings: Socket weld to schedule 40 pipe size. Grade 316 stainless steel.

6 Unions: 1034 kpa (150 psi) stainless steel, ground joint. Grade 316.

7 Flanges: 1034 kpa (150 psi) stainless steel, slip-on type with 1.6mm (1/16") Teflon gaskets. Grade 316. (or Lamons Flexatalic, SS 316).

8 Steam Traps

9 Provide individual traps for heating units.

10 Provide a sediment strainer at each trap.

11 Thermostatic traps shall be provided for units with slowly varying, low volume loads (i.e., convection-radiation type heating units) and for drip points of branch risers to each unit. A pipe cooling leg is recommended before the drip trap.

12 Float and thermostatic traps are recommended for heating units with steam pressures up to 345 kpa (50 psig), with varying pressures and loads (modulating type operation), (i.e., heaters, air heating coils, and liquid coil heaters). Use at drip points.

13 Bucket traps are recommended for steam pressures above 345 kpa (50 psig) and heavy intermittent loads. Inverted type is self cleaning.

14 Where steam binding or locking conditions can occur, use a specialty trap.

15 Except for thermostatic traps at convectors, locate traps as close to the heater outlet as possible.

16 Prevent water hammer at all water collection points.

17 Protect traps against freezing.

18 Flash Steam

19 Recover such heat by means of flash tank. Use the flash steam as a heat source for low pressure systems. If this is not possible, use the available flash steam and high temperature condensate for feed water or domestic water heating through a shell and tube economizer.

20 Provide Steam Pressure Reducing Stations

21 Complete with pressure reducing valve(s), valved bypass, strainer and pressure gauge on upstream side, relief valve and pressure gauge on downstream side.

22 Pressure Reducing Valves

23 Use single-seated valves for dead-end and tight shut-off. Use pilot controlled or air-loaded direct-operated valves where variable inlet pressures occur and when close control of the reduced pressure is necessary. Where light loads and cycling control, use two reducing valves in parallel and size valves for 70 and 30 percent of maximum flow. Two-stage reduction is recommended for pressure reductions over 689 kpa (100 psig).

24 Pressure reducing valve(s) shall have diaphragm, bronze body, balanced design, stainless steel trim and pilot operator.

25 Steam Air Vents

26 Provide automatic steam air vents of the thermostatic balanced pressure type, with brass or semi-steel body, renewable stainless steel head and seat. Fabricate thermostatic liquid filled bellows of phosphor bronze.

Section 23 23 00 Refrigerant Piping

1 Tubing

1.1 Tubing shall be processed for refrigerant installations, deoxidized, dehydrated and sealed.

1.2 Hard copper tubing shall be type ACR B to ASTM B280 (ASTM B280-18).

1.3 Annealed copper to ASTM B280 (ASTM B280-18) for a maximum of the last 61cm (2’) of piping at refrigerant equipment.

2 Fittings

3 Design pressure 2068 kpa (300 psi) and 121 deg. C (250 deg. F) .

4 Brazed wrought copper, joint shall be silver solder.

5 Long radius type for elbows and return bends.

6 Sleeves

7 Hard copper sleeve sized to provide 6mm (¼") clearance around and between sleeves and uninsulated pipe or between sleeve and insulation.

8 Insulation

9 Exterior insulation shall be wrapped in aluminum alloy jacketing.

10 Installation

11 Bleed inert gas into pipe during brazing.

12 Purge refrigerant lines and piping.

13 When multiple lines are run, spread pipes 152mm (6") minimum to allow for expansion and contraction.

14 Install straight, parallel and close to walls and ceilings, with specified pitch.

15 Piping to be installed to prevent condensate or oil from flowing back into compressor or evaporator.

16 Bleed dry nitrogen into piping when sweating connections.

17 Enclose tubing exposed to mechanical injury in rigid or flexible conduit.

18 Soft annealed tubing: bend without crimping or constriction.

19 Hard drawn copper tubing: do not bend and minimize use of fittings.

20 Hot Gas Lines: Provide trap at base of risers greater than 244cm (8') high and at each 762cm (25') thereafter. Provide deep trap at top of risers.

21 Testing

22 Pressure and leak testing shall be performed.

23 Provide 4 days notice to Consultant and DTIR before charging.

24 Consultant and DTIR have the right to request Contractor to cut out 2 fittings per 25 to allow for inspection of purity of joints

Section 23 25 00 HVAC Water Treatment

1 Feedwater Equipment

1.1 Pre-Charged Expansion Tanks

1.1.1 Tanks to be suitable for 689kpa (100psi) working pressure.

1.1.2 Tank shall be precharged as required to suit system requirements.

1.1.3 Drains shall discharge to a floor drain.

1.1.4 Tanks shall be complete with suitable supports.

1.1.5 Tank shall be complete with automatic fill.

1.1.6 Provide lockshield isolation valve on supply.

1.1.7 All expansion tanks shall be supported with suitable hangers or pipe stands as required according to the size of the tank.

1.2 Automatic Water Feeder:

1.2.1 Pipe relief valve to floor drain.

1.2.2 To be complete with reduced pressure type back flow preventer.

1.2.3 Domestic water shall not be directly connected to piping systems containing glycol.

2 Chemical Treatment

3 System water shall be slightly alkaline at all times, between 7.0 and 9.0 pH. Chemical additives shall not adversely affect any components of the system (i.e., mechanical pump seals, valve glands, etc.).

4 Chemical treatment shall be provided for the water, steam and condensate, boilers, chilled and condenser water and glycol heating systems (not required in glycol systems if inhibitors already present in glycol).

5 Provide chemical pot feeder piped in system with extra strong Schedule 80 black steel pipe and crosses provided in lieu of 90º turn with unused opening plugged. Fittings also to be extra strong 2068kpa (300psi).

6 Provide chemical boil-out of boilers using chemicals recommended by the chemical treatment manufacturer. Isolate auto-air vents during initial treatment. Pre-operational cleaner shall be used to clean all closed chilled water, hot water and glycol piping systems.

7 After pressure tests are completed and approved, prior to start-up and placing into operation, flush and clean out all piping systems before adding any chemical treatment.

8 Provide a 40% propylene glycol, pre-mixed solution complete with inhibitors for the glycol heating system.

9 Provide corrosion inhibitors for all piping systems and supervise cleaning operation.

10 Chemical treatment supplier shall supervise the treatments and boil-out of all systems, and provide test reports before systems are made operational. Approval in writing of the test results is required from the mechanical design engineer before the system is considered acceptable.

11 See 15010 for testing requirements.

12 Factory trained representatives from the chemical treatment supplier shall provide on-site instruction (minimum one hour) in operation and maintenance procedures for the to the building operators.

Section 23 30 00 HVAC Air Distribution

1 HVAC Ducts and Casing

1.1 Galvanized sheet metal ductwork shall be specified for supply, return and washroom exhaust air systems. All ductwork shall consist of sheet metal manufactured, shipped and fabricated using oil-free methods.

1.2 Classification shall be in accordance with SMACNA (fan static pressure shall determine classification).

1.3 Construction

1.3.1 Ductwork shall be to ASHRAE and SMACNA. (see below for additional requirements) Ductwork shall be galvanized steel, lock forming quality to ASTM A525M (ASTM A525M: 1991), Z90 zinc coating.

1.3.2 Clean ductwork, plenums and equipment prior to start-up.

1.3.3 Longitudinal seams shall be to SMACNA Standard Fig. 105 Types L-1 to L-5.

1.3.4 Duct Joints

1.3.5 Joints shall be to ASHRAE and SMACNA.

1.3.6 Manufactured joint systems (Ductmate and Nexus) are also acceptable.

1.3.7 Ductwork at all intakes, exhausts and other places where moisture may occur shall be watertight. At these places ductwork shall be sloped towards a low point where a minimum 32mm (1¼") drain with deep seal trap shall be provided, discharging to a funnel floor drain. Air handling unit intake and exhaust plenums shall each be provided with a minimum of two such drains with trap depth a minimum 150% of the unit maximum static pressure. Provide an electronic primer on each trap. Dishwasher exhaust ductwork shall also be watertight.

1.3.8 Ductwork shall be free from pulsation or objectionable noises.

1.3.9 Install duct elbows having a throat radius 1½ times the diameter, or fabricate with square throats and backs fitted with duct turns. Duct turns shall be fabricated with double width blades of approved construction.

1.3.10 All vertical ducts in shafts shall be rigidly supported with steel angle. In no case shall angles be less than 38mm x 38mm x 6mm (1½" x 1½" x ¼").

1.3.11 Where ducts pass through walls or floors, coordinate with architectural/structural disciplines to ensure integrity of the construction. At fire dampers and where ducts pass through floors, provide a continuous galvanized steel angle iron frame minimum size 38mm x 38mm x 6mm (1½" x 1½" x ¼") (or as per fire damper manufacturer requirements) which shall be bolted to the construction and made air-tight to the same by applying appropriate caulking compound. Sheet metal at these locations shall be bolted to the angle iron.

1.3.12 During construction, seal all openings with polyethylene and tape at all times to prevent entrance of dirt, dust, etc.

1.3.13 Round Ducts

1.3.13.1 Concealed round branch ducts up to 36cm (14") diameter may be constructed with longitudinal or spiral lock seams.

1.3.13.2 Concealed round branch ducts 38cm (15") and over and all exposed round ducts shall be factory fabricated conduit consisting of helically wound galvanized iron strips with spiral lock seams. Fittings for these conduits shall be fabricated of 20 gauge galvanized sheet steel of gauges per SMACNA with butt welded seams of standard dimensions.

1.3.13.3 Long radius elbows shall be used where space permits. Where 90 deg. take-offs are necessary, conical “Ts” shall be used.

1.3.13.4 Conical tee fittings shall follow SMACNA Fig. 3-4 90 deg. Tee with Oval to Round Tap.

1.3.13.5 Round ducts and fittings shall be galvanized steel of the following minimum gauges:

Duct Diameter	Spiral Duct Gauge	Plain Duct Gauge
20-0cm (8"-0")	28	24
23-36cm (9"-14")	26	24
38-66cm (15"-26")	24	N/A
69-91cm (27"-36")	22	N/A
94-127cm (37"-	20	N/A

1.3.14 Finish

1.3.14.1 Where ducts run exposed outside of mechanical rooms provide a satin coat finish which is to be followed by suitable painting.

1.3.15 Duct Sealing

1.3.15.1 Sealing shall be in accordance with SMACNA pressure classifications.

1.3.15.2 All duct joints and connections shall be made airtight with duct sealant, tape or a combination thereof (method depends on the classification), applied according to the manufacturer’s recommendations as the ducts are being constructed.

1.3.15.3 Duct sealant shall be:

1.3.15.3.1 Water and oil resistant

1.3.15.3.2 Compatible with duct materials.

1.3.15.3.3 Rated at 25 or less for flame spread and 50 or less for smoke developed.

1.3.15.3.4 Non toxic, low VOC emission.

1.3.15.4 Duct tape shall be:

1.3.15.4.1 Polyvinyl treated, open weave fibreglass, 51mm (2") wide.

1.3.15.5 Method

1.3.15.5.1 Surfaces shall be cleaned and treated in accordance with manufacturer's recommendations.

1.3.15.5.2 Apply sealant in accordance with SMACNA and manufacturer's recommendations.

1.3.15.5.3 Where tape is required by the classification, bed tape in sealant (overlapping the area to be sealed by 51mm (2")) and recoat with minimum of 1 (one) coat of sealant to the manufacturer's recommendations, and closing all openings in the weave.

1.4 Special Duct Materials

1.4.1 Ductwork for kitchen exhaust shall be welded construction minimum 18 gauge type 30 stainless steel, complete with cleanouts, to the requirements of NFPA 96 (NFPA (Fire) 96: 2017), latest edition. Welded black steel (minimum 16 gauge) is permitted where the kitchen exhaust duct is concealed in ceilings, walls or shafts.

1.4.2 Laboratory exhaust ductwork (serving chemical fume hoods and chemical storage cabinets) shall be minimum 18 gauge type 316 stainless steel with welded joints.

1.4.3 Dishwasher exhaust ductwork shall be aluminum, sloped to a low point with a drain and deep seal trap.

1.5 Flexible Ductwork

1.5.1 Flexible ductwork shall be used for acoustical purposes at supply air terminal units. The minimum length shall be 91cm (3'), maximum length shall be 152cm (5'), with at least one support required. Note: Flexible ductwork is not permitted on the return or exhaust side.

1.5.2 There is to be no more than a 15 degree change in direction in flexible ductwork. For changes in direction of more than 15 degrees, use rigid ductwork for the change (i.e. provide sheet metal elbows at air terminals).

1.5.3 Flexible ducts shall be:

1.5.3.1 UL listed for Class I air duct material, UL-181 (UL 181: 2013).

1.5.3.2 In accordance with NFPA Standard 90A (NFPA (Fire) 90A: 2017).

1.5.3.3 Constructed of a non-collapsible, corrosion resistant, spring steel helix bonded to a vinyl inner liner and covered with a factory applied, wrapped, glass fiber acoustic insulation and vapour barrier jacket.

1.5.3.4 Capable of operating at pressure from 10" positive to 1" negative.

1.5.3.5 Capable of operating at temperatures from -18 deg. C (0 deg. F) to 93 deg. C (200 deg. F).

1.5.3.6 Install flexible ductwork fully extended and use only foil tape, not grey fabric tape, to seal ends of flexible ductwork.

1.6 Storage of Ductwork

1.6.1 All ductwork shall be stored indoors, on pallets and tightly wrapped/covered in poly. Storing ductwork outdoors under tarps is not permitted.

1.7 Duct Cleaning prior to Installation

1.8 Clean inside surfaces of ductwork, during/prior to installation, to remove oil, debris and dust. Use non-toxic cleaners to remove oil.

Section 23 33 00 Air Duct Accessories

1 Relief Dampers

1.1 Avoid use of unregulated relief dampers.

1.2 Where unregulated relief damper must be used, apply heavy duty type which will not flutter or chatter under normal wind velocity or fan discharge conditions.

2 Volume Dampers

3 At each supply, return and exhaust air branch take-off and in such other locations to allow proper and easy balancing of the air distribution systems, furnish and install as close as possible to the take-off, volume dampers with damper regulators.

4 Provide single blade dampers in branch take-offs for volumes up to 28 m3/min (1000 cfm) and multiple opposed blade dampers for volumes over 28 m3/min (1000 cfm).

5 All volume dampers to be supported at both ends.

6 Turning Vanes

7 To be used to improve air flow through changes in direction of ductwork, when large radius turns or two 45 degrees elbows cannot be used because of space considerations.

8 Factory or shop fabricated single thickness without trailing edge, to recommendation of SMACNA.

9 Access Doors

10 Provide adequately sized galvanized steel access doors for all devices requiring inspection, maintenance or cleaning.

11 Access doors shall be located before and after coils, filters, fans, automatic dampers, at fire dampers, fresh air and exhaust air plenums, bottoms of risers, and where required elsewhere.

12 Access doors shall be minimum 30cm x 30cm (12" x 12") for hand access and 61cm x 61cm (24" x 24") for body access.

13 Access doors shall be tight fitting with Allen key Camlock. Screw-slot locking devices are not allowed. Insulate access doors where they are installed in insulated ductwork or plenums.

14 Access doors in ductwork shall be no more than 914cm (30’) apart for duct cleaning purposes.

15 Gasketed panels (patches) minimum size 30cm x 30cm (12" x 12") and fabricated from the same material as the duct and fastened with sheet metal screws are permitted if the access is for cleaning only; otherwise access doors shall be provided.

Fire Resistance

Fire-resistive ceilings may be provided with duct openings complying with UL testing.

Provide fire dampers at all fire separation penetrations.

Fire Dampers

Fire dampers shall be ULC approved and labeled, and lock in a closed position when released by approved fusible links.

Shop fabricated fire dampers shall not be accepted, the dampers shall be a manufactured item.

Each damper shall be provided with a suitably located access panel with removable covers to allow resetting of dampers.

Fire dampers shall be located within the fire separation.

Provide galvanized steel angle frames, sized as per manufacturer’s recommendation, on the outer perimeter of all fire damper installations, on both sides of the penetration.

Fire dampers shall be complete with corrosion resistant springs, bearings, bushings and hinges.

Flexible Connections

Flexible connection shall be:

Heavy glass fabric, double coated with neoprene.

Non-combustible.

Weatherproof and air tight.

Resistant to acids, grease, alkaline, oil and gasoline.

Acceptable for temperatures up to 93. Deg C (200 deg. F).

Flexible connections shall be pre-assembled of 24 gauge galvanized metal clinched by means of a double lock seam to each side of the fabric.

Flexible connections shall be installed on the inlet and outlet connections of each fan and A/H unit (although not required on A/H unit if internally isolated).

Flexible connections shall be a minimum of 152mm (6") long and installed with adequate slack (a minimum of 76mm (3") of fabric between the metal ends whether the equipment is on or off) and a ground strap.

36 Sound Attenuators /Duct Silencers

37 Outer casings of silencers shall be fabricated from not less than 22 gauge galvanized steel in accordance with the ASHRAE Guide or SMACNA recommended construction for ductwork. Seams to be lock-formed and mastic-filled. Interior casings for silencers shall be fabricated from not less than 26 gauge galvanized perforated steel. Use 10 gauge HTL outer casing to reduce noise transmission in applications where additional sound attenuation is required.

38 Silencers shall not leak air or fail structurally when subjected to a differential air pressure of 20cm (8") water gauge inside to outside of casing.

39 Filler material shall be not less than 16kg/m3 (1 lb./cu.ft.) inorganic mineral or glass fiber packed under at least 5% compression. Material shall be inert, vermin and moisture proof and further enclosed with a tight woven fabric beneath the perforated liner. Combustion rating of the filler material shall be not less than the following when tested in accordance with ASTM #84 (Standard not found), NFPA Standard 255 (NFPA (Fire) 225: 2017) or UL No. 723 (UL 723: 2018):

40 Flame Speed Rating = 25

41 Smoke Development Rating = 50

42 Fuel Contribution Rating = 50

43 Acoustical test shall conform to ASTM E-477073 (standard not found) standard method of testing duct liner material and manufactured silencers for acoustical and airflow performance. Tests shall be run both with and without air flowing through the silencer at not less than 3 different flow rates. All ratings shall be based on test data from a nationally known qualified independent laboratory. Test methods shall eliminate effects due to end reflection, vibration, flanking transmission and standing waves in the reverberant room. Air flow and pressure loss measurements shall be made in accordance with the applicable portion of ASME, SMACNA and ADC airflow.

44 Acoustic duct liner is not permitted.

45 Provide silencers in all ducts to and from air handling units.

Section 23 34 00 HVAC Fans

1 General

1.1 Statically and dynamically balance fans so no objectionable vibration or noise is transmitted to occupied areas of the building or adjacent properties.

1.2 Provide balanced variable sheaves for motors 10 kW and under and fixed sheave to 15 kW and over.

1.3 Fans shall be capable of accommodating static pressure variations of ±10% with no objectionable operating characteristics.

1.4 All exhaust air systems shall be complete with birdscreen and low leakage backdraft dampers. Refer to Section 23 09 00 for motorized backdraft damper requirements.

1.5 Provide suitable vibration isolation and flexible connections (refer to other sections of this document).

2 Beltguards

3 Provide for each V-belt drive a perforated galvanized steel belt guard, constructed with a galvanized steel frame and access openings for tachometers.

4 Belt guards shall be securely bolted to floor or apparatus, and shall completely enclose drive and pulleys.

5 Fans shall be selected to allow for reduced fan speeds and therefore reduced sound power levels.

6 Centrifugal type with multi-blade wheel statically and dynamically balanced.

7 Install fans on solid or hollow steel shafts as required and mount on self-aligning ball bearings. Provide lubrication fittings within the casing, within reach and sight of bearings. Provide extended lubrication fittings only if there is an unavoidable lack of access to a bearing (e.g. due to a small existing mechanical room on a renovation project).

8 Provide variable sheaves for motors 11 kW and under and fixed sheaves for 15 kW and over.

9 Provide flexible connections at the inlet and outlet of fan section.

10 Fan motors shall be mounted within the casing of all air handling units.

11 Centrifugal Fans

12 Provide multi-blade wheels in heavy gauge steel housing reinforced for service encountered.

13 Provide V-belt drives with fan and motor mounted on reinforced, rigid steel base with adjustable motor mount.

14 Provide heavy duty, self-aligning, anti-friction bearings with external lubrication.

15 All units shall be provided with suitably sized vibration isolators.

16 Units suspended from the structure shall be provided with suitably sized hanger rods. Steel channel sections shall be provided to distribute the weight of the units over an appropriate number of joists where such structural framing occurs.

17 Floor mounted units shall be supported by angle iron stands or pipe stands. Flexible connections shall be provided at the inlet and outlet of each fan.

18 Fans shall be mounted in such manner so that maximum space is available for access to all parts requiring periodic maintenance while maintaining adequate headroom. Co-ordinate with other sections to ensure that maximum access is maintained.

19 Provide access door and drain connection to scroll.

20 In-Line Centrifugal Fans

21 Characteristics as for centrifugal, with axial flow and direct or belt drive.

22 Provide AMCA arrangements 1 or 9 as indicated with stiffened flanges, smooth round inlets and stationary guide vanes.

23 Cabinet Fans

24 Centrifugal direct drive fan.

25 Galvanized steel housing.

26 Disconnect within the fan housing.

27 Acoustically lined housing.

28 Packaged Exhausters

29 Wall and roof exhausters shall be complete with disconnect switch.

30 Exhausters shall be direct or belt drive and shall be constructed in such a manner that motors, disconnects, etc. are readily accessible.

31 Each roof exhauster shall be mounted on a wooden curb; ensure that weather tight flashing is provided. Curb height shall be a minimum of 46cm (18") above the top of the finished roof.

32 Heavy aluminum dome type housings shall be reinforced as necessary on sizes with 500 mm wheel and larger.

Section 23 37 00 Air Outlets and Inlets

1 Grilles, Registers, and Diffusers

1.1 Supply air shall be introduced through ceiling mounted supply diffusers. Careful attention must be given for supply diffusers and return/exhaust air grilles located in secure areas or subject to impact (eg. gymnasiums). Diffusers and grilles shall be tamper- proof, heavy duty, c/w safety chains as appropriate. Supply diffusers in gymnasiums shall be complete with safety chains and wire guards.

1.2 Return and exhaust air shall be removed through ceiling mounted registers.

1.3 Size grilles, registers and diffusers for proper air velocities and low noise levels.

1.4 Air supply to a space shall be distributed to the occupied zone as per ASHRAE and also the grille and diffuser manufacturer’s recommendations. Ensure that proper air distribution and occupant comfort are achieved through appropriate air outlet application, quantity, selection and location.

1.5 For educational facilities, there shall be a minimum of four supply air diffusers per classroom (other quantities/configurations may be considered but will be allowed only with written permission from DTIR).

1.6 Select air outlets so that the combined sound from all diffusion in a room meets the design criterion.

1.7 All grilles and diffusers shall be of one manufacturer, where possible.

1.8 All diffusers, grilles and registers shall be free of fluttering, chattering and vibration.

1.9 Install in accordance with manufacturer's instructions.

2 Air Louvres and Screens

3 Apply louvres that minimize entry of snow and water into the equipment. Louvres to have drainable blades.

4 Provide galvanized wire mesh 'bird' screen with each louvre and wall cap.

5 Locate air intake louvres a minimum of 76cm (30") above the building finished roof or 198cm (78") above grade level. Consider local snow fall and drifting or other conditions which may warrant increasing height above grade level or roof level

Section 23 38 00 Ventilation Hoods - Kitchen Grease Exhaust Hoods

1 Kitchen Grease Exhaust Hoods and Exhausters

1.1 An Underwriters Limited Canada (ULC) listed and labeled grease exhaust hood with welded exhaust ducting and a roof exhauster with backdraft damper at the point of discharge to the outside is required and shall be in accordance with NFPA-96 (NFPA (Fire) 96: 2017).

1.2 Hood shall be minimum 18gauge welded stainless steel complete with stainless steel filters, a ULC listed fire damper and balancing damper, (where applicable), welded duct collar, a flush mounted LED light fixture incorporated into the unit and shall be constructed with an integral 76mm (3") airspace (double wall construction) on the rear side. Entire hood and fan system shall be installed to NFPA 96 requirements, latest edition.

2 V-belt drives shall be of canvas and rubber construction of approved manufacture having a matched belt drive to prevent slippage and undue wear upon starting. Drives shall be multi-

belt, none having less than two and shall be designed for 150% of the specified motor nameplate rating.

Section 23 40 00 HVAC Air Cleaning Devices

1 Air Filters and Filter Gauges

1.1 Filter media shall be UL listed, Class I or Class II, as approved by local authorities. Ensure that filter sections are supported with acceptable documentation with respect to resistance to air flow at design air velocities.

1.2 The filter selections shall be based on published ratings of dust holding capacity, arrestance, and efficiency. Ratings shall be based on ASHRAE. 52.2 (ASHRAE 52.2-2017) criteria.

1.3 Fabricate filter frames and supporting structures of galvanized steel with necessary gasketting between frames and walls. Provide holding frames with "T" section construction. Provide standard size frames to allow filter media of multiple manufacturers.

1.4 Provide galvanized steel blank-off plates as required, to fit all openings.

1.5 Panel Filters

1.5.1 Extended surface high loft pleated media, moisture resistant frame, welded wire pleat support grid with the media bonded to the grid and the frame. Minimum MERV 8 efficiency.

1.5.2 Pre-filters shall be moisture resistant polyester panel filters with internal steel wire support suitable for mounting in a standard filter track. Provide minimum 16 gauge galvanized steel or extruded aluminum metal holding frames containing 11 gauge wire mesh on leaving air side. Minimum MERV 8 efficiency.

1.6 Cartridge Type Filters

1.6.1 Disposable pleated synthetic media type with corrugated separators.

1.6.2 Housing shall consist of galvanized steel or aluminum sides and headers with perimeter gaskets.

1.6.3 Minimum MERV 14 efficiency.

1.7 High Efficiency Bag Filters (allowed only if specific written permission is obtained from DTIR)

1.7.1 Media shall be reinforced synthetic preformed into a series of pockets and bonded to a header. Minimum MERV 14 efficiency.

1.7.2 Holding frames shall be galvanized steel or extruded aluminum with sealing grooves, gaskets and locking clips.

1.8 Specialized Filters (e.g. activated carbon for odour control)

1.8.1 May be required depending on site conditions.

1.8.2 Media shall be regenerative activated carbon with 50-55 minute absorption capacity in accordance with the standard accelerated chloropicrin test. Provide adequate filtration for dusting from the activated carbon.

1.8.3 Housing shall consist of galvanized steel or aluminum sides and headers with perimeter gaskets.

1.8.4 Provide a detachable test element to indicate the extent of saturation of the media.

1.9 Locate filters for straight-through unrestricted air flow to eliminate turbulence, dead air spaces and eddy currents. Construct and install filters to prevent passage of unfiltered air. Provide closed cell foam, rubber or neoprene gaskets.

1.10 Ensure proper and safe access to filter for servicing.

1.11 Provide bird screens on outside air intakes and provide weather protection for filter banks.

1.12 Filter Gauges

1.12.1 Provide a permanent dial type filter gauge for each filter bank and remote indication if equipment is located in areas of difficult access.

1.12.2 Select gauges with ranges appropriate to the filter manufacturer's maximum permissible pressure drop.

1.12.3 Gauges shall have pointer flags set to the filter manufacturer's pressure drop for the clean (new) condition and also for the maximum permissible pressure drop i.e. the recommended replacement (dirty) value.

1.13 Replace filters used during testing and commissioning period. Filter media to be new and clean, as indicated by the filter gauges, at the time of acceptance

Section 23 51 00 Breeching, Chimneys and Stacks (#2 Fuel Oil, Natural Gas or Propane)

1 Mechanical engineer to size breeching and chimneys to handle peak gas flow at the design gas temperature and excess air so that the over fire boiler draft will be as per manufacturers recommendation, and as per code and CSA Standards.

2 Chimneys shall be a minimum of 274cm (9') above the highest point of the highest roof on the building. Mechanical engineer must determine if conditions warrant a higher stack. Dispersion modeling shall also likely be carried out (not by mechanical designer) to confirm if the design stack heights and the ventilation system configurations are sufficient. If the modeling indicates additional stack heights or other measures are required to ensure proper air quality in the building, mechanical designer shall make changes necessary to accomplish this.

3 Breeching

3.1 Shop fabricated, 14 gauge all welded mild steel, or prefabricated, double walled insulated systems as per chimney section. Prefab systems must be rated for use as a breeching.

3.2 Attach to boiler using fully sealed flanged connection.

3.3 Suspend breeching at 183cm (6') centres and at each joint on horizontal runs.

3.4 Connect breeching branches at 45 degree to main breeching.

3.5 Provide thermometer on breeching branch to each boiler.

4 All Fuels Pressure Chimney

4.1 ULC labelled, 538 deg. C (1000 deg. F) (continuous) rated, all fuels.

4.2 Sectional, prefabricated, double wall with minimum of 25mm (1") mineral wool insulation with mated fittings and couplings.

4.3 To ensure gas tightness, all joints shall be flanged and chimney systems shall be factory tested and approved to 152cm (60") w.c.

4.4 Liner shall be minimum 0.876mm (0.0345") thick, 316 stainless steel.

4.5 Shell shall be 304 stainless steel.

4.6 90 deg. Tee, straight pipe and flue connector are to suit the application.

4.7 Support chimneys at bottom (preferably above base tee), and install guides and flashing components, as required.

4.8 Install flashings on chimneys, as required.

4.9 Install cones, cleanouts and drains, as required.

4.10 All fasteners and screws used to assemble chimney to be stainless steel.

4.11 Follow manufacturer and SMACNA installation and recommendations for shop fabricated components. Chimneys shall be offset from boilers complete with base cap and drain.

4.12 Install chimney to manufacturers recommendations complete with all required components. Particular attention shall be paid by the design engineer and contractor to the overall integrity of the breeching and chimney system and its penetration through the building structure. Design engineer to provide written confirmation of his visual inspection of the complete system (before it concealed by insulation and/or the building construction).

5 Accessories

5.1 Cleanouts shall be bolted, gasketed type, full size of breeching, as indicated. Provide so that all section of breeching can be cleaned and inspected.

5.2 Hangers and supports shall be in accordance with the recommendations of the Sheet Metal and Air Conditioning Contractors National Association Inc. (SMACNA) and the chimney manufacturer.

5.3 Exit cone, storm collar, guy system (if applicable including guy section, wire and tensioners), flashing components, alignment guide, wall support, base tee, drain cap, drain shall be in accordance with the chimney manufacturers recommendations.

5.4 Base cap and drain are to be accessible and have a disconnect and trap.

5.5 Ensure wire guy tensioners allow for expansion and contraction of new chimney. A suitable galvanized structural steel guy frame above the roof line is also acceptable if guying is required.

5.6 Apply at least one coat of corrosion resistant primer and paint to fabricated supports made of ferrous metal.

5.7 Apply cold galvanized zinc metal touch-up as required on galvanized metal work.

Section 23 52 00 Heating Boilers

1 Primary heat generation shall be provided by hot water boilers rated for and certified for oil firing. The boilers shall also be rated for and certified for firing of natural gas. Plates/decals on boilers to indicate these certifications. The boiler plant typically consists of two fire tube or cast iron boilers. Other boilers may be accepted with written permission from DTIR.

2 Domestic hot water shall be heated by the main building heating plant with this plant incorporating sufficient capacity to provide indirect domestic hot water heating. A separate domestic hot water boiler serving indirect domestic hot water heaters shall be provided where the summer load is below the minimum safe turn down ratio of the smallest main building heating plant boiler. Other systems/equipment may be considered but will be allowed only with written permission from DTIR (also refer to Part 2, related Facility Services Subgroup Divisions 20-29 for facility specific detailed design requirements). Where a separate boiler for domestic hot water is required, provide piping and valves so that the main heating plant boilers can be used to heat the domestic hot water at the discretion of the building operator.

3 Establish the capacities, arrangement and number of boilers such that when any one boiler in the main building heating plant (ie. excluding the separate boiler for domestic hot water if present) is out of service, the remaining boilers in the main building heating plant shall be sufficient to offset the full building transmission heat loss. Note that this excludes heat for ventilation. Select boiler sizes to provide the maximum operating efficiency and cost effectiveness for the facility.

4 The main boiler hydronic systems shall utilize treated fresh water. Through heat exchangers, secondary hydronic loops of 40% propylene glycol solution or thermal fluid shall serve heating units requiring freeze protection.

5 Boilers shall be provided with individual chimneys.

6 Fire tube boilers shall be mounted on a steel frame with forced draft burner and all necessary controls. The entire unit shall meet CSA requirements and be constructed in strict accordance with ASME requirements. Provide two lifting eyes on top of boiler. Hinged front and rear doors shall be gas tight, insulated and secured with heavy duty cap screws and replaceable brass nuts. Front and rear tube sheets and flue shall be fully accessible for inspection and cleaning when doors are open. Provide observation ports at each end of boiler. Provide adequate handholes and armholes for boiler inspection and cleaning. Provide a spring loaded relief door with gasket seat. Insulate casing with readily removable mineral fiber insulation covered by sectional preformed sheet metal jacket. Boiler casing temperature shall not exceed ambient boiler room temperature by 10 deg. C (50 deg. F) maximum with surface air velocity of 0.3 m/s. Factory paint boiler, base and other components with hard-finish silicone enamel.

7 Cast iron boilers shall have a sectional cast iron heat exchanger (conforming to ASME requirements and tested for a maximum working pressure of 100 kPa - 200 kPa) with glass fibre rope gasket material carefully installed between sections and be mounted on a structural steel base with front plate, removable panels and lifting lugs. Provide forced draft burner and all necessary controls. Insulate entire boiler with mineral fiber and finish with steel cover jacket with factory applied baked enamel. Provide adequate clean-out and access doors, and openings including observation ports and relief openings. Torque boiler sections together as per manufacturers recommendations and provide a written report indicating the final torque readings. In addition to the normal hydrostatic test on the water side, sectional boilers shall be tested for leakage on the gas side after the sections are assembled by applying soapy water to each joint while maintaining a minimum air pressure of 76mm (3") w.c. This test must be witnessed by the mechanical design engineer or person authorized by the mechanical design engineer and also the DTIR mechanical inspector. Contractor to provide a written report indicating the results of this test. Provide a minimum of four working days notice of the time for this test.

8 Boiler shall fire light oil (and be certified for future natural gas firing) and be complete with all standard accessories including modulating oil burner, minimum 51mm (2") thick insulation (on all sides, top and bottom) under sectional preformed metal jacket (both readily removable and reinstalled), float operated low water cut-off, pressure gauges, automatic water feeder, ASME safety relief valve, and all necessary controls for safe automatic operation. The boiler-burner combination must be approved as a package from an accredited testing organization (eg. ULC) and documentation of this approval shall be reviewed and confirmed by the mechanical design engineer.

9 Low water cut-offs shall be piped with test-n-check valves and air vent for testing of the low water cut-offs without draining down the boiler.

10 All boiler temperature and pressure gauges shall be calibrated in both metric and imperial and shall be the dual temperature and pressure type.

11 Units shall be complete with necessary control transformers in a pre-wired control panel.

12 Control panels shall be complete with wiring diagrams.

13 Boiler-burner combination shall be factory rated and guaranteed to operate at a minimum fuel to hot water efficiency of 80% for firing rates of 40% to 100%.

14 The boiler-burner shall be started up and put into operation by factory trained representatives of the manufacturers (who must be a licensed burner mechanic). The complete boiler package shall be tested to check construction, operation and function of all controls, and performance. A written report of the start-up shall be provided to DTIR indicating CO2, smoke, pressure, and flame readings (readings shall be taken with an electronic analyzer with a copy of the actual test print out included in the report). The licensed burner mechanic shall also sign the report. Factory trained representatives of the

manufacturers shall also provide on-site instruction (minimum four hours) in operation and maintenance procedures for the to the building operators.

15 The design and installation shall be such that the minimum return water temperature to the boilers and maximum temperature differential between the supply and return water (under all operating conditions) is per the boiler manufacturers recommendations. See also Heating Design Considerations in related Facility Services Subgroup Divisions, including Division 25

16 Circulator pumps are required at boilers for thermal break.

Section 23 57 00 Heat Exchanger/Converters

1 Plate Heat Exchangers

1.1 Plate shall be constructed of type 316 stainless steel and shall be a double gasket design to prevent mixing of the two fluids. Gaskets shall be nitrile or EPDM as recommended by the manufacturer. Minimum design pressure to be 689kpa (100psig) at 135 deg. C (275 deg. F).

1.2 Heat exchangers to be hydrostatically tested at one and one half times the design pressure prior to shipping. Each unit to be designed to Section VIII, Division 01 of the ASME code and name plate stamped accordingly.

1.3 Capacity and heating surface of convertors shall be based on water and/or glycol conditions.

1.4 Heat transfer plates shall be secured in a heavy duty epoxy painted carbon steel frame.

1.5 All connections 64mm (2½") and over shall be flanged.

1.6 Convertors shall set horizontally with sufficient clearance between convertors.

1.7 Piping to convertor shall be complete with shut-off valves.

2 Tube-in-Shell Heat Exchanger

2.1 Units shall be designed for heating fluid in shell and heated fluid in tubes.

2.2 "U" tube type with 20 mm minimum seamless copper tubes with brass tube support suitable for 1030 kPa working pressure. Maximum tube velocity shall be 1.2 m/s.

2.3 Water chamber and tube bundle shall be removable for inspection and cleaning. Prime coat exterior of units. Ensure installation permits removal of tubes without disturbing installed equipment or piping. Provide for temperature regulator sensor at water outlet.

2.4 Heating media in shell shall be 2 pass design, tube side may be 4 pass design.

2.5 Shall be designed, constructed and tested in accordance with ANSI/ASME Boiler and pressure Vessel Code, Section VIII, CSA B51(CSA B51:19) and provincial pressure vessel regulations.

2.6 Shell shall be steel designed with 150 psi working pressure. All connections 64mm (2½") and over shall be flanged. All connections 51mm (2") and under shall be 1361kg (3000 lb.) couplings.

2.7 Head shall be cast iron or fabricated steel. Provide tappings for relief valve, thermometers and pressure gauges, drain and vacuum breaker.

2.8 Tube sheet shall be steel.

2.9 Mounting supports shall be steel or cast iron saddles with attaching U-bolts.

Section 23 70 00 Central HVAC Equipment

1 Air Handling Units

1.1 Packaged air handling units shall be designed in accordance with the latest ASHRAE Standard 62 (Standard 62.1-2007) “Ventilation for Acceptable Indoor Air Quality”.

1.2 Insulation and Liner

1.3 Insulate unit panels with 51mm (2") thick neoprene coated rigid fibrous glass or foam insulation (minimum density of 24kg/m3 (1.5 lbs./cu.ft)). Cover with minimum 20 gauge solid galvanized sheet metal.

1.4 Fans - refer to Section 23 30 00 HVAC Air Distribution and related sub-sections

1.5 Filters - refer to Section 23 40 00 HVAC Air Cleaning Devices, and related sub-sections.

1.6 Humidifiers - refer to Section 23 84 00 -Humidity Control Equipment and related sub-sections.

1.7 Casing

1.7.1 Heavy formed structural steel frame work shall be used to mount equipment and support exterior steel panels. Reinforce panels where required. Minimum exterior casing thickness shall be 18 gauge with outdoor units minimum 16 gauge.

1.7.2 Provide hinged access doors complete with fasteners and gasket seals in all sections to allow for easy servicing of components. Doors shall be minimum 152cm (5'-0") high. If the unit height will not accommodate 152cm (5'-0") high doors, doors shall equal unit height less 152mm (6"). Door width shall be 457mm (18") or 102mm (4") less than section length. Provide double glazed glass windows in access doors for fan and humidifier sections.

1.7.3 Provide heavy duty marine type lights inside units in fan and humidifier sections. Provide light switches on outside of unit adjacent access doors.

1.7.4 Construct indoor units of galvanized steel. Construct outdoor units of galvanized steel with exterior surfaces epoxy coated in colour of Owner's choice. Weld or bolt and seal seams and mount on galvanized steel roof curb with wood nailing strip. Outdoor units shall be provided with weather hoods and storm proof louvres on both the supply and exhaust sides.

1.7.5 Drain pans shall be IAQ type (sloped in two planes) insulated double wall stainless steel. Ensure no standing water at any time or at any point (after air handling unit has been installed ensure proper drainage of water). Provide a drain connection at the low point (recessed with no lip) of each pan which shall be connected to a 32mm (1¼") drain with deep seal trap discharging on the access side of the unit. Indoor unit drains shall be piped with copper or PVC-DWV from the pan, through to the traps and then to a funnel floor drain. At the minimum, a separate trap shall be provided for pans on each side of every filter bank in the unit to prevent air bypass around the filters through untrapped drain lines. Trap depth shall be a minimum 150% of the unit maximum static pressure; unit mounting height shall be such that mechanical room floor does not require cutting/gouging to accommodate the trap. Provide an electronic primer on each trap. Outdoor units shall have traps drainable for freezing conditions. Pans are

to be coated with an anti-microbial agent. Drain pans shall be provided in the furthest upstream section of the unit and from there downstream until (and including) the section after the pre-filters, in all coil sections, the heat recovery section, (both the supply and exhaust sides) and humidifier section.

1.7.6 Units shall be provided with vibration isolation.

1.8 Coils

1.8.1 General Design Considerations

1.8.1.1 Design air handling unit and mixing chamber (if applicable) to ensure even air temperature distribution across the face of coils.

1.8.1.2 Wet coils shall not exceed the recommended carry over face velocity. Make face velocity corrections for uneven distribution.

1.8.1.3 Water velocity shall not exceed 7 fps.

1.8.1.4 Coils deeper than 6 rows are not recommended.

1.8.1.5 Design coil banks to allow independent coil isolation, drainage, venting and maintenance operations.

1.8.1.6 The air handling systems shall be on a separately scheduled circulation loop. Each coil shall also have its own 2 or 3-way valve. Prevent coils from being exposed to freezing conditions during both system shut-down and normal operation, e.g. use high efficiency mixing boxes, outside air dampers with negligible leakage, and maintain circulation. Coils shall utilize a pre-mixed 40% propylene glycol water solution (with inhibitors) unless specific written permission to do otherwise is obtained in writing from DTIR. Glycol fill systems shall have a motorized pump.

1.8.1.7 Provide access for maintenance and replacement on both sides of coils.

1.9 Provide hinged access doors not less than 102mm x 152mm (4" x 6") for access to motor and fan shafts for test purposes.

1.10 Operating Dampers - See Div 25 Integrated Automation for operating damper requirements.

Section 23 72 00 Air -to-Air Energy Recovery Equipment

1. General

1.1 Heat recovery systems shall be used where high ventilation rates are implemented.

1.2 Analysis shall be carried out by the mechanical designer so that it is clear the heat recovery system selected will minimize owning, operating and maintenance costs over the life of the building.

1.3 Several methods of energy recovery are indicated below, other types may be considered but will be allowed only with written permission from DTIR.

1.4 Install to manufacturer's recommendations. Install access doors in duct at entry and exit of reclaim devices.

2. Energy Recovery Wheels

2.1. Energy recovery units shall be rotary air-to-air heat exchangers having equal latent and sensible efficiency. The latent and sensible efficiencies shall have been tested in accordance with the latest ASHRAE performance guidelines. The transfer media shall be non-asbestos, in accordance with NFPA and pass UL and ASTM flame and smoke tests. The rotor shall be constructed of corrugated aluminum treated with inorganic compounds and strengthened with radial spokes for rigidity. The desiccant coating shall be bacteriostatic, non-toxic and non-corrosive.

2.2. The transfer media shall not allow airflow to be radial and shall be capable of passing solids up to 300 microns. The transfer media shall, when exchanging energy at the efficiency specified, run dry to the touch.

2.3. The casing of the rotary heat exchanger shall have a built-in purge section allowing a maximum cross contamination of particulate to 0.01% by volume of exhaust air.

2.4. The unit casing shall be constructed of minimum 10 gauge welded structural steel to ensure rigidity and stability, and shall be galvanized after manufacture. Casing side panels shall be removable to provide easy access to internal parts. Unit shall be factory assembled, tested and shipped as one piece.

2.5. Seals shall be provided on periphery of the rotor as well as on duct divider and purge section. Seals are to be spring loaded, adjustable and constructed of neoprene. Seals are to be held in place with clips fastened to stud welded bolts and compressed by a retaining band. The required seal clearance is to be factory set and checked at installation.

2.6. The rotor shall be driven by a belt around the outside of the rotor powered by a variable speed fractional h.p. A/C motor. Variation of motor speed shall be accomplished via an adjustable frequency A/C motor drive.

2.7. The drive motor and thermostat body shall be factory mounted and wired on the side panel of the rotary air-to-air exchanger.

2.8. The manufacturer must have a minimum of 5 years experience in the manufacturing of rotary energy recovery wheels. The wheels shall be set up and put into operation by a factory trained representative of the manufacturer, who shall also provide on-site instruction (minimum four hours) in operation and maintenance procedures to the building operators.

2.9. Also to be included in the contract is service and preventative maintenance for energy recovery wheels which shall be performed by factory trained technicians and tradesmen a minimum of four times per year during the warranty period. **The warranty period for energy recovery wheels shall be extended to two years.** During this period, the energy

recovery wheel systems shall be inspected and serviced and any deficiencies present shall be corrected. Following each service visit, a report shall be submitted to DTIR indicating the items checked and service work performed, and the condition of the equipment. The contractor shall also consult with the building maintenance supervisor on each trip regarding the performance of the equipment.

3. Air to Air Fixed Plate Exchanger (allowed only if specific written permission is obtained from DTIR)

3.1. Casing shall be 20 gauge galvanized steel. Heat transfer surfaces shall be corrugated aluminum, edge sealed and bonded to the casing. Condensate drain to be DN 50 (NPS 2). Provide removable access panels. Cross contamination of airstreams is not permitted

4. Run Around Coil System (allowed only if specific written permission is obtained from DTIR)

4.1. A run around loop is a built-up system rather than a manufactured item and is specified in the appropriate sections. Run around loops shall be charged with a 40% propylene glycol solution.

5. Energy recovery equipment shall be insulated with 51 mm (2") thick mineral fibre insulation. Provide insulation and liner as for air handling unit panels where appropriate. See also Facility Services Subgroups- General (FSS-G), Equipment Insulation.

Section 23 80 00 Decentralized HVAC Equipment

1. Electric Heating

1.1 The use of electric heating must be approved in writing by DTIR before proceeding.

1.2 In electrically heated buildings, evaluate and determine the type of heat source required including but not limited to the following:

1.2.1 Natural Convection Heaters

1.2.1.1 Baseboard heaters.
1.2.1.2 Draft barrier heaters.
1.2.1.3 Architectural convection heaters.
1.2.1.4 Ceiling infrared heating.
1.2.1.5 Floor infrared heating.
1.2.1.6 Mechanical duct heaters.
1.2.1.7 Pipe heat tracing.

1.2.1.8 Snow melting cables.

1.2.1.9 Electric furnaces.

1.2.2 Forced Air Heaters

1.2.2.1 Ceiling unit heaters.

1.2.2.2 Wall unit heaters.

1.3 Baseboard type heaters are to be commercial grade, low watt density. Cabinets shall be finished with two coats of baked enamel in ivory colour.

1.4 All electric type heaters shall be controlled by wall type thermostats. Integral type thermostats are not permitted.

1.5 Electrical heating systems shall have a high temperature cut-out that will automatically discontinue current to the heating elements if the temperature exceeds the maximum safe limits.

Section 23 82 00 Convection Heating and Cooling Units

1. Heating

1.1 Provide heat at all windows and clerestory glazing.

2. Electric Heating

2.1. Electric resistance heating will only be considered where an owning and operating cost advantage is indicated by a comparative cost study of alternative heating systems (for example, in a remote vestibule a long distance from a boiler room). The use of electric heat requires approval in writing from DTIR

3. Finned-Tube Radiation Heaters

3.1. Wall Finned-Tube Radiation (for educational facilities, not permitted in learning spaces or administration areas and permitted in cafeterias and gymnasiums only if mounted at high level)

3.1.1. Finned- tube radiation shall be of the non-ferrous type, aluminum fins, 32mm (1¼") seamless copper tube, enclosure shall be constructed of minimum 16 gauge

steel complete with hanger, brackets, etc. Use double slope enclosures in educational facility gymnasiums.

3.1.2. Enclosures shall be complete with access doors complete with cam locks to all valves, vents, etc.

3.1.3. Provide end caps on all radiation. Where wall-to-wall, sufficient space shall be left for removal of end cap, but not greater than 76 mm (3"). Provide end filler pieces which do not cover any of the radiation grille.

3.1.4. Elements shall have 114mm x 114m (4½" x 4½") aluminum fins, and shall be designed for use at 1724kpa (250psi) with 149 deg. C (300 deg. F) water.

3.1.5. All radiation enclosures, and accessories shall be prime coated with a baked enamel primer.

3.1.6. Performance shall be based on 82 deg. C (180 deg. F) average water with a -7 deg. C (20 deg. F) temperature drop and 18 deg. C (65 deg. F) entering air

3.1.7. Radiation fin elements shall be supported on roller bearing, two piece saddle type hangers.

3.1.8. Radiation Installation

3.1.8.1. Install a compressible sealer strip extending the full length of enclosure.

3.1.8.2. Joiner pieces shall be of such a length so as not to cover any part of grille. Use butt type joints.

3.1.8.3. Where element lengths are less than 50% of the enclosure length, the element shall be broken into two (2) sections spaced equally in the enclosure

3.1.8.4. Radiation interconnecting piping shall be type L copper, with wrought copper fittings and joints 95-5 soldered.

4. Panel Radiators

4.1. Radiators shall be manufactured of cold rolled low carbon steel, fully welded and consisting of header pipes at each end.

4.2. Radiator header pipes shall include all necessary supply, return and air vent connections. Internal baffling shall be provided as required.

4.3. Standard piping connections shall be 19mm (¾") NPT taper threaded sockets, located in either side, or vertical positions. Air vent connections shall be c" NPT taper threaded sockets.

4.4. Working pressure shall be medium pressure: 586kpa (85psi) max. (tested at 758kpa (110 psi)).

4.5. Radiator expansion shall not exceed 1.3 mm/linear m (0.016”/linear ft) at 102 deg.C (215 deg. F). Expansion compensation shall be provided in the piping as required.

4.6. Radiators shall be phosphatized and primed with flat white baked enamel.

4.7. Radiators shall be finish painted with a gloss baked enamel for a total paint thickness of 2 to 3 mils.

4.8. Wall mounting brackets, joiner pieces, hold down clips etc., shall be provided with radiators.

5. Unit Heaters

5.1. Unit heater casing shall be of 16 ga. steel with all corners rounded, gloss enamel finish, threaded connections for hanger rods.

5.2. Coils shall be constructed from seamless copper tubing with mechanically bonded aluminum fins evenly spaced. Coils shall be of the flat plate type and tested to a minimum of 1207kpa (175psi).

5.3. Fans shall be of the direct drive standard propeller type, machined and balanced to eliminate vibration. Horizontal models shall be complete with sleeve bearings and a fan guard. Vertical models shall be complete with grease lubricated ball bearings.

5.4. Motors shall be totally enclosed of standard pattern for the duty. Motors shall be mounted out of the heater air stream.

5.5. Each unit shall be equipped with a multiple louvered type diffuser. Provide an adjustable pattern diffuser on vertical models and four-way louvres on horizontal models.

5.6. Units shall be controlled by a wall mounted thermostat/temperature sensor with a metal cover and guard.

5.7. Cabinet Unit Heaters

5.7.1. Coils shall be copper tube extended surface type with mechanically bonded aluminum fins.

5.7.2. Fans shall be quiet operating, forward curved, centrifugal blowers properly balanced to provide quiet operation, direct drive by silent operating non-radio interference vibration isolated capacitor motors of standard manufacture.

5.7.3. Cabinets shall be minimum16 ga. steel, phosphatized, prime coated for finishing after installation.

5.7.4. All units shall have a three (3) speed switch and manual starter accessible through an access door in the front cover.

5.7.5. Units shall be controlled by a thermostat/temperature sensor with a metal cover and guard mounted on the opposite wall.

5.7.6. Heaters shall be wall mounted only. Airflow to be in on the front panel at the top and out at the bottom panel. Heaters shall have recessed installation.

Section 23 83 00 Radiant Heating Units

1. Radiant Ceiling Panels

1.1 The radiant ceiling panels shall consist of extruded aluminum having an overall thickness of approximately c". Copper tubing of 12.7mm (½") I.D. shall be mechanically attached to the aluminum faceplate. There shall be a non-hardening heat conductive paste between the copper tubing and the aluminum faceplate.

1.2 Panels shall be of adequate width. The length shall be from wall to wall in typical rooms. Panels shall be constructed of 152mm (6") wide aluminum extrusions and shall be held flat with cross braces on electro-galvanized, chromate-dipped saddle brackets and spring clips.

1.3 Panels shall be finished in the manufacturer's standard white colour (or as selected by the Engineer).

1.4 Performance shall be based on an 82 deg. C (180 deg. F) mean water temperature (MWT) in a room with 21 deg.C (70 deg.F) air temperature and natural convection.

1.5 Installation

1.5.1 Supply and install 51mm (2") thick foil faced fibreglass insulation over active panels (refer to insulation section). Insulation foil face shall be installed up, seal all edges of foil with tape so that there is no exposed insulation (insulation not required for radiant panels installed below fire rated ceilings)

1.5.2 Interconnecting of radiant panels shall consist of 12.7 mm (0.500") O.D. soft copper tubing or accessories as recommended by manufacturer, i.e., factory supplied 360º inter-connecting loops and 180º return U-bends. Supply first to panel tubing pass closest to perimeter wall. Multiple panels shall be circuited to ensure serpentine flow over complete length of zone. Individual serpentine panel coils connected in series is unacceptable for multiple panel zones. Connecting loops to be layed flat to prevent air locking.

1.5.3 All radiant panels shall be installed by personnel wearing clean white gloves to avoid soiling the panel face.

1.5.4 Where lay-in panels are to lay in a suspended T-bar ceiling grid, coordinate metric or imperial sizing. All panels are to be supported by the T-bar and safety wire spaced 4' on centre, two hanger wires per cross brace, or as recommended by the manufacturer, whichever is the most stringent. Where cross T's are used between panel ends, the cross T's shall be flush with the exposed edge of the moulding. Provide channel moulding at walls and secure tees where panels butt together.

1.5.5 Where panels are to be recessed into a gypsum board ceiling, the panels shall be supplied with a recessed frame of extruded aluminum. The frame shall be painted to match the radiant panels and shall have a 1mm (0.04") thickness by 25mm (1") wide exposed flange with neat mitred corners. Install the panel in the ceiling and secure with safety wire.

1.5.6 Where the ceiling is fire rated, install the radiant panels below the ceiling membrane.

1.5.7 Hold down clips to be provided at all brackets front and back, for T-bar and drywall ceilings.

1.5.8 The last two feet of the run out connecting into the panel to be Type L soft copper only.

1.5.9 All system piping shall be thoroughly cleaned, flushed, drained and refilled before radiant panels are connected into the system.

1.5.10 No installation of radiant ceiling panels shall begin until all glazing has been completed and all exterior openings closed in. All wet work, including cement, plaster ring, terrazzo, etc., shall be completed and dried out before radiant ceiling panels are installed.

2. In-floor Radiant Heat

2.1. Insulate floor under all in-floor radiant heat with minimum 51mm (2") insulation.

2.2. Tubing shall be cross linked polyethylene, rated at 82 deg. C (180 deg. F) and 689kpa (100psi) working pressure and in accordance with ASTM F876 (ASTM F876-17). Tubing shall have an oxygen diffusion barrier capable of limiting diffusion to 0.02 grains/cubic foot/day.

2.3. The tubing shall have a safe bending radius of 152mm (6").

2.4. Fittings shall be of corrosion resistant brass and consist of an insert, serrated compression ring and nut. Fittings to be supplied by the tubing manufacturer.

2.5. Manifolds bodies shall be constructed of cast brass with brass supply and return piping adapters. Provide air vents, drains, thermometers, and installation brackets for each manifold. Each radiant loop (circuit) shall have a balancing and shut off valve.

2.6. Provide individual valves (telestats) for each zone where the manifold serves multiple zones and a single control valve where the manifold serves a single zone.

2.7. Piping to be installed at maximum 30cm (12") centres and secured to wire mesh with wire ties spaced at 91cm (3') maximum on straight runs. At 180 degree bends provide a minimum of three ties.

2.8. Prior to the installation of the concrete, the piping system shall be pressurized to 276kpa (40psig) with this pressure maintained for a minimum of 24 hours. The piping shall also be maintained at this pressure until the concrete has set.

2.9. Manifolds shall be in the walls unless written permission is received from DTIR.

2.10. Contractor shall have installer on site during all concrete pours

3. Note: Residential style baseboard radiation will not normally be allowed and will be permitted only if specific written permission is obtained from DTIR.

Section 23 84 00 Humidity Control Equipment

1. Humidifiers

1.1 Direct boiler steam humidifiers are not to be used. Natural gas or propane fired humidifiers are also not approved for use. Humidifier types other than those noted below may be considered but will be allowed only with written permission from DTIR.

1.2 The mechanical design engineer shall coordinate water quality testing at or near the building site to determine hardness, conductivity etc. These and other relevant parameters shall be measured with the humidifier type and corresponding water treatment systems selected and sized using the test results. The acceptable products considered for the project must all be capable of utilizing the water provided to the humidifiers. The mechanical design engineer shall obtain written confirmation from each manufacturer of such capability and provide a written report to DTIR with recommendations on the humidifier type and water treatment systems to be provided.

1.3 Electronic Humidifiers

1.3.1 Humidifiers shall be self-contained, microprocessor controlled, electrode or coil steam generating. with CSA and ULC approval.

1.3.2 Shall have electronic capacity control (25-100%) and solenoid control of supply and drain lines.

1.3.3 The rated steam output shall be the net of the unit rating after allowance for heat lost in water drained from the unit.

1.3.4 Water supply shall be 6.4mm (¼") tubing with ball valve shut off, and drain shall be 25mm (1").

1.3.5 Humidifiers shall be set up and put into operation by a factory trained representative of the manufacturer, who shall also provide on-site instruction (minimum four hours) in operation and maintenance procedures to the building operators.

1.3.6 Controls to include solid state panel, solenoid valve on water and drain lines, humidistat (not required if provided by building automation), direct wired airflow proving switch, automatic drain/flush with selectable override, amp meter and cylinder replacement indicator light (for electrode type), electronic water level control (including high and low water cut off and skimmer functions), and shall be interlocked with the A/H unit for shut down of operation.

1.3.7 Also, to be included in the contract is service and preventative maintenance for electronic humidifiers and their associated water treatment systems which shall be performed by factory trained technicians and tradesmen a minimum of four times per year during the warranty period**. The warranty period for electronic humidifiers and their associated water treatment systems shall be extended to two years**. During this period, the humidification systems shall be inspected and serviced and any deficiencies present shall be corrected. Following each service visit, a report shall be submitted to DTIR indicating the items checked and service work performed, and the condition of the equipment. The contractor shall also consult with the building maintenance supervisor on each trip regarding the performance of the equipment.

1.4 Steam to Steam Humidifiers

1.4.1 Steam fired evaporative humidifiers shall use low pressure steam to generate humidification steam.

1.4.2 Construction

1.4.2.1 Vaporizing chamber, cover and fittings shall be stainless steel with Heli-arc welded seams.

1.4.2.2 Tank and cover shall be constructed of stainless steel.

1.4.2.3 Cover shall be quick removal type using threaded knobs; gasket shall be held in place by flanges that are formed as part of the cover and evaporating chamber; flanges shall interlock to lock the gasket between them.

1.4.2.4 Vaporizing chamber and front cover plate shall be easily removable for access to the vaporizing chamber for removal of loose scale.

1.4.2.5 Heat exchanger shall be constructed of copper alloy tubes and header with welded joints.

1.4.3 Accessories

1.4.3.1 Steam valve shall integrate with the building system controls.

1.4.3.2 Provide steam trap and strainer; trap to be float and thermostatic.

1.4.3.3 Humidifier shall be covered with 19mm (¾") thick reinforced aluminum foil faced mineral fibre insulation; all surfaces except the front face panel shall be insulated.

1.4.3.4 Water level control shall provide for automatic refill, and skimmer bleed-off functions.

1.4.3.5 Water level sensing unit shall have 3 Teflon coated stainless steel probes screwed into a threaded probe head, with probe isolation shirts.

1.4.3.6 Probe head shall be mounted on the front of the vaporizing chamber.

1.4.3.7 Solenoid operated fill valve.

1.4.3.8 Surface skimmer shall be provided which is field adjustable.

1.5 Controls

1.5.1 Control cabinet shall be a NEMA 12 enclosure. Control devices shall be mounted on a sub-panel within the enclosure. Cabinet shall be factory wired and mounted to the side of the humidifier.

1.5.2 Controls to include solid state panel, solenoid valve on water and drain lines, humidistat (not required if provided by building automation), direct wired airflow proving switch, automatic drain/flush with selectable override, electronic water level control (including high and low water cut off and skimmer functions), and shall be interlocked with the A/H unit for shut down of operation.

1.6 Steam Dispersion Device

1.6.1 Tube banks shall consist of a horizontal header/separator and a designated quantity of vertical dispersion tubes to achieve the required steam capacity.

1.6.2 Header and separator shall span the width of the air handling unit heating coil bank.

1.6.3 Construction

1.6.3.1 Header and separator shall be constructed of stainless steel and be fitted with nipples for dispersion tube connections.

1.6.3.2 Tublets shall be non-metallic and designed for the steam temperature. Tublets shall extend through the wall of and into the center of the dispersion tube, and incorporate a properly sized orifice.

1.7 All air handling units shall be provided with humidification systems to maintain minimum 30% relative humidity during winter design conditions.

2. Dehumidifiers

2.1. Swimming pool facilities shall be provided with a dedicated ventilation system featuring a packaged dehumidification ventilation unit, Pool dehumidification type unit, with heat recovery capability to assist in pool water heating or air stream heating.

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