
SECTION	PAGE
PART 1 GENERAL	3
1.1 General	3
1.2 Work Included	3
1.3 Related Work Specified Elsewhere	3
1.4 Reference Standards	3
1.5 Requirements of Regulatory Agencies	4
1.6 Alternatives	4
PART 2 PRODUCTS	5
2.1 Duct Sealing	5
2.2 Low Pressure Ductwork	5
2.3 Duct Openings	5
2.4 Wall Openings	5
2.5 Hangers and Supports	6
2.6 Flexible Collars	6
2.7 Turning Vanes	6
2.8 Instrument Test Ports	7
2.9 Duct Access Doors	7
2.10 Dampers	7
2.11 Fire Dampers	8
2.12 Grilles/ Diffuser	8
2.13 Louvres Intakes and Vents	9
2.14 Condensing Units	9
2.15 Supply Fan Unit (Includes Relief Fan)	10
2.16 Refrigeration System	12
PART 3 EXECUTION	15
3.1 Standards	15
3.2 Air Balancing	15
3.3 Low Pressure Ductwork	15
3.4 Duct Access Doors	16
3.5 Dampers	16
3.6 Fire Dampers	16
3.7 Motorized Dampers	17
3.8 Fans	17

PART 4	SCHEDULES	18
Table 8	Grilles Diffusers Louvers	18
Table 9	Supply Fan Unit (includes Relief Fan)	18
Table 10	Preheat/ Reheat Coils	18
Table 11	Air Filters	18
Table 12	Condensing Unit	19

PART 1 - GENERAL

1.1 GENERAL

- .1 All drawings and all sections of the specification shall apply to and form an integral part of this section.
- .2 All air distribution systems shall meet Manitoba Building Code, ASHRAE and SMACNA Standards.

1.2 WORK INCLUDED

- .1 Work shall include but not limited to the following:
 - .1 Fans: Supply, return/relief, exhaust with associated ductwork, fire dampers, balancing dampers c/w acoustic duct liner when noted.
 - .2 Grilles, registers. Louvers, filters, electric heating coils
 - .3 Condensing unit and associated refrigeration piping.
 - .4 Carry the cost and assistance air balance contractor. Pulley and belt changes as required.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- .1 Mechanical General Provisions: Section 15010
- .2 Insulation: Section 15100
- .3 Plumbing: Section 15430
- .4 Electrical : Division 16

1.4 REFERENCE STANDARDS

- .1 SMACNA: HVAC Duct Construction Standards, Metal and Flexible HVAC Duct Leakage Test Manual.
 - .1 Low velocity duct construction standards.
 - .2 Balancing and adjustment of exhaust systems.
 - .3 Fire damper guide for air handling systems.
 - .4 NFPA 90A-Latest Revision: National Fire Protection Association -Installation of Air Conditioning and Ventilating.
 - .5 UL-151: Underwriters' Laboratories Air Duct.
 - .6 ADC 106R2: Air Diffusion Equipment Test Code.
 - .7 AMCA 201-73, AMCA 300-67, AMCA 301-77, AMCA 302-73, AMCA 303-73, AMCA 2408-69.
 - .8 Ashrae: Handbook, Fundamentals and Systems Volumes.
 - .1 Air duct design.
 - .2 Duct construction.
 - .9 ASHRAE 52- (76), "Method of Testing Air Cleaning Devices Used in General Ventilation for removing Particulate Matter".
- .2 Refrigeration Piping.
 - .1 ANSI/AMCA-210- (1985), Laboratory Methods of Testing Fans for Rating.
 - .2 ANSI/ASHRAE-17-(1986(R1990)), Method of Testing for Capacity Rating of Thermostatic Refrigerant Expansion Valves.
 - .3 ANSI/ARI-450-(87), Water Cooled Refrigerant Condensers, Remote Type.
 - .4 ANSI/ARI-495-(85), Refrigerant Liquid Receivers.
 - .5 ANSI/ARI-520-(85), Positive Displacement Refrigerant Compressors, Compressor Units , and Condensing Units.
 - .6 ANSI/ARI-710-(86), Liquid Line Driers.
 - .7 ANSI/ASME-B16.26-(1988), Cast Copper Alloy Fittings for Flared Copper Tubes.
 - .8 ANSI/ASME-B16.29-(1986), Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings – DWV.
 - .9 ANSI/ASME-B31.5-(1987), Refrigeration Piping.
 - .10 ANSI/ASME-B16.34-(1988), Valves-Flanged, Threaded and Welding End.

- .11 ASTM-B280-(92), Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- .12 ANSI/AWS-A5.8-(89), Specification for Brazing Filler Metals.
- .13 CAN/CGSB-19.13-(M87), Sealing Compound, One Component, Elastomeric, Chemical Curing.
- .14 CSA B52-(M1991), Mechanical Refrigeration Code.
- .15 CAN/CSA-080 Series-(M89), Wood Preservation.
- .16 ANSI/ASME Boiler and Pressure Vessel Code, (1992).
- .17 EPS 1/RA/1-(1991), Code of Practice for the Reduction of Chlorofluorocarbons Emissions from Refrigeration and Air Conditioning Systems, Canadian Environmental Protection Act Code of Practice.

1.5 REQUIREMENTS OF REGULATORY AGENCIES

- .1 Manitoba Building Code, local Authority having Jurisdiction.

1.6 ALTERNATIVES

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

PART 2 - PRODUCTS

2.1 DUCT SEALING

- .1 Seal all joints on all supply, return and exhaust ductwork with high pressure duct sealant.
 - .1 Foster 30-02 Duro-Dyne S-2
- .2 Cover all joints with high pressure duct tape polyvinyl treated, open weave fibreglass, 50mm (2")
 - .1 Duro-Dyne FT-2
- .3 Leakage in accordance with SMACNA HVAC Leakage Test Manual.

2.2 LOW PRESSURE DUCTWORK

- .1 Ductwork: Galvanized Steel
 - .1 Lock forming quality: to ASTM A525M, Z90 zinc coating.
 - .2 Thickness: to SMACNA, ASHRAE
 - .3 Fabrication: to SMACNA, ASHRAE
- .2 Joints: Galvanized Steel
 - .1 SMACNA or proprietary manufactured duct joint. Proprietary manufactured flanged duct joint shall be considered to be a class A seal.
 - .1 Ductmate Canada Ltd. system for propriety joints; Exanno Nexus.
- .3 Fittings: Galvanized Steel
 - .1 Fabrication: SMACNA
 - .2 Radiused elbows: standard radius.
 - .3 Square elbows: to 400mm (16") with single thickness vanes.
 - .4 Square elbows: over 400mm (16") with double thickness vanes.
 - .5 Provide branch and main duct balancing dampers.
 - .6 Sub branch duct with 45° entry and balancing damper on branch and or Sub branch duct with square connection, volume extractor and branch duct balancing damper.
 - .7 Transitions:
 - .1 Diverging: 20° maximum included angle.
 - .2 Converging: 30° maximum included angle.
 - .8 Offsets: radiused elbows.
 - .9 Obstruction deflectors: maintain full cross sectional area. Maximum included angles as transitions.

2.3 DUCT OPENINGS

- .1 Use 1.2 mm (18 ga.) galvanized sleeves where ductwork passes through rated floor assemblies. Sleeves to extend 150 mm (6") above floor. Use watertight mastic between sleeved and floor material. (See Section 15010, OPENINGS IN FIRE SEPARATIONS).
- .2 Seal area between ducts and openings with mineral wool and ULC firestop system. Testing to meet ASTM E814: Fire Test of Through-Penetration Firestops. UL 1479: Through-Penetration Firestop Systems. (See Section 15010, OPENINGS IN FIRE SEPARATIONS).

2.4 WALL OPENINGS

- .1 Provide 1.2 mm (18 ga.) galvanized sleeve 50 mm (2") wider than wall thickness. Opening located in fire rated walls to have sleeve c/w louvered fire damper to meet code requirements. (See Section 15010, OPENINGS IN FIRE SEPARATIONS).
- .2 Provide 300 mm (12") duct extension in mechanical room openings, where smoke detectors are noted on Electrical drawings, to support detector and provide proper sensing plenums.

2.5 HANGERS AND SUPPORTS

- .1 Fabricate strap hangers to same material as duct but next sheet metal thickness heavier than duct. Maximum size duct supported by strap hanger 500mm (20"). Hanger configuration to SMACNA details. Hanger not to interrupt exterior duct insulation (See Section 15100 WORKMANSHIP).
- .2 Support vertical ducts at every floor with angle iron collar sized to provide proper bearing. Provide intermediate vertical support at ¼ and ¾ points in addition to angle iron collar at each floor.
- .3 Support horizontal ducts on maximum 2.4 m (80") centres by non-perforated galvanized steel.
- .4 Riveted strap for ductwork 900 mm (36") (either dimension) or less, and minimum 25 mm x 25 mm x 3 mm (1" x 1" x 1/8") galvanized angle iron passing under ducts 925 mm (37") or over (either dimension) with 9.4 mm (3/8") dia. threaded rods suspending angles from structure.
- .5 Use universal concrete type inserts of black malleable iron, for threaded connection with lateral adjustment, top slot for reinforcing rods and lugs for attaching to forms.
- .6 Hangers shall be galvanized steel angles with galvanized steel rods, locking nuts and washers to SMACNA following table:

Duct Size		Angle Size		Rod Size		Spacing	
Mm	In.	Mm	In.	Mm Ø	In. Ø	M	Ft.
up to 750	up to 30	25x25x3	1x1x1/8	6	1/4	3	10
775 to 1050	31 to 41	40x40x3	2x2x1/8	6	1/4	3	10
1075 to 1500	42 to 59	40x40x3	2x2x1/8	10	3/8	3	10
1525 to 2100	60 to 83	50x50x3	2x2x1/8	10	3/8	2.5	8
2125 to 2400	84 to 94	50x50x5	2x2x3/16	10	3/8	2.5	8
2425 and over	95 and over	50x50x6	2x2x1/4	10	3/8	2.5	8

2.6 FLEXIBLE COLLARS

- .1 Provide flexible non-combustible neoprene connectors between "All" fans "each side" air moving devices, ducts or casings where required to prevent excessive movement of long ducts, at building expansion joints.
 - .1 Shall be galvanized sheet metal frame with fabric clenched by means of double locked seams. Fire resistant, self extinguishing neoprene coated glass fabric density of 1.3 kg/m².

2.7 TURNING VANES

- .1 For duct dimensions 456 mm (18") or less:
 In the plane of turn, Junior Vane Rails shall be supplied having the rails 57 mm (2 1/4") wide and vanes spaced on 50 mm (2") centres.
- .2 For ducts larger than 456 mm (18"):
 Duro Vane Rails shall be supplied having the rails 114 mm (4 1/2") Wide and vanes spaced on 114 mm (4 1/2") centres.
- .3 Double thickness turning vanes shall be Duro-Dyne Vane Rails.
- .4 Factory or shop fabricated single thickness and double thickness with trailing edge to recommendation of SMACNA.

2.8 INSTRUMENT TEST PORTS

- .1 1.6mm (1/16") thick steel zinc plated after manufacture
- .2 Cam lock handles with neoprene expansion plug and handle chain.
- .3 28mm (1 1/8") minimum inside diameter. Length to suit insulation thickness.
- .4 Neoprene mounting gasket.
- .5 Test ports installed in welded stainless duct to be of a compatible material, installed such that duct integrity is maintained regardless of whether connection is threaded, welded or gasketed.
- .6 Locate in ductwork at supply fan discharges, on intake of exhaust and return fans, in hot and cold ducts coming off plenums, in major duct branches and everywhere pitot tube measurement is required for proper balancing of air condition, ventilation and exhaust systems. Do not place closer than six feet to elbows. Space very 150 mm (6") across the air stream at each location. Refer to drawings for additional opening requirements.
 - .1 Lawson-Taylor 1.2 mm (18 ga.) cadmium-plated deep drawn flange type with quic-lock cap retained with a ball chain, c/w gaskets. At insulated ductwork use a quick-loc extension c/w neoprene tipped prolite insulating plug.

2.9 DUCT ACCESS DOORS

- .1 Non-insulated ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm (1/4") thick complete with sheet metal angle frame.
- .2 Insulated ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6mm (1/4) thick complete with sheet metal angle frame and rigid glass fibre insulation to match ductwork insulation thickness.
- .3 Gaskets: neoprene or foam rubber.
- .4 Hardware:
 - .1 Up to 300mm x 300mm (12" x 12"): 2 sash locks complete with safety chain.
 - .2 301mm to 450mm (12" to 18"): 4 sash locks complete with safety chain.
 - .3 451mm to 1000mm (18" to 40"): piano hinge and minimum two sash locks.
 - .4 Doors over 1000mm (40"): piano hinge and two handles operable from both sides.
 - .5 Hold open devices.
 - .6 300mm x 300mm (12" x 12") plexi-glass viewing panels with removable insulation fasteners.
- .5 Supplier Manufactured only: Acudor, Air-O-Metal, Lehage, Milcor, Titus, Controlled Air.

2.10 DAMPERS

- .1 Single blade:
 - .1 One sheet metal thickness heavier than duct with V-grade stiffened size and configuration to recommendations of SMACNA, locking quadrants with inside and outside end bearings.
- .2 Multi bladed:
 - .1 Factory manufactured or material compatible with duct. Opposed blade configuration to recommendation of SMACNA. Bearings: self-lubricating nylon. Linkage: Shaft extension with locking quadrant. Channel frame c/w angle stop.
- .3 Splitter:

- .1 One sheet metal thickness heavier than duct with appropriate stiffening. Double thickness air foil shape construction. Control rod with locking device and position indicator. Rod configuration to prevent end from entering duct. Pivot, piano hinge. Fold leading edge.
- .4 Backdraft/ Relief:
 - .1 Multi leaf, aluminium, flexible sealing edges (maximum blade width) 150mm (6") counter-weighted.

2.11 FIRE DAMPERS

- .1 List and bear label of ULC and shall meet requirements of Fire Commissioner of Canada, and NFPA 90A and Warnock Hersey.
 - .1 Provide thermal blanket assembly (indicate UL/ULC index arrangement number) when used in conjunction with square, rectangular, round, square to round ceiling diffuser.
- .2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation and breakaway duct connections.
- .3 Top hinged: offset single damper, round or square, multi-blade hinged or interlocking type, roll door type, guillotine type, sized to maintain full duct cross section as indicated.
- .4 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.
- .5 40mm x 40 x 3mm (1 5/8" x 1 5/8" x 1/8") angle iron frame on full perimeter of fire damper, on both sides of fire separation being pierced.
- .6 Ruskin, Controlled Air, Nailor-Hart

2.12 GRILLES/DIFFUSER

- .1 General:
 - .1 Provide standard product to meet capacity, throw, noise level, throat and outlet velocity.
 - .2 At ceiling grilles, provide independent suspension from the basic structure and/or ceiling when indicated to maintain fire protection membrane integrity.
 - .3 Where grilles, penetrate fire walls and fire partitions, provide approved steel sleeve secured to structure in accord with NFPA 90A Latest Edition.
- .2 Grilles & Registers:
 - .1 Standard Areas
 - .1 Louvered Face Return/Exhaust/Relief/Transfer:
 - .1 45° Deflection Fixed: Steel/Aluminium blades shall run parallel to the long or short dimension.
 - .1 Where indicated provide integral volume control damper of the opposed blade type operable from the register face.
 - .2 0° Deflection Fixed: Aluminium grid core steel with steel support bars/Extruded aluminium.
 - .1 Where indicated provide integral volume control damper of the opposed blade type operable from the register face.
 - .3 Frames:
 - .1 Steel: (See Schedule) standard with exposed welded joints and mitered corners.
 - .2 Aluminium: (See Schedule) extruded satin finish with mechanical fasteners and mitered corners.
 - .3 Provide full perimeter gaskets.

- .4 Provide plaster frames as plaster stops where set into plaster or gypsum board at all locations.
- .5 Provide concealed fasteners and operators.
- .4 Screws:
 - .1 Install with flat head cadmium plated screws in countersunk holes where fastenings are visible.
- .2 Ceiling Diffusers:
 - .1 Fully Adjustable Air Pattern:
 - .1 Steel/Aluminium, multi-core, inner core shall consist of 3/4 cone assembly that shall be completely removable for access to damper/grid assembly. Non-protrusive airflow directional tabs shall be provided on the back of the inner cones for airflow pattern adjustment. Frame to suit ceiling.
 - .1 Where indicated provide integral volume control damper/grid assembly.
 - .2 Ceiling Return/Exhaust/Relief/Transfer:
 - 1 45°Deflection Fixed: Steel/Aluminium blades shall run parallel to the long or short dimension. Frame to suit ceiling.
 - .1 Where indicated provide integral volume control damper of the opposed blade type operable from the register face.
 - 2 0°Deflection Fixed: Aluminium grid core/14 gauge steel with steel support bars/Extruded aluminium. Frame to suit ceiling.
 - .1 Where indicated provide integral volume control damper of the opposed blade type operable from the register face.

2.13 LOUVRES INTAKES AND VENTS

- .1 Stationary Louvres
 - .1 Construction:
 - .1 Welded with exposed joints ground flush and smooth.
 - .2 Material:
 - .1 Extruded aluminium alloy 6063-T5
 - .3 Blade:
 - .1 Stormproof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1500mm.
 - .4 Frame, head, sill jamb:
 - .1 100mm (4") deep one piece extruded aluminium, minimum 3mm (1/8") thick with approved caulking slot, integral to unit.
 - .5 Mullions:
 - .1 At 1500mm (5 Ft.) maximum centres.
 - .6 Fastenings:
 - .1 Stainless steel (Society of Automotive Engineers) SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminium and head of bolt, or between nut, ss washer and aluminium body.
 - .7 Screen:
 - .1 12mm (1/2") exhaust, 25mm (1") intake mesh, 2mm (3/16") dia. wire aluminium birdscreen on inside face of louvres in formed U-frame.
 - .8 Finish:
 - .1 Repainted finish in accordance with Aluminium Association Designation Systems for Aluminium Finishes. Colour as selected by the architect.

2.14 CONDENSING UNITS

- .1 Units with cooling capacities of 12,000 BTU thru 60,000 BTU cooling with (control board suitable for accept DDC signal):
 - .1 Each unit shall be c/w factory authorized site start-up.

- .2 Approvals: Tested in environmental test room and rated in accordance with ARI Standard 210-81 sound rated in reverberant sound test room in accordance with ARI Standard 270-84. Condensing unit and components within bonded for grounding to meet safety standards for servicing required by the C.E.C. certified by C.S.A.
- .3 Equipment Warranty: The compressor to have a warranty for a full 5 years. All other components to have a warranty of one year.
- .4 Cabinet: Heavy gauge galvanized steel with outdoor enamel paint finish. Drainage holes in base channels for moisture removal. Heavy duty channels under the base to raise the unit off the mounting surface.
- .5 Condenser Fan: Direct drive fan. Vertical discharge of air. Fan motor totally enclosed from weather, dust and corrosion. A rain shield on the motor. Fan service access by removal of fan guard, Corrosion resistant PVC coated steel wire fan guard.
- .6 Fin Coil: Ripple-edged aluminium fins machine fitted to seamless copper tubes. Extra large four sided wrap around coil configuration extra large surface area with low air resistance. Lanced fins maximum exposure of fin surface to air stream fins are equipped with collars that grip the tubing for maximum contact area. Flared shoulder tubing connections and silver soldering tight, leak proof joints. Factory tested under high pressure to insure leak proof construction. Entire coil accessible for cleaning. Non-corrosive PVC coated steel coil guard.
- .7 Refrigerant Line Connections, Electrical Inlets and Service Valves: Suction and liquid lines located outside of the cabinet and made with sweat connections. Brass service valves. Thermometer well located in the liquid line to check refrigerant charge on expansion valve system. Suction and liquid line service valves and gauge ports accessible outside of the cabinet. Refrigerant line connections, service valves and field wiring inlets located in one central area of the cabinet.
- .8 Unit to be c/w the following accessories.
 - .1 Expansion valve.
 - .2 Low ambient control capable of operating at 45°F.
 - .3 Time off control.
 - .4 High pressure switch.
 - .5 Low pressure switch.
 - .6 Filter drier in liquid line.
 - .7 Low ambient kit.
 - .8 Start kit.
 - .9 Refrigeration piping c/w metallic vibration absorbers.
 - .10 Sight glass / moisture indicator.

2.15 SUPPLY FAN UNIT (INCLUDES RELIEF FAN)

- .1 General: As an indoor unit. Multi-Position with approved motor mounting for vertical positioning where indicated. Field built up arrangement.
- .2 Unit Construction:
 - .1 Unit casing shall be of minimum 18 (1.3mm) gauge satin coat galvanized sheet metal. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two part acid based etching primer. Finish coat shall be an electrostatically applied enamel, to all exposed surfaces. All unprotected metal and welds shall be factory coated.
 - .2 All walls, roofs and floors shall be of formed construction, with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water resistant sealant.
 - .3 Units shall be provided with lift out access doors.
 - .4 Casings shall be supported on formed steel channel or structural channel supports, designed and welded for low deflections. Integral lifting lugs shall be provided for hoisting.

- .5 All units shall be internally insulated with 25 mm (1") thick 3 lb./cu.ft. (48 kg./cu.m.) high density acoustic duct liner to ASTM G21 and G22. Secured to metal panels with a fire retardant adhesive and welded steel pins at 400 mm (16") o/c. All longitudinal insulation joints and butt ends shall be covered by a sheet metal break to prevent erosion of exposed edges.
 - .6 Cooling unit drain pan adapter base plate shall be mounted on the discharge outlet and be provided with a 12 mm (1/2") M.P.T. drain connection with dual position drain pans.
- .3 Fans (Supply)
- .1 Centrifugal fans shall be rated in accordance with AMCA Standard Test Code. Fan manufacturer shall be a member of AMCA. All fans and fan assemblies shall be dynamically balanced during factory test run. Fan shafts shall be selected for stable operation at least 20% below the first critical RPM. Fan shafts shall be provided with a rust inhibiting coating.
 - .2 Fans shall be equipped with greaseable pillow block bearings, supported on a rigid structural steel frame.
 - .3 The ratio of blast area to nominal outlet area for forward curved fans shall be 60% or greater.
 - .4 Drives shall be adjustable on fans with motors 5 HP (3.73 kw) or smaller. On fans with larger motors, fixed drives shall be provided. All drives shall be provided with a rust inhibiting coating. The fan supplier shall provide for drive changes (if required) during the air balance procedure.
 - .5 Motor, fan bearings and drive assembly shall be located inside the fan plenum to minimize bearing wear and to allow for internal vibration isolation of the fan-motor assembly, where required. Motor mounting shall be adjustable to allow for variations in belt tension.
 - .6 Fan-motor assemblies shall be provided with internal vibration isolators. Isolators shall be bolted to steel channel welded to unit floor which is welded to the structural frame of the unit. The isolators shall be neoprene-in-shear type for single 9" (230mm) to 15" (380mm) forward curve fans. All other fans shall incorporate vertical spring type isolators with levelling bolts, bridge bearing waffled pads. Fans shall be attached to the discharge panel by a heavy glass fabric, neoprene impregnated, with a double locking fabric to metal connection.
 - .7 Fan motors shall be high efficiency open drip proof, direct drive.
- .4 Coils
- .1 Cooling: Direct Expansion, Cased/insulated, Field Installed
 - .1 Shall be copper tube, aluminium fin, copper headers with sweat connections alternate tube circuited. Fins constructed of aluminium or copper shall be rippled for maximum heat transfer and shall be mechanically bonded to the tubes by mechanical expansion of the tubes. The coils shall have a galvanized steel casing. All coils shall be factory tested with air at 300 psig (2070 kPa) while immersed in an illuminated water tank.
 - .2 Headers shall be outside the air handling unit for maximum serviceability. A non-headered end of the coil shall be fully concealed. Provide auxiliary drain pan complete with 1/2" (13mm) MPT drain connection at headered end of cooling coils.
 - .3 Provide an insulated header cover to conceal exposed headers.
 - .4 Coils shall be removable from the unit at the header end, unless shown otherwise on the drawings.
 - .2 Heating: Electric, Cased, Field Installed
 - .1 CSA-approved open-coil electric duct heaters.
 - .2 Construction:
 - .1 Frame shall be of galvanized cold rolled steel.
 - .2 Open-coil nickel-chromium resistance wire elements, shall be supported on ceramic bushings held in element support brackets. (Elements shall be crimped to monel or stainless steel terminal lugs and terminal pins shall be

- positively prevented from rotating by means of non-round bulkhead bushings).
- .3 Duct heaters shall be flanged-type (DHF) for attachment to external duct flanges.
- .4 Protective screens on both sides of the heater.
- .3 Overheat Protection:
 - .1 Built-in primary, automatic, recycling cut-outs shall be supplied in all heaters, built-in, secondary, manual, reset cut-outs. They shall be of disc-type for horizontal air flow installation.
- .4 Built-In Controls:
 - .1 The following built-in devices shall be supplied with duct heaters as integral, prewired components (control board suitable for accept DDC signal):
 - .1 Magnetic contactors.
 - .2 Silent mercury contactor.
 - .3 Fused control transformer (24-120 volts).
 - .4 Pressure differential switch.
 - .5 Fusible disconnect switch.
 - .6 S.C.R. (modulating control).
 - .7 Load fusing.
 - .8 High temperature limit control.
 - .9 Disconnect switch with door inter-lock.
- .5 Filters: Cased/insulated c/w with insulated access door. Field Installed
 - .1 Filters shall be extended surface pleated filters Merv rated.
 - .2 Filter sizes and capacities shall be as scheduled.
 - .3 Filters shall be UL900 Class 2 listing.
 - .4 Filter Construction:
 - .1 Filters shall be constructed of reinforced, non-woven cotton/synthetic blend media laminated to an expanded metal grid on the air leaving side and formed into radial wedge pleats.
 - .2 Frame shall be moisture-resistant chipboard with perforated steel support grilles on the upstream and downstream sides.
 - .5 Performance:
 - .1 Initial and final resistances shall not exceed the scheduled values.
 - .2 Media area must equal or exceed that of the specified filter.
 - .3 The average atmospheric dust spot efficiency shall be 25-30% as determined by ASHRAE Standard 52.1 test methods.
 - .4 The manufacturer shall guarantee performance as stated in the literature within tolerances as outlined in Section 7.4 of ARI Standard 850.
- .6 Fire alarm circuits shall be powered from a relay in unit circuitry. Note the unit shall have the capability to either operate or shutdown via a control switch at the fire alarm panel.

2.16 REFRIGERATION SYSTEM

- .1 Refrigeration Work:
 - .1 Submit the following Shop Drawings and product data in accordance with Section 15010.
 - .1 Provide diagrams of field installation, internal wiring and piping for field assembly, with refrigerant flows, pipe sizes, pressure drops and velocities at each stage in equipment and suction lines.
 - .2 Provide nameplate data on compressor listing capacity, design temperature, refrigerant used and weight of refrigerant charge.
 - .3 Provide information on all isolating pads used at each equipment contact point.
 - .2 Execute Work of this section by skilled trades persons regularly employed in the installation of process refrigeration equipment.
 - .1 Process refrigeration Manufacturer shall be regularly engaged in production of specified equipment, and one who issues catalogue information with correction

- factors where published ratings are based on parameters different from those specified.
- .2 Installation shall be performed by certified refrigeration mechanics/technicians approved by Department of Labour as part of Quality Assurance program. Submit qualifications for approval prior to commencement of the Work.
- .3 Installation must comply with requirements listed in EPS 1/RA/1.
- .3 Source Quality Control:
 - .1 Factory leak test air-cooled condenser coils at minimum gauge pressure of 2.1 Mpa.
 - .2 Factory leak test evaporator coils to 2.1 Mpa.
 - .3 Contractor hereby warrants the refrigerant piping system loss of refrigerant and satisfactory operation of compressor for one year in accordance with the warranty provisions of 15010.
 - .4 Ship equipment factory dehydrated and sealed with dry nitrogen with tracer and charge of lubricating oil. Contractor shall charge unit on site in accordance with this section of the Specification.
- .2 Piping:
 - .1 Use factory cleaned and sealed seamless nitrogenised ACR copper, Type L.
 - .2 Conform to ANSI/ASME-B31.5 and ASTM B280 requirements and EPS 1/RA/1.
 - .3 Relief valve discharge pipe on outdoor installations shall be black steel pipe, Schedule 40, with welded or screwed joints.
 - .4 Use "Cush-a-clamp" type connection system.
- .3 Fittings:
 - .1 Conform to ANSI/ASME-B16.26 and ANSI/ASME-B16.29
 - .2 Long radius type for elbows and return bends.
 - .3 Wrought copper or forged brass solder type, except that flared fittings may be used for soft annealed copper tubing.
 - .4 Brazing materials shall conform to ANSI/AWS A5.8 and be SIL-FOS-15 phosphor-copper –silver alloy for copper piping jointed by copper fittings; 170 Mpa silver solder for brass fittings; 95-5 solder for connections to equipment or accessories.
 - .5 Flexible connections: 10mm nominal or less shall be made using coiled soft copper tubing. For larger sizes, use seamless flexible bronze hose with bronze wire braid covering. Use factory sealed neoprene jacket until where freezing may occur.
 - .6 Identify all refrigerant piping in accordance with Section 15010.
- .4 Valves:
 - .1 Construction:
 - .1 ANSI/ASME-B16.34.
 - .2 Service Valves:
 - .1 Forged brass Class 500 up to 3.5 Mpa packless and cast bronze Class 375 up to 2.5 Mpa.
 - .2 Moisture proof seal type for below freezing applications.
 - .3 Back seated and ball check for inspection and replacement under pressure.
 - .4 Removable seal cap and gauge port for control capillary connections for compressors.
 - .3 Stop Valves:
 - .1 22mm nominal OD or less shall be diaphragm packless type with integral mounting bracket, forged brass bodies and bonnets, globe and angle, non-directional type.
 - .2 28mm nominal OD or larger shall be heavy globe or angle body, positive sealing, self-aligning, heavy nylon disc.
 - .3 Purge, drain, charging, angle or globe type with flare or brazing type outlet connection shall have stem for socket wrench and removable seal cap.
 - .4 Relief Valves:
 - .1 Safety relief type with fusible plug or rupture disc in forged brass body.

- .2 Reseating type with forged brass body.
- .3 Duplex valves as indicated or by code regulations arranged so that only one valve can be rendered inoperative at a time.
- .5 Check Valves:
 - .1 Spring operated, guided piston type with forged brass body in flare connection sizes up to 22mm nominal OD.
 - .2 Guided piston type, spring operated with bolted bonnet or cover plate in sweat connections 28mm nominal OD and above.
- .6 Solenoid Valves:
 - .1 With field replaceable coil, serviceable without removing valve from line. For pump-downs, use manual lift stem. Rate coils according to temperature service.
 - .2 Provide upstream of thermostatic expansion valves and strainers.
- .7 Expansion Valves:
 - .1 ANSI/ASHRAE-17
 - .2 Thermostatic type with external equaliser, adjustable superheat setting, capacity and bulb change to suit operating conditions.
- .5 Driers:
 - .1 Provide liquid line driers to ANSI/ARI 710, UL approved and rated to SWP-3.5 Mpa.
 - .2 Size as indicated, but not less than recommended by equipment Manufacturer's nominal tonnage rating for type of refrigerant used.
 - .3 Size 16mm OD or larger shall be replaceable cartridge type and installed as indicated. Provide isolating and relief valves.
 - .4 Provide suction line driers as per liquid line drier and Manufacturer's suction line ratings, with pressure drops rated to refrigerant used and operating suction pressure.
- .6 Sight Glass:
 - .1 Provide moisture indicating, double sight glass upstream of expansion valve and near receiver outlet.

PART 3 - EXECUTION

3.1 STANDARDS

- .1 Maintain all standards of constructing and suspending ductwork as set forth in the 'ASHRAE' and SMACNA standards.
- .2 Co-ordinate and adjust locations of ceiling outlets with lighting and equipment layouts.
- .3 Duct sizes are inside dimensions. If ducts are acoustically lined, outside duct size to be increased as required.
- .4 Single thickness partitions between ducts is not acceptable.
- .5 All ductwork shall seams and joints sealed with Duro-Dyne S2 duct sealers. Apply duct sealer in strict accordance with manufacturers recommendations, to joints and seams to provide a air-tight, water-tight installation. Prior to application, ductwork to be dry and free of greases, etc.
- .6 All fans to be base mounted or hung using spring vibration isolators.
- .7 Duct connections to be made using 101 mm (4") neoprene, each side of fan.

3.2 AIR BALANCING

- .1 Shall be done as part of this Work.
- .2 Section 15800 shall provide initial alignment and tension of all fan pulleys and belts.
- .3 Section 15800 shall work in co-ordination with the Air Balance and Testing Agency to assure the installation of all manual adjusting dampers and pitot tube enclosures are as required to allow proper adjustment of the air system.
- .4 Section 15800 shall make any changes in the pulleys and belts, and any additional manual dampers for correct balance as recommended by the Air Balance Agency, at no additional cost to Owner.

3.3 LOW PRESSURE DUCTWORK

- .1 Duct Sizes shown on plans are a guide for duct runs only. Transition and change duct sizes and provide fittings at no extra cost to contract. Confirm site conditions and confer with Architectural, Structural and Electrical drawings.
- .2 Where duct width exceeds 450 mm (18") in largest dimension, stiffen by cross breaking sheets diagonally. Beaded ducts as per SMACNA catalogue Fig. 1.13 acceptable alternative.
- .3 Duct sizes are inside dimensions. If ducts are acoustically lined, outside duct size to be increased as required.
- .4 Provide duct turns in all elbows of ducts 1200 mm (48") wide and greater in segments of 600 mm (24") maximum.
- .5 Single thickness partitions between ducts not acceptable.
- .6 All ductwork shall have seams and joints sealed. Apply duct sealer in strict accordance with manufacturers recommendations, to joints and seams to provide an air-tight, water tight installation. Prior to application, ductwork to be dry and free of grease, etc. Use 6 mm (1/4") bead of material along joints. Material, when dry, to have 3.2 mm (1/8") depth extending 25 mm (1") one each side of joint or seam.

- .7 Where ductwork conflicts with mechanical and electrical piping and it is not possible to divert ductwork or piping to stay within allowable space limitations, provide duct easements. Easements not required on pipes 100 mm (4") and smaller outside dimension, unless this exceeds 20% of duct area. Irregular or flat shaped piping requires duct easement. Hangers and stays in ductwork to be parallel to air flow. If easement exceeds 20% of duct area, duct to be split into two ducts with original duct area being maintained. Easements to be approved by Architect before installation.
- .8 If ductwork is not adequately braced and/or supported to provide good installation, additional bracing and/or supports to be provided at no extra cost to Owner. Architect to interpret.
- .9 Assemble round duct sections using beaded couplings attached with sheet metal screws.

3.4 DUCT ACCESS DOORS

- .1 Locate properly for inspection and servicing. Doors and frame to be rigid, close-fitting, with rubber gaskets, galvanized hinges with brass pins and at least two galvanized cam locks. Rivet frame and hardware to ducts.
- .2 Install airtight, insulated access doors in ductwork at all:
 - .1 Fire dampers and motorized dampers (for inspection, repair and resetting). Provide access doors on both upstream and downstream sides of automatic dampers.
 - .2 Duct mounted coils (duct access upstream and downstream sides for cleaning).
 - .3 Fan inlets and outlets (for inspection of impellers and vanes).
 - .4 Duct mounted smoke detectors (for inspection of in-duct sensors).
 - .5 Filters.
 - .6 Temperature control components.
 - .1 In addition all motorized dampers are to be installed with a clear viewing port as part of the ductwork system with exterior removable insulated jacket,

3.5 DAMPERS

- .1 Manual:
 - .1 Install in manner acceptable to manufacturer where noted on drawings.
 - .2 Manual balancing dampers with quadrants and locks shall be installed in all branch ducts to facilitate a complete air balance for all systems including supply air, exhaust air and relief (except where grilles are specified to be supplied with key operated dampers).
 - .3 Balancing dampers shall generally be installed as far up-stream as possible and shall match the pressure rating of the duct system.
- .2 Backdraft:
 - .1 Backdraft dampers shall be installed in all relief air outlets and exhaust outlets except where motorized dampers are specified. Where relief of exhaust air outlets terminate in a roof hood the dampers shall be installed at the top of the roof hood curb frame.
 - .2 Backdraft dampers shall be leaf-lite c/w neoprene tip.

3.6 FIRE DAMPERS

- .1 Fire dampers in walls to be firmly friction fitted to walls. Fire dampers in floor to be firmly friction fitted to floor. Install fire dampers only in positions for which they have been tested.
- .2 Item .1 above also applies to fire door installations.
- .3 Install U.L.C. labelled fusible link folding blade fire dampers in fire separations where shown, and where otherwise required by authorities having jurisdiction. Fire dampers shall conform to N.B.C.
- .4 Fire Dampers and fusible links shall be tested and approved by ULC or other Testing Agency recognized by the authorities having jurisdiction.

- .5 Depending on the rating of fire separation, based on architectural drawings and specifications, the rating, construction and testing of the fire damper will conform as listed above.
- .6 Use type 'B' fire dampers, i.e., blades out of air stream, in all ducts passing through fire separations. Use combinations fire damper-balancing damper, with blades in air stream, on sidewall or return, or floor mounted supply, up to maximum size of 0.372 m (576 sq. in.).
- .7 Use a type 'A' fire damper, ie., blades in-the air stream. For sidewall return above 0.372 m (576 sq. in.) in size.
- .8 Frames shall extend full thickness of wall or floor in which dampers are installed. Frames shall be large enough so air flow is not obstructed when dampers are open. Under no circumstances will a fire damper installed in the standard duct at the fire barrier be allowed.
- .9 Construction and arrangement of fire dampers shall be approved in each, prior to installation. Provide access door for replacement of fusible links.
- .10 Fire dampers shall be installed where directed by the local Building Inspection branch an/or the Fire Marshal and the Contractor shall be guided by the drawings as to location.

3.7 MOTORIZED DAMPERS

- .1 New: Total of 6.
- .2 Existing 1 relocated.

3.8 FANS

- .1 Each fan to be base mounted using spring vibration isolators.
- .2 Duct connections to be made using 101 mm (4") neoprene, each side of fan.
- .3 Allow for drive change to obtain final air quantity for each exhaust fan.

PART 4 - SCHEDULES

TABLE 8 - GRILLES DIFFUSERS LOUVERS

Mark	Mfr.	Model	Core	Frame	Border	Blade	Fast	Finish	Remarks
SG-1	Price	520			F		A		
R3	Price	97			surface			B12	
L-1	Price	HP609							A

Remarks:

A Extend border. Anodized aluminium. Colour selection approval by City.

TABLE 9 – SUPPLY FAN UNIT (INCLUDES RELIEF FAN)

Mark	Mfr.	Model	CFM	Sp	Motor	RPM	Heating	Cooling Btu	Remarks
SF-2	Delhi	9209	1600	1 ½ "	2 Hp	1784	40 KW	48,000	A, B, C
RF-2	Delhi	9209	1600	1 ¼ "	1 ½ Hp	1786			

Remarks:

- A** All cased cooling coils are Engineered Air, (built-up)
- B** All preheat coils are Thermolec. Preheat heating coil construction, (built-up)
- C** All cased insulated filter section are (built-up)

TABLE 10 – PREHEAT/REHEAT COIL

Mark	Model	Velocity	AFM	Size	APD ΔP	Gpm	WPD ΔFt	BTU/Kw	Remarks
PHC-2	EH Price	500 Fpm min	1600					40,000 w	A

Remarks:

A Preheat heating coil construction.

TABLE 11 - AIR FILTERS

Mark	Model	Velocity Fpm	CFM	Size	Efficiency		APD	Remarks
					30%	85%		
FIL-2	Aeropleat® III	(<) 500	1600	2@ 24x24x4	✓		.07"	A

Remarks:

A Manufacturer: As a cased insulated unit. Merv 7.

TABLE 12 - CONDENSING UNIT

Mark	Manufacturer	Model	Btu	Refrigerant	Remarks
CU-2	Lennox	XC21-048	48,000 (Nominal)	R410A	A, B, C, D

Remarks:

A Cased cooling coil is by EngAir.

- B** Complete with internal hot gas by pass.
- C** See cooling coil performance for condition. Two stage compressor.
- D** Existing chain link fence, confirm existing mesh and gauge wire for required slat sizing. Vinyl vertical insert slat locking top to be installed on two sides, wind load factor and privacy factor approximately 75%. Option Lock: 25-year limited pro-rata warranty. Submit color samples for approval.

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