1 General

1.1 INSTRUCTIONS

.1 Comply with Instructions to Proponents, Enbridge Master Construction Agreement and General Requirements of Division 01.

1.2 RELATED SECTIONS

.1 Section 00 43 33.20 – Proposed Products Form, Mechanical

.2 Section 23 05 00 – Common Work Results for HVAC

.3 Section 23 07 00 – HVAC Insulation

.4 Section 23 70 00 – Central HVAC Equipment

.5 Section 23 80 00 – Decentralized HVAC Equipment

.6 Division 25 – Integrated Automation

.7 Division 26 – Electrical

1.3 DESCRIPTION

.1 Air distribution and ventilation equipment and systems, including ductwork, fans, duct accessories (such as dampers and turning vanes), air diffusers, air treatment equipment, sound attenuators, smoke dampers, fire dampers, and hoods, as described herein.

1.4 QUALITY ASSURANCE

.1 Galvanized steel ductwork material to ASTM A653 / A653M-03 or ASTM A792 / A792M-03.

.2 Stainless steel type 304 material to ASTM A480 / A480M-06b.

.3 Ducts in accordance with ASHRAE.

.4 Duct fabrication including fittings as recommended by SMACNA.

.5 Joints in accordance with ASHRAE for galvanized ductwork. Joints to be continuous inert gas welded for stainless steel and aluminum ductwork.

.6 Hanger configuration to SMACNA details.

.7 Flexible ductwork with requirements of UL "Standards for Safety, Air Ducts", UL-181 Class 1 and NFPA 90A.

.8 AMCA 500 *Test Methods for Louvers, Dampers and Shutters*.

.9 Fire Dampers: CAN/ULC-S112-10 *Standard Method of Fire Test of Fire-Damper Assemblies*. UL 555 *Standard for Safety; Fire Dampers*.

.10 Smoke Dampers: CAN/ULC-S112.1-10 *Standard for Leakage Rated Dampers for Use in Smoke Control Systems*.

.11 Combination Fire and Smoke Dampers shall meet both fire damper and smoke damper standards.

.12 Conform to the requirements of local by-laws, Ministry of Labour Regulations and all other authorities having jurisdiction.

1.5 SUBMITTALS

.1 Provide shop drawings, maintenance data and operating instructions for the following equipment:
Fans
GRD (grilles, registers, and diffusers)
Fire dampers
Combination Fire and Smoke Dampers
VAV terminals
High Induction Diffusers

1.6 SAMPLES

.1 Samples and mock-ups are required for the following:

Medium pressure duct work and joints.

Volume boxes.

Flexible ductwork.

1.7 MANUFACTURED ITEMS

.1 Grilles, registers, and diffusers shall be the product of one manufacturer for generic type; that is: grilles and registers by one, diffusers by one or same.

.2 Lighting troffers shall be completely independent of lighting fixtures but suited to the lighting fixtures supplied.

.3 Medium and high pressure spiral duct, fittings and specials shall be factory fabricated.

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

1.8 DUCT PRESSURE TESTING

.1 This Trade shall refer to Section 23 05 00 for instructions covering pressure testing of supply air ductwork.

.2 This Trade shall co-operate with the TAB Trade and shall prepare all ducts for testing with sealed blank off plates and connections for the blower and the flow meter.

2 Products

2.1 LOW PRESSURE DUCT MATERIALS

.1 Ductwork shall be constructed to withstand 1½ times the working static pressure with a leakage rate of 5% maximum and designed to operate at 750 Pa maximum pressure.

.2 Fabricate ducts from smooth finish prime grade, new, open hearth, soft steel sheet, galvanized, conforming to manufacturer's standard gauges as specified herein.

.3 Gauges and Reinforcing of Sheet Metal Ductwork

Largest Dimension	Galvanized Steel Thickness mm		Aluminum B&S Thickness mm		Recommended Construction Transverse Joints & Bracing
	Duct	Slip	Duct	Slip	
Up to 300 mm	0.6	0.6	0.89	1.04	Drive cleat on side, flat S cleat on top and bottom. Joints on 2400 mm centres max.
310 to 610 mm	0.71	0.71	0.89	1.04	
620 to 760 mm	0.71	0.71	0.89	1.04	Drive cleats on sides up to 610 mm and 38 mm standing S cleat over 610 mm. Top and bottom, 29 mm standing S cleat over 610 mm. Joints on 1194 mm centers maximum. Stays if required.
770 to 1540 mm	0.89	0.89	1.04	1.35	
1550 to 1800 mm	1.04	1.04	1.35	1.65	Drive cleats on sides up to 610 mm and 38 mm standing S cleat reinforced with 32x3 mm bar over 610 mm. Top and bottom 38 mm standing S cleat with 44x3 mm reinforcing bar. Joints on 1194 mm centres max.*
1810 to 2290 mm	1.04	1.04	1.35	1.65	As above for 38 mm plus dual 10 mm threaded rod stay bracing.
2300 mm and up	1.35	1.04	1.65	1.65	38 mm standing S cleat reinforced with 35 mm x 35 mm x 3 mm angle on sides, top and bottom. Joints on 1194 mm centres maximum.**
* 38 x 38 x 3 mm angle reinforcing located mid-way between joints around entire duct or joints made on 610 mm centres. ** 38 x 38 x 3 mm angle reinforcing located midway between joints around entire duct, plus 10 mm threaded rod stay bracing at 610 mm centres or joints made on 610 mm centres plus stays.					

.4 Aluminum Ductwork

.1 Fabricate ducts from smooth finish prime grade aluminum sheet conforming to manufacturer's gauges as specified above.

.5 Acoustical Liner

.1 Ducts are to be increased in size by thickness of insulation to maintain inside dimensions as per indicated duct sizes.

2.2 SEALED DUCTWORK

.1 Sealants used on duct systems shall have a flame spread rating of not more than 25 and a smoke developed classification of not more than 50, or as per latest building code requirements. Sealant shall be ULC approved as manufactured by Transcontinental or equal.

2.3 VARIABLE FLOW SYSTEM DUCTWORK

.1 All supply air ductwork used in conjunction with variable flow damper systems or Variable Air Volume Systems (VVT or VAV) shall be treated as medium pressure ductwork (750 Pa positive pressure) to comply with SMACNA standards. All joints shall be Ductmate, Namasco or Nexus and sealed and taped with approved sealant for a leakage rate as required during duct pressure testing.

2.4 VOLUME-CONTROL DAMPERS

.1 Splitters shall be made of at least the same metal thickness as the duct (minimum thickness 0.86 mm). They shall be securely hinged at the air leaving edge, and made of two thicknesses so the entering edge presents a rounded surface to air flow. Minimum length of splitter is 300 mm. Splitter length is 1½ times the width of the smaller duct when duct width is from 200 mm to 600 mm. Splitter length for duct widths greater than 600 mm is 1¼ times the width of the smaller duct.

.2 Splitters shall be anchored at the air entering edge by a SRP-40 Duro Dyne fitting and a 6 mm adjustable rod that passes through a Duro Dyne SRP-14 ball joint damper casting, on the outside of the duct.

.3 Butterfly dampers shall be constructed of 16 gauge steel or 1.6 mm thick aluminum. Sizes up to 300 mm wide and 760 mm long shall be of standard louvre blade construction. Larger size ducts use standard size multi-blade louvre dampers with a minimum of 150 mm blade.

.4 Manual dampers shall be lockable in place with damper quadrant. Damper rod end to be marked indicting blade position.

.5 Volume Control Dampers (VCD) shall be Ruskin CD-35 with opposed linkage hardware and lockable quadrant.

2.5 FIRE DAMPERS

.1 Fire dampers shall be constructed to the applicable standards listed in the Quality Assurance section in Part 1 of this document. They shall be ULC listed and labelled for 1½ hour fire rating.

.2 Provide multi-blade ‘Fire Dampers for Dynamic Systems’, suitable for application in HVAC systems with velocities to 10 m/s. Maximum pressure shall be 1 kPa. Dynamic Fire Dampers shall be operated by a stainless steel closure spring and latch.

.3 Fire dampers shall be galvanized steel channel frame curtain type galvanized steel interlocking blades, minimum 22 gauge galvanized steel enclosure, and 70°C fusible link standard. Fusible links for 100°C, or 140°C shall be provided if indicated on drawing as such.

.4 Fire damper configuration shall be low resistance type B with blades located outside of the air stream for rectangular ductwork, and type CR for round and type CO for oval ductwork.

.5 Fire damper assemblies shall have factory installed sleeves.

2.6 COMBINATION FIRE AND SMOKE DAMPERS

.1 Provide and install, as shown on plans, Combination Fire/Smoke Dampers, as manufactured by Nailor Industries, Inc., which meet or exceed the following criteria:

.1 Dampers shall meet the requirements of NFPA 80, 90A, 92, 101 and 105. Dampers shall be classified by Underwriter's Laboratories and labeled as a 1 1/2 hour Fire Damper under UL 555 and as a Class I or Class II Smoke Damper under UL 555S at an elevated temperature of 165°F for use in dynamic or static Smoke Control Systems.

.2 Dampers shall be tested under UL 555 and UL 555S by UL to a minimum velocity/pressure rating of 2000 fpm @ 4" w.g.

.3 Frame shall be constructed of 16 ga. galvanized steel hat channel with mitered corners reinforced with die-formed corner gussets for strength. Blades shall be 14 ga. equivalent galvanized steel formed double-skin airfoil design on 5 1/2" centers.

.4 Dampers shall be of opposed blade configuration with an interlocking blade design that provides complete flame and smoke seal under fire conditions at an elevated temperature of 2000°F when in the closed position.

.5 Dampers requiring blade seals to maintain leakage class when under elevated temperature conditions are not acceptable. Blades axles shall be 1/2" dia. plated steel, double bolted at each end of blade to ensure positive locking connection. Hex, square friction-fit or press-fit axles are not acceptable. Bearings shall be self-lubricating oilite bronze type. Blade linkage shall be zero-maintenance, concealed in frame, out of airstream. Jamb seals shall be compression type stainless steel.

.6 Dampers shall be provided with factory installed sleeves, length dependent on wall thickness, minimum 16". Wall thickness shall be field verified by contractor. Factory sleeves shall be caulked to UL requirements and shall be 20 ga. through 84" wide and 18 ga. above 84" wide.

.7 Appropriate externally mounted electrical pneumatic actuators shall be installed by the damper manufacturer in the factory. Actuators shall incorporate an OEM internal spring return mechanism; external after-market spring mechanisms are not acceptable.

.8 Each damper shall be equipped with a UL Classified heat responsive device that will cause the damper to close in a controlled manner and lock in a closed position by means of an over center/knee lock linkage, when the duct temperature reaches the maximum degradation temperature of the damper/actuator assembly as required by UL 555S. Closure devices that cause instantaneous closure are not acceptable.

.9 Damper and actuator assembly shall be factory cycled a minimum of 3 times to ensure correct operation.

.10 Submitted pressure drop data to be based on tests in accordance with AMCA Standard 500-D. Dampers must comply with the requirements of AMCA 511 Certified Ratings Program and be qualified to bear the AMCA Seal for Air Performance.

.11 Standard of acceptance shall be Nailor Industries Model Series 1220.

.12 Dampers shall be provided with Electric Resettable Link (heat sensor) at a fixed temperature of 165ºF. When a high temperature is sensed by the ERL, the sensor interrupts power to the actuator and the actuator's spring return mechanism causes the damper to close and lock. The ERL shall be factory installed and wired together with the associated actuator to meet ULC requirements.

.13 Dampers shall be provided with the MLS-300 Series Position Indicator Switch Pack. The position indicator switch pack shall indicate open and closed position of the damper blades by incorporating two SPDT switches that are used to operate signal lamps to indicate position.

.14 Dampers shall be provided with the DTS damper test switch for user testing. The DTS shall be mounted right on the damper and enable a maintenance person to test and cycle the damper. When the DTS is pushed and held, the damper shall cycle closed and open. The DTS and MLS-300 shall be combined to allow for a single person to cycle the damper and verify operation.

2.7 TURNING VANES

.1 Turning vanes in rectangular duct elbows shall be double walled vanes equal to Duro-Dyne "Duro Vane Rail" or Hart & Cooley "Ducturn".

2.8 ACCESS DUCT DOORS

.1 Provide Acudor HD-5070 duct doors for low-pressure sheetmetal duct up to 750 Pa static pressure. Doors shall be 24 gauge galvanized steel, double panel, and insulated along with gasketing between the door, frame, and duct. Frame shall be 24 gauge galvanized steel with 16-mm notched knock-over tabs. Insulation shall be 50 mm fibreglass batt compressed to 25 mm.

.2 Provide Acudor HD-5080-HP duct doors for sheetmetal duct up to 2.0 kPa static pressure. Door shall be rated for leakage no greater than 10 L/s per m^2 at 2.0 kPa. Doors shall be 24 gauge galvanized steel, double panel, and insulated along with gasketing between the door, frame, and duct. Frame shall be 24 gauge galvanized steel with 16-mm notched knock-over tabs. Insulation shall be 50 mm fibreglass batt compressed to 25 mm.

.3 For un-insulated low-pressure sheetmetal duct up to 750 Pa static pressure, ductwork access panels may be fabricated from 20 gauge galvanized steel, hinged to 20 gauge galvanized mounting frame complete with 16-mm notched knock-over tabs and gasketing between the door, frame, and duct.

.4 Hinges shall be continuous aluminum piano hinge.

.5 Gaskets shall be 3-mm thick by 15-mm wide closed cell neoprene gasketing between the door and frame and also between the frame and duct.

.6 Latches shall be self-tightening, hand operated cam latch.

.7 Duct door material shall match the duct material. Substitute aluminum or stainless steel in the above-specified doors as required.

.8 Access doors shall be a minimum of 200 x 200 mm.

2.9 TEST PORTS

.1 Test ports to be Air Power Equipment Co. or equivalent manufacturer. Use Dial 1000 for flat ducts and Dial 2000 for round ducts.

2.10 FLEXIBLE CONNECTORS

.1 Provide pre-assembled flexible duct connections as manufactured by Duro-Dyne of .66 mm steel and Durolon fabric having a density of 8 g/m^2 and a tensile strength of not less then 2 x 1.8 kN. "Grip-Lok" connectors shall band 75 mm metal to 150 mm fabric to 75 mm metal.

2.11 FLEXIBLE DUCT RUNOUTS

.1 Flexible ductwork, where shown on the drawings, shall be T/L-A by Flexmaster. The duct shall be made of perforated dead soft aluminum and manufactured in a manner to produce a triple lock mechanical joint. The core will be factory wrapped with fibreglass insulation and covered by a flame-retardant polyethylene vapour barrier, rated at a maximum of 500 Pa and -250 Pa (negative pressure) and a maximum velocity of 20 m/s.

.2 The duct shall be listed by Underwriters' Laboratories Canada as a Class 1 Air Duct Connector and complying with NFPA Standards 90A and 90B. The duct must be approved by the Consultant, CSA and the Ontario Fire Marshal's Office.

.3 Provide galvanized iron, rounded edged, hose clamps. Hangers shall be plastic coated iron bands.

2.12 EXHAUST VENTILATORS

.1 Fans shall be PennBarry Zephyr Exhaust Ventilators. Each unit to be complete with chrome grille or plastic face grille, duct extension, a wall cap brick vent or gooseneck on roof, bird screen and backdraft damper. Brick vent colour selected by Consultant. Fire stats are not required for these fans.

.2 Refer to Schedules for HVAC for model and capacity parameters.

2.13 FAN DRIVES

.1 Unless specified otherwise, all V-belt fan drives shall be sized for 150% of nominal motor horsepower, and ratings should be based on standard belt ratings, not ‘super-duty’ or hi-capacity type ratings.

.2 Motors 7½ HP and less to have adjustable pitch, motor sheaves. On motors over 7½ HP, the fan manufacturer is to provide constant speed V-belt drives. The fan supplier is to replace the motor sheave, if required, after installation to adjust the fan capacity.

.3 Vertically mounted motor shafts shall be supported with ball bearings.

2.14 REMOTE OR CONCEALED BEARING GREASING SYSTEM

.1 Where bearings for any fans or fan units are not easily accessible for greasing, extensions with Alemite fittings are to be provided to a point of easy accessibility, and bearings are to be equipped with grease relief valve.

2.15 VAV AIR TERMINALS WITH/WITHOUT REHEAT COILS

.1 Factory-assembled, externally powered, variable air volume control terminal. Unit shall be complete with a damper assembly, flow sensor, externally mounted volume controller, collars for duct connection and all required features. Control box shall be clearly marked with an identification label that lists such information as nominal cfm, maximum and minimum airflow limits, coil type and coil hand, where applicable

.2 Unit Cabinet:

.1 Constructed of 0.8 mm galvanized steel with round or rectangular inlet collar and rectangular discharge with slip and drive connection. All primary air inlet collars shall accommodate standard flex duct sizes

.2 Unit casing shall be lined with 13 mm thick, 0.6 kilograms dual density fiberglass insulation that meets UL 181 and NFPA 90A. Insulation shall be attached to the unit casing by adhesive and weld pins.

.3 The control air damper assembly shall be constructed of heavy gauge galvanized steel with solid shaft rotating in self-lubricating and wear resistant bearings. Damper shaft shall be marked on the end to indicate damper position. Damper blade shall incorporate a flexible gasket for tight airflow shutoff and operate over a full 90°.

.4 Unit controls shall be by Division 25. Provide controls enclosure for mounting of field installed controls.

.5 The box manufacturer shall refer to Integrated Automation, Division 25, to ensure co-ordination of controls and boxes.

.6 The unit shall be equipped with an amplified flow probe located in the unit inlet. Air flow for the pressure independent controller shall be determined with a factory supplied 12 point total pressure, center averaging cross flow sensor, having a magnification resulting in no greater than 13.3 m/s @ 250 Pa developed signal.

.7 Unless otherwise noted on the equipment schedule, transmitted sound level shall not exceed NC30 when rated at 375 Pa inlet pressure and 1.5 m of lined duct downstream of terminal unit. Ratings shall be in accordance with the current AHRI standard 885.

.8 For model and capacity see Schedules on drawings.

2.16 GRILLES, REGISTERS, AND DIFFUSERS

.1 Provide all grilles, registers, and diffusers complete with accessories as detailed on the drawings.

.2 For T-Bar lay-in ceilings the grilles, registers, and diffusers shall lay into T-Bar system and no flange shall extend beyond flange of T-Bar.

.3 Check architectural details, verify size of units and flanging requirements prior to ordering any units.

.4 Where diffusers are supplied individually with splitter take-off, an equalizing grid is required. All other diffusers require equalizing grids and combination balancing take-off units.

.5 On aluminum ductwork systems, aluminum diffusers, grilles, registers, fasteners and dampers shall be used.

.6 Gymnasium or General Purpose Room diffusers shall have a spring lock for inner cores and retaining cord to prevent inner cone from falling out of outside cone.

.7 This Trade is cautioned that before ordering of any units architectural details should be checked for verification of size of unit and flanging arrangement required.

.8 See schedule on drawings for manufacturer and model.

2.17 FIRE-RATED DUCTWORK

.1 Insulate all fire-rated ductwork per the requirements of Section 23 07 00.

2.18 HIGH INDUCTION DIFFUSERS

.1 General

.1 Furnish and install as shown on the plans and schedules, high induction air diffusers. Alternates are acceptable only if they can demonstrate, by software simulation, that sufficient performance will be achieved.

.2 Manufacturers must provide documented design information including equipment pressure drops, sound power information, velocity and throw profiles, orifice and/or cylinder locations, and suspension details. Equipment performance shall match or exceed scheduled design performance. Manufacturers must be able to provide room airflow simulation details using software to illustrate compliance with the above noted items as scheduled.

.3 The diffuser shall ensure a high rate of induction which minimizes temperature stratification and drafts in the occupied space to meet ASHRAE Standard 55 when operating in heating and cooling modes, even in variable air volume conditions. Sound power levels shall be as specified, generally not greater than 45 dB(A).

.2 Type KaPipe

.1 Type KaPipe duct diffusers shall be manufactured from galvanized steel with integrated rows of high induction eccentric cylinders (the “drums”). The drums shall be manufactured of an ABS composite which is UL94 tested, category V-0. Drums shall be available in black or white.

.2 Diffusers shall be designed to operate under variable airflow conditions, in heating or cooling modes.

.3 Each drum shall be 100 mm long and 35 mm in diameter. Discharge direction shall be manually adjustable by rotating the drums up to 360°. Drums shall be mounted in an aluminum cradle designed for support and to permit manual adjustment if required. Drum cradles manufactured from non-metallic materials are not acceptable.

.4 All duct diffusers shall be pre-balanced at the factory and shall not require balancing on-site. This shall be achieved by using dynamic flow balancing software to calculate the flow through each individual diffuser section, considering the geometry of the duct, the slot quantity and positions, and drum settings. The diffuser manufacturer must submit this calculation as part of the technical shop drawings to demonstrate the following:

(1) Actual air flow delivered through each diffuser section shall be within ±10% of the design value.
(2) Maximum total pressure drop through each duct diffuser system shall not exceed 50 Pa (0.2 in wc).

.5 The duct shall be coated outside with a baked polyester enamel paint, providing a smooth, easy-to-clean finish. Refer to the manufacturer’s colour chart for options.

.6 Duct diameters less than, or equal to, 400 mm (16”) shall be manufactured from 0.88 mm (22 gauge) galvanized steel. Duct diameters from 450 mm (18”) to 900 mm (20”), inclusive, shall be manufactured from 1 mm (20 gauge) galvanized steel. An internal metal reinforcement profile shall be included on all sizes.

.7 Duct diameters ranging from 200 mm (8”) to 450 mm (18”) shall ship in sections no greater than 2000 mm (6.5’) long. Duct diameters larger than 450 mm (18”) shall ship in sections no greater than 1500 mm (5’) long.

.8 Provide accessories (elbows, branches, reducers, passive duct, and end caps) as detailed on the plans. The above specified accessories, and all sleeves, are to be provided by the duct diffuser manufacturer.

3 Execution

3.1 GENERAL DUCT INSTALLATION

.1 This Trade shall furnish all labour and incidental materials and perform all the operations for the installation of the ventilating systems as shown on the drawings or as specified.

.2 All ducts shall be located in co-operation with the other trades to clear lights, pipes, plumbing, etc. In cases where cross beams, pipes, etc., must pass through ducts, air foils must be installed.

.3 In general, all ducts shall be constructed so that they may be dismantled and cleaned. All visible internal portions of duct outlets behind grilles and registers shall be painted dull black.

3.2 GENERAL DUCTWORK CONSTRUCTION

.1 Duct up to 600 mm in either dimension shall have reinforcing ribs, spaced not more than 2400 mm apart.

.2 Ducts over 600 mm in either dimension shall have reinforcing ribs, spaced not more than 1200 mm apart. Ducts shall have supplemental stiffening as required to prevent drumming and provide a structurally sound assembly.

.3 All sides of ducts over 450 mm in either dimension, except those to which rigid board type insulation is to be applied, shall have all sides cross-broken, except area of the duct where outlets are to be installed.

3.3 CHANGE IN SHAPE OR DIMENSION

.1 Slope requirements for transformations that either increase or decrease duct area to a minimum of 1:7.

.2 The angle of transformation at connections to heaters or other equipment shall not exceed 30 degrees from a line parallel to the airflow on the approaching side of the equipment, and 45 degrees on the leaving side of the equipment. The angle of approach may be increased to meet space conditions when the transformation section is provided with vanes.

3.4 CHANGES IN DIRECTION

.1 In general, changes in direction and in shape shall be kept to the minimum, permitted only by distribution requirements and building conditions. Turns shall be made with elbows as conditions necessitate in the following order of preference on all supply, return and exhaust ductwork.

.1 Un-vaned elbow, throat radius full-width of duct and full heel radius.

.2 Un-vaned elbow, throat radius ¾-width of duct and full heel radius.

.3 Square elbow with double thickness turning vanes spaced at 40 mm centres up to 600 m duct and 80 mm centres over 600 mm. Rovane duct turning vanes are acceptable.

3.5 OBSTRUCTION AND RESTRICTIONS

.1 Where possible, avoid locating any pipe, electrical conduit structural member, or other obstructions inside the duct. Particular care should be taken to avoid obstruction in elbows and tees as the air pressure drop is much greater than in straight ducts. When obstructions cannot be avoided, the following rules shall apply.

.2 In straight duct, any pipe or other round obstructions more than 100 mm in diameter shall be encased in an easement. In small ducts, all pipe or round obstructions shall be covered with an easement if it blocks more than 20% of the duct area.

.3 Any flat or irregular shape, the width of which exceeds 75 mm or 10% of the duct area shall be encased in an easement. Hangers or stays through the duct shall be caulked tight and installed parallel to air flow.

.4 When an obstruction equals or exceeds 20% of the duct area, the duct shall either be transformed, or split into two sections so the original duct area is maintained. When the duct is transformed to accommodate an obstruction, the angle of transformation approaching the decreasing area section shall not exceed 1 in 4 and the slope of the increasing section shall not exceed 1 in 7.

.5 An obstruction which restricts only a corner of the duct shall be treated by transforming the ducts, provided the reduction does not exceed 20% of the original area. The slope of the decreasing section shall not exceed 1 in 4 and the slope of the increasing section shall not exceed 1 in 7.

3.6 HOLES IN DUCTS

.1 Provide in duct systems, holes required for the installation of pipes, hangers, conduits, etc. where these are permitted to pass through ducts as only approved and authorized on site by the Consultant. Holes are to be cut to the diameter and in locations as approved. After pipe has been installed, hole shall be caulked to close any space left between edge of hole and pipe surface.

3.7 SEAMS

.1 Sections shall be assembled with Pittsburgh lock or grooved longitudinal seams, fully closed for tightness and appearance.

3.8 JOINTS AND REINFORCEMENT

.1 Duct sections shall be jointed by flat or standing S-cleats which shall conform to following general requirements.

.2 Ducts up to 450 mm in width shall have flat S-cleats on top and bottom and drive cleats on sides.

.3 Ducts over 450 mm width shall have standing S-cleats on top and bottom and drive cleats on sides.

.4 Where length of drive cleat exceeds 600 mm, a standing S-cleat or standing T-cleat shall be used and corners taped for tightness.

3.9 SUPPORTING OF DUCTS

.1 All ducts shall be adequately supported. For ducts up to 450 mm in width, hangers shall be placed on not more than 2400 centres; ducts 483 mm and above in width on not more than 1200 mm centres. Hangers shall be placed plumb and present a neat appearance.

.2 Hangers on ducts up to 900 mm in width shall be constructed from galvanized band iron 32 mm x 3 mm. On ducts greater than 900 mm in width, hangers shall be constructed from galvanized iron angles not less than 32 mm x 32 mm x 3 mm. Hangers shall extend down the sides of the ducts to bottom of duct with angle bent around bottom for support. Fasten to duct with sheet metal screws on sides and bottom. Hangers on ducts to be of same material as ductwork.

.3 Hangers bands shall extend the full depth of duct with bottom of hanger being toed in under duct. Hangers shall be attached to the duct using not less than three rivets or sheet metal screws.

.4 On reinforced concrete, all hangers for ductwork shall then be fastened to the concrete by Ram-Set studs or expansion shields and lag bolts.

.5 Ducts can not be supported from the furring or ceiling construction.

.6 In apparatus rooms, at approved locations where ducts are supported from the floor, there shall be installed galvanized angle irons with base plates anchored to floor slab. Supports shall be placed so as not to interfere with access to or around equipment and shall be attached to floor slab.

.7 The use of perforated band iron for supporting of ducts will not be permitted.

3.10 SEALED DUCTWORK

.1 Sealants used on duct systems shall have a flame spread rating of not more than 25 and a smoke development classification of not more than 50 or as per latest Building Code requirements. As manufactured by Transcontinental or equal Multi purpose Sealant ULC approved.

3.11 WATERTIGHT DUCT

.1 Provide watertight ductwork at minimum 1.0 mm or as required to suit larger duct sizes for:

"Wet" air exhaust, showers, etc.

Fresh air intake

.2 Form bottom of duct without longitudinal seams. Weld joints of bottom sheets and sides. Weld transverse joints and caulk.

.3 Slope horizontal branch ductwork down towards hood served. Slope header ducts down toward risers.

.4 Fit base of risers with 150 mm deep drain sump and 32 mm drain connection, with deep seal trap and valved drain line to open funnel drain. Note special duct construction for Kitchen exhaust system.

.5 All ductwork, grilles, fasteners, etc. handling wet air exhaust from showers, washrooms, etc. shall be aluminum from grille to a point 3 m downstream.

3.12 SPECIAL BRACKET

.1 Where the method of support specified above is not applicable, vertical risers and other duct runs shall, in general, be supported by substantial angle brackets designed to meet field conditions.

3.13 REINFORCING OF SHEET METAL – GENERAL

.1 All ductwork 300 mm and over in either dimension to be cross broken except those to which internal rigid board insulation is applied. Where drive cleat is used top and bottom corners to be caulked before cleat is turned over to make duct air tight.

.2 All other joints to be caulked at all corners before and after joint is made to make duct completely air tight.

.3 All standing S-cleats referred to are to be machine made for purposes of extra reinforcing.

.4 All longitudinal seams are to be Pittsburgh lock seam hammered over and made air tight.

.5 Where a duct falls into a certain maximum duct size classification the entire duct, sides to and bottom, is to be of the gauge specified.

.6 Sheet metal screws to be used on sides of ducts where standing S-cleat is used or reinforcing angle on 300 mm centres or minimum 2 screws per side.

3.14 BAFFLES

.1 Baffles shall be installed in all mixing chambers to prevent stratification and as required to obtain even temperature across heat exchangers or coils as required by Temperature Control Contractor.

3.15 TEST HOLES IN DUCTWORK

.1 Where necessary to provide opening in the ductwork for the insertion of the pitot tube, there shall be provided at each of these locations a metal cap to close this hole. Test holes and caps are to be located in 150 mm grids as required by the TAB Trade.

3.16 SHEET METAL INSTALLATION

.1 All necessary allowances and provisions shall be made in the installation of the ducts for the structural conditions of the building, and other trades and ducts shall be transformed or divided as may be required. Wherever this is necessary, the required area shall be maintained. All of these changes, however, must be approved and installed as directed at the site, or as approved on shop or erection drawings.

.2 During installation, the open ends of ducts shall be protected to prevent debris and dirt from entering. This Trade shall install this work in accordance with the overall approved progress schedule and in co-operation with all other Trades so there will be no delay to other trades.

3.17 DUCTS AT MASONRY

.1 Where ducts are shown connecting to or terminating at masonry openings, and/or along the edges of all plenums at floors, walls, or ceilings, provide a continuous 38 mm x 38 mm x 6 mm galvanized angle iron which shall be bolted to the construction and made air tight to same by applying approved caulking compound on the angle before they are drawn down tight. The sheet metal at these locations shall be bolted to the continuous angle iron.

3.18 DUCTS THROUGH FLOOR

.1 Where vertical ducts pass through floor openings, supporting angles shall be rigidly attached to ducts and to the structure. Angles shall be of approved size to support the ductwork. The supporting angles for any duct whose dimension is not greater than 900 mm in any one dimension shall be not less than 32 mm x 32 mm x 3 mm and placed on at least two sides of the duct.

.2 The supporting angles for any duct whose dimensions is greater than 900 mm in any one dimension shall be not less than 38 mm x 38 mm x 5 mm. Where ducts are installed in large shafts, these ducts shall be provided with angles not less than 50 mm x 50 mm x 6 mm and sound packing as specified to general conditions and seal entire sleeve areas to Consultant's approval.

3.19 MIXING BOX AND PLENUM CHAMBERS

.1 This Trade shall fabricate the mixing boxes and the fan units and shall provide all necessary baffling of air flow through the mixing box in order to obtain even temperature across the heating coils as required by the Temperature Control Trade.

.2 The Ventilation Contractor shall supply and install all plenum chambers where shown and required on the drawings. Plenum chambers shall be installed at return of all air units. Each plenum shall have an access door of a size approximately 610 mm x 914 mm with casement fasteners.

.3 Mixing boxes and plenums to be constructed of one gauge heavier than normal duct construction for width specified.

3.20 VOLUME-CONTROL DAMPERS

.1 Splitter dampers shall be installed on all branch take offs as detailed on drawings. Butterfly balancing dampers shall be provided behind all return or exhaust grilles. Provide all special dampers required and as specified otherwise. On multi-zone units, volume dampers are to be installed in each zone duct where not provided by the unit manufacturer.

3.21 EXAMINATION FOR FIRE OR SMOKE DAMPER OPENINGS

.1 Inspect areas to receive dampers. Notify the Engineer of conditions that would adversely affect the installation or subsequent use or maintenance of the dampers. Do not proceed with installation until unsatisfactory conditions are corrected.

3.22 FIRE DAMPERS

.1 Install dampers at locations indicated on the drawings and in accordance with manufacturer's UL approved installation instructions.

.2 Generally where any duct or any outlet passes through any required fire wall or fire rated ceiling the duct shall be provided with the Fire Marshall's approved automatic fire dampers built into the wall complete with approved break away joints. Dampers must be supported from the structure and not from the ducts or grilles.

.3 In addition, install in all systems where ducts service two or more stories, at each floor level Fire Marshall approved dampers, leaf dampers, fitted with fusible links of a Fire Marshall approved temperature rating to close air tight on linkage failure. Provide access to dampers for linkage replacement.

.4 Install dampers square and free from racking with blades running horizontally.

.5 Do not compress or stretch damper frame into duct or opening.

.6 Handle damper using sleeve or frame. Do not lift damper using blades or jackshaft.

.7 Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

.8 The complete fire damper installation is to meet approval of all authorities having jurisdiction. All fire damper locations must be shown on Record Drawings.

3.23 COMBINATION FIRE AND SMOKE DAMPERS

.1 Install dampers at locations indicated on the drawings and in accordance with manufacturer's UL approved installation instructions.

.2 Generally where any duct or any outlet passes through any required fire wall or fire rated ceiling the duct shall be provided with the Fire Marshall's approved automatic combination fire and smoke dampers built into the wall complete with approved break away joints. Dampers must be supported from the structure and not from the ducts or grilles.

.3 Install dampers square and free from racking with blades running horizontally.

.4 Do not compress or stretch damper frame into duct or opening.

.5 Handle damper using sleeve or frame. Do not lift damper using blades or jackshaft.

.6 Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

.7 The complete combination fire and smoke damper installation is to meet approval of all authorities having jurisdiction. Provide initial verification testing and documentation of all combination fire and smoke dampers installed. All damper locations must be shown on Record Drawings.

3.24 MOTORIZED DAMPERS

.1 The Controls Trade will supply all motorized dampers. This Trade shall install all motorized dampers under supervision of the Controls Trade and shall provide 450 mm x 450 mm access doors for complete access to all damper bearings.

3.25 TURNING VANES

.1 Install small arc foil hollow vanes in duct elbows where centre-line radius is less than 1¼ times turning dimension of duct.

.2 Square elbows with turning vanes equal to Hart and Cooley double thickness vanes spaced at 38 mm centres up to 600 mm duct and 83 mm centres over 600 mm. Rovane duct turning vanes are acceptable.

3.26 ACCESS DUCT DOORS

.1 Install duct doors to access fire or other dampers, for service and inspection, and for cleanouts where required on specialty systems.

3.27 ACCESS PLENUM DOORS

.1 Install plenum doors to access plenums.

3.28 FLEXIBLE FAN CONNECTIONS

.1 Install Duro Dyne Grip-Lock Durolon duct connectors to suit system pressure between ductwork and all fan equipment on both sides to isolate all fan equipment.

3.29 FLEXIBLE DUCT RUNOUTS

.1 Provide flexible hose run-outs where shown on plans

.2 The tube must maintain an even diameter when fixed. The ends of the spiral tube and seamed ducts are to be fitted with a coupling to provide smooth surfaces for the fitting of the flexible tube, and this shall be made air tight with an approved sealing compound, the material surface having been previously cleaned with thinners. Provide a rigid elbow at each diffuser for a 90° turn. See Detail DD-17.

.3 Sizes shall be as shown on the drawings. Minimum length of run-outs shall be 600 mm, maximum length shall be 2 m. All flexible run-outs to diffusers shall be installed level taut.

.4 Provide sealing of joints complete with galvanized iron hose clamps with sealer and tape. Hangers shall be plastic coated iron bands or plastic hangers.

3.30 FANS

.1 Install exhaust fans where indicated.

.2 Make all duct connections to fans with flexible connectors.

.3 Level units while fans are in operation and align ductwork providing clearance in proportion to flexible duct connector length ensuring that misalignment of ductwork when fan is not in operation does not strain or damage the connector.

.4 Note requirements for vibration isolation indicated in Section 23 05 00.

3.31 VAV AIR TERMINALS

.1 Install boxes as indicated on floor plans complete with all ductwork and transition as required.

.2 Where the boxes are mounted flush to the underside of the floor slab, they shall have rubber isolation pads installed between the slab and the mounted lugs. All boxes must be supported from structure not ceiling system.

.3 Easy access shall be provided to the internal mechanical constant pressure regulator. The interior of the box shall be acoustically insulated.

.4 The box manufacturer shall refer to the controls section to ensure co-ordination of controls and boxes.

3.32 LOCATION OF OUTLETS

.1 The position of all outlets shown on the drawings are approximate only and this Trade shall check the location of all outlets with the Consultant and make such adjustments in position as are necessary to conform with architectural features acoustic tile pattern, etc. and the outlets required by other trades without extra charge. Ceiling outlets and their assemblies must be constructed so that they fit the spacing and construction of the removable acoustic ceiling.

3.33 GRILLES, REGISTERS, AND DIFFUSERS

.1 Install all grilles, registers, and diffusers as detailed on the drawings and in strict compliance with manufacturer's recommendations.

3.34 OUTSIDE OPENINGS

.1 Louvres, bird screens, etc. for these intakes and exhausts unless specifically noted otherwise, will be supplied and installed by others. Supply and install all necessary ductwork and plenums for intakes and exhausts and patch around same to make a weather-tight job. Co-operate with all other trades on exact location of these openings, ducts, and louvres serving the air systems. Supply and install 14 gauge. louvre blank-offs for blanking off any unused portion of louvres.

3.35 WEATHER LOUVRES

.1 All weatherproof supply and exhaust air louvres, min. 40% free area, will be supplied and installed by General Trades.

3.36 NOISE LEVEL REQUIREMENTS

.1 The Testing and Balancing Trade shall measure the sound level in each room. Sound levels shall meet those indicated in Section 23 05 00.

.2 It is the intention of the specification to establish maximum sound pressure levels which must not be exceeded. This Trade shall, where necessary, install sufficient sound attenuation equipment, in addition to that specified, to reduce the sound levels to those listed above.

3.37 SLEEVES

.1 Where the branch take off goes through the floor or wall construction, there shall be placed around the take off, a sleeve which shall be large enough in diameter that the air conduit with insulation can expand and contract without restriction.

.2 All openings for duct shall be thoroughly sealed with caulking where the high velocity risers pass through. This Trade shall pack insulation around the duct to eliminate circulation stack effect of the air as specified under General Conditions.

3.38 SILENCER SUPPORTS

.1 Install spring hanger supports as recommended by the Noise and Vibration Control Trade.

3.39 HIGH INDUCTION DIFFUSERS

.1 Refer to manufacturer installation manuals for details on installation and air pattern adjustment. Where diffusers are to be hung, threaded rods or wires are to be supplied by the installing contractor.

.2 For KaPipe duct installations, contractors must take precautions to ensure that airflow patterns through the diffuser are not turbulent. Provide straightening vanes if KaPipe duct is mounted immediately downstream of an elbow.

END OF SECTION