METROLINX

Capital Projects Group

HVAC Air Distribution Specification

Specification 23 30 00

Revision 0
Date: August 2018

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Amendment Record Sheet

Amendment in Clause No.	Date of Amendment	Description of Changes

LIST OF CONTENT

TABLES

1. GENERAL

1.1. SCOPE OF WORK

1.1.1. Provide HVAC air distribution equipment as required, scheduled and specified herein.

1.2. DESIGN REQUIREMENTS

1.2.1. Provide standard product to meet capacity, throw, noise level, throat and outlet velocity.

1.2.2. Diffusers, grilles, and registers shall be of steel or aluminum construction, factory primed and painted with baked enamel or acrylic, white color, unless otherwise scheduled.

1.2.3. Diffusers, registers and grilles shall be compatible with the designed ceiling/wall type.

1.2.4. Provide registers and grilles with frames that are compatible with adjacent construction, with countersunk mounting holes. Refer to drawings for exact details of ceiling/wall construction.

1.2.5. Engineering data shall be based upon tests conducted in accordance with the latest ASHRAE Standard 70, Method of Testing for Rating the Performance of Air Outlets and Inlets at non-isothermal conditions. Published Noise Criteria (NC) data shall be determined based upon a 10 dB room attenuation across all octave bands. Lab test reports shall be available upon Metrolinx request.

1.2.6. Metrolinx air distribution design guidelines.

1.2.7. Design requirements are also based on Part 2 specified requirements of products.

1.3. RELATED WORKS

1.3.1. Section 20 05 05 - Mechanical Work General Instructions.

1.3.2. Section 20 05 10 - Basic Mechanical Materials and Methods.

1.3.3. Section 20 05 40 – Mechanical Work Commissioning.

1.4. REFERENCE STANDARDS

1.4.1. Standards and codes to be latest editions adopted by and enforced by local governing authorities.

1.4.2. ANSI/AHRI Standard 880, Performance Rating of Air Terminals.

1.4.3. ANSI/AMCA Standard 210, Laboratory Method of Testing Fans for Certified Aerodynamic Performance Rating.

1.4.4. ANSI/ASHRAE 70, Method of Testing the Performance of Air Outlets and Air Inlets.

1.4.5. ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.

1.4.6. ASTM A240 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

1.4.7. ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

1.4.8. ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

1.4.9. ASTM C1071 Standard Specification for Duct. Lining Insulation (Thermal and. Sound Absorbing Material).

1.4.10. ASTM E90 Standard Test Method for Laboratory Measurement of. Airborne Sound Transmission Loss of Building Partitions and Elements.

1.4.11. ASTM E413 Classification for Rating Sound Insulation.

1.4.12. ASTM G21 Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

1.4.13. ASTM E814 Standard Test Method for Fire Tests of Penetration Firestop Systems.

1.4.14. CAN/ULC S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.4.15. CAN/ULC-S110 Standard Methods of Test for Air Ducts.

1.4.16. CAN/ULC S115 Standard Method for the Fire Tests of Firestop Systems.

1.4.17. CAN3-A23 Concrete Materials and Methods of Concrete Construction.

1.4.18. CSA S269.1 Falsework and Formwork.

1.4.19. International Organization of Standardization (ISO) Standard 3741, Acoustics-Determination of Sound Power Levels of Noise Sources Using Sound Pressure-Precision Methods for Reverberation Rooms.

1.4.20. NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.

1.4.21. NFPA 92 Standard for Smoke Control Systems.

1.4.22. NFPA 101 Life Safety Code.

1.4.23. NFPA 105 Standard for Smoke Door Assemblies and Other Opening Protectives.

1.5. Spare Parts

1.5.1. Wire mesh.

1.6. TRAINING

1.6.1. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

1.6.2. Include for 3 training sessions of maximum 7 hours duration per session for 7 Metrolinx people per session.

1.6.3. Refer to Section 20 05 05 for additional general requirements.

1.7. WARRANTY

1.7.1. Products to be guaranteed by manufacturer, for a minimum of 2 years after acceptance by Metrolinx.

1.8. DELIVERY, STORAGE AND HANDLING.

1.8.1. Handle and store products in accordance with manufacturer's instructions, in locations approved by Metrolinx. Include one copy of these instructions with product at time of shipment.

1.9. SUBMITTALS

1.9.1. Refer to submittal requirements in Section 20 05 05.

1.9.2. Submit shop drawings/product data sheets for all products specified in this Section except shop fabricated ductwork and fittings.

1.9.3. Supply reviewed copies of ventilator/curb assembly shop drawings or product data sheets to trade who will cut roof openings for ventilators, and ensure openings are properly sized and located.

1.9.4. Submit shop drawings/product data sheets as follows:

a) to regulatory authority for review and approval prior to submitting to Consultant.

b) copies of all calculations, stamped and signed by same engineer who signs layout drawings, and a listing of all design data used in preparing the calculations, system layout and sizing requirements;

c) complete system test certificate.

1.9.5. Product Data

a) Submit product data sheets indicating:

1) technical data, supplemented by bulletins, component illustrations, detailed views, technical descriptions of items, and parts lists;

2) performance criteria, compliance with appropriate reference standards, characteristics, limitations, and troubleshooting protocol. Include capacity, throw and terminal velocity, noise criteria, and pressure drops with grille and diffuser shop drawing/product data sheet submission;

3) product transportation, storage, handling, and installation requirements;

4) product identification in accordance with Metrolinx requirements.

1.9.6. Shop Drawings

a) Submit shop drawings including:

1) capacity and ratings;

2) mounting details to suit locations shown, indicating methods and hardware to be used;

3) evidence that fire rated duct manufacturer is ULC listed to size requirements shows on drawings;

4) duct leakage test data prior to ductwork being covered from view;

5) manufacturer's colour chart(s) for all items for which a finish colour is to be selected;

6) proper installation certification from fire rated duct manufacturer as specified in Part 3 of this Section;

7) applicable control components and control wiring schematic.

1.10. QUALITY ASSURANCE

1.10.1. Site personnel are to be licensed in jurisdiction of the work and under continuous supervision of a foreman who is an experienced system installer and a journeyman licensed in jurisdiction of the work.

1.10.2. Grilles and diffusers are to be tested and performance certified to ANSI/ASHRAE 70, Method of Testing the Performance of Air Outlets and Air Inlets.

1.10.3. Check and verify dimensions and conditions at site and ensure work can be performed as indicated. Coordinate work with trades at site.

1.10.4. Verify working condition of existing system equipment which has direct interface with project work and is to remain. Replace with new equipment where necessary.

1.10.5. System components must be ULC listed and labelled.

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

1.10.7. Manufacturers Qualifications

a) Manufacturer shall be ISO 9000, 9001 or 9002 certified. Manufacturer of product shall have produced similar product for a minimum period of five years. When requested by Consultant, an acceptable list of installations with similar product shall be provided demonstrating compliance with this requirement.

b) Manufacturers are to be current members of Air-Conditioning, Heating and Refrigeration Institute (AHRI), and products are to be in accordance with requirements of standards listed previously.

c) Where manufacturers provide after installation onsite inspection of product installations, include for manufacturer's authorized representative to perform onsite inspection and certificate of approvals.

1.10.8. Installers Qualifications

a) Installers for work to be performed by or work under licensed Mechanical Contractor.

b) Installers of equipment, systems and associated work are to be fully qualified and experienced installers of respective products and work in which they are installing.

c) Where manufacturers provide training sessions to installers and certificates upon successful completion, installers to have obtained such certificates and submit copies with shop drawings.

1.10.9. Regulatory Requirements

a) Products and work to comply with applicable local governing authority regulations, bylaws and directives.

b) Include for required inspections and certificate of approvals of installation work from local governing authorities.

2. PRODUCTS

2.1. GALVANIZED STEEL DUCTWORK

2.1.1. Galvanized steel sheet is to be hot dipped in accordance with requirements of ASTM A653. G60 galvanizing for bare uncovered duct to be finish painted. G90 for all other galvanizing.

2.1.2. Rectangular

a) Lock forming grade hot dip galvanized steel, ASTM A653, shop fabricated, minimum #26 gauge.

2.1.3. Round

a) Factory machine fabricated, spiral, mechanically locked flat seam, single wall duct, fittings and couplings.

2.1.4. Flat Oval

a) Factory machine fabricated, single wall, 4-ply spiral lock seam duct, fittings and couplings.

2.2. GALVANIZED STEEL ROUND PVC COATED DUCTWORK

2.2.1. Factory made G90 galvanized steel, ASTM A653, spiral seam smooth wall round duct and fittings with metal gauges in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible for a 2.5 kPa (0.36 psi) pressure, with a 4 mm thick PVC coating permanently fused to both sides of the duct, fittings and sleeve joint pieces, and type 316 stainless steel sheet metal screws and support hardware.

2.3. RECTANGULAR ALUMINUM DUCTWORK

2.3.1. Alloy 3003 Temper H14 aluminum, ASTM B209, shop or factory fabricated, water-tight, with metal gauges and fabrication in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit the duct working pressure classification, and type 316 stainless steel support hardware.

2.4. ROUND ALUMINUM DUCTWORK

2.4.1. Alloy 3003 Temper H14 aluminum, ASTM B209, factory fabricated, water-tight, smooth interior, single wall duct, and fittings of spiral lockseam construction with site sealed beaded sleeve (slip type) joints, all in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit duct working pressure classification, and type 316 stainless steel sheet metal screws and support hardware.

2.5. RECTANGULAR STAINLESS STEEL DUCTWORK

2.5.1. 300 Series stainless steel, type 304 or type 316 as specified in Part 3 of this Section, ASTM A167 and ASTM A480, with a #4 finish where bare (uncovered) and exposed in finished areas and a #2B finish elsewhere, with, unless otherwise specified, metal gauges in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit duct location and working pressure classification, and stainless steel support hardware to match duct material.

2.6. ROUND STAINLESS STEEL DUCTWORK

2.6.1. Factory made, spiral, mechanically locked flat seam, single wall duct fabricated from type 316 stainless steel to ASTM A240 with metal gauges in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible for 2.5 kPa (0.36 psi) pressure. Type 316 stainless steel fittings equipped with leak-proof stainless steel couplings secured to connecting duct by means of stainless steel sheet metal screws and duct sealer. Duct system performance is to meet SMACNA's Leakage Class 3 requirements at system design static pressure. Stainless steel finish is to be a #2B mill finish where concealed or exposed in unfinished areas and a #4 finish where exposed in finished areas.

2.7. ROUND STAINLESS STEEL LINED DUCTWORK

2.7.1. Double wall self-sealing duct system constructed from type 316 stainless steel to ASTM A240 and consisting of 24 kg/m3 (1.5 lb/ft³) density, 25 mm (1") thick glass fibre insulation meeting NFPA 90A requirements and 25/50 flame spread/smoke developed ratings when tested in accordance with CAN/ULC S102 and wrapped in a thick non-woven polyester fabric, sandwiched between double wall duct and fittings. Spiral, mechanically locked, flat seam outer casing, and perforated inner liner with 3.2 mm (1/8") perforations on 6.4 mm (¼") staggered centres. Fittings and couplings constructed as for ducts and air-tight to SMACNA Leakage Class 3 requirements. Concealed duct and exposed duct in unfinished areas is to have a #2B mill finish. Exposed duct in finished areas is to have a #4 finish.

2.8. FLEXIBLE METALLIC DUCTWORK

2.8.1. Bare

a) Spirally wound, semi-rigid, self-supporting corrugated aluminum duct with continuous triple lock seams, SMACNA Form "M-UN", ULC S110 listed and labelled as a Class 1 Air Duct, constructed of dead soft aluminum strip, and supplied in 3 m (10') lengths.

2.8.2. Insulated

a) Spirally wound, semi-rigid, self-supporting corrugated aluminum duct with continuous triple lock seams, SMACNA Form "M-I", ULC S110 listed and labelled as a Class 1 Air Duct, constructed of dead soft aluminum strip, supplied in 3 m (10') lengths and factory covered with 40 mm (1-½") thick, 12 kg/m3 (0.75 lb/ft³) density fibreglass insulation with a vinyl jacket meeting 25/50 flame spread and smoke developed requirements tested in accordance with CAN/ULC S102.

2.9. FLEXIBLE CONNECTION MATERIAL

2.9.1. Waterproof, indoor-outdoor type flexible connection material meeting requirements of NFPA 90A, consisting of woven glass fibre fabric coated on both sides with synthetic rubber. Acceptable products are:

a) Duro Dyne Canada Inc. "DUROLON";

b) Dyn Air Inc. "HYPALON";

c) or approved equivalent.

2.9.2. Waterproof, flameproof, high temperature flexible connection material meeting requirements of NFPA 90A, consisting of a woven glass fibre fabric coated on both sides with silicone rubber.

2.9.3. Standard of quality assurance manufacturers are:

a) Duro-Dyne Canada Inc. "THERMAFAB";

b) Dyn Air Inc. "SILICON HI-T";

c) or approved equivalent.

2.10. METAL DUCT SYSTEM JOINT SEALANT

2.10.1. ULC listed and labelled, premium grade, grey colour, water base, non-flammable duct sealer, brush, or gun applied, with a CAN/ULC S102 tested maximum flame spread rating of 5 and smoke developed rating of 0.

2.10.2. Standard of quality assurance manufacturers are:

a) Johns Manville;

b) Manson Insulation;

c) Knauf Insulation;

d) or approved equivalent.

2.11. ACOUSTIC LINING

2.11.1. Minimum 25 mm (1") thick acoustic lining material meeting 25/50 flame spread and smoke developed ratings tested in accordance with CAN/ULC S102, meeting NFPA 90A, ASTM C1071, and ASTM G21 requirements, not supporting microbial growth, flexible for round ducts, board type for rectangular ducts, consisting of a bonded fiberglass mat coated on inside (airside) face with a black fire-resistant coating.

2.11.2. Standard of quality assurance manufacturers are:

a) Johns Manville;

b) Manson Insulation;

c) Knauf Insulation;

d) or approved equivalent.

2.12. FACTORY INSULATED FIRE RATED DUCTWORK

2.12.1. DuraSystems Barriers Inc. "DuraDuct HP" or "DuraDuct GNX" duct, or approved equivalent, two hour fire rated, constructed, ULC listed and labelled for fire rated ventilation applications. Duct is constructed of a galvanized steel inner liner, a galvanized steel outer jacket, and all required fittings and accessories, including support hardware.

2.13. IN-SLAB EXHAUST DUCTWORK

2.13.1. ECCO Manufacturing "ECCODUCT" or approved equivalent, spiral wound, galvanized steel.

2.13.2. 300 mm x 45 mm (12" x 1-¾") rectangular duct supplied in 3 m (10') lengths complete with factory supplied galvanized steel connection couplers, fittings, exterior discharges with back draft dampers, and support brackets. Concrete encased duct and fittings are 3 hour fire rated in accordance with tests conducted by Intertek/Warnock Hersey in accordance with ULC S115 and ASTM E814, are to have an impact loading rating of 200 kg (440 lb) from 1.5 m (5') with no permanent deformations in accordance with CAN3-A23, and are to have a point loading rating with 1 mm (1/32") permanent deformation when tested to CSA S269.1.

2.14. CASING AND PLENUM MATERIAL AND ACCESSORIES

2.14.1. Unless otherwise specified, casing and plenum material is to be same as connecting duct material.

2.14.2. Accessories such as access doors and drain pans are to be constructed of same material as casing and plenum and are to be in accordance with Chapter 6 of SMACNA HVAC Duct Construction Standards Metal and Flexible.

2.15. ACOUSTIC PLENUM PANELS

2.15.1. Vibro-Acoustics Ltd. type "AP" or approved equivalent, 100 mm (4") thick panels with acoustic media meeting NFPA 90A requirements sandwiched between minimum #24 gauge galvanized sheet steel, with airside face perforated, access doors where shown, and with acoustic performance as follows:

Table 2-1 Acoustic Performance

Octave Bands, (Hz)	125	250	500	1000	2000	4000
Transmission Loss	21	28	39	50	53	56
Absorption Coefficient	0.7	0.9	.99	.99	0.9	0.9

2.15.2. Standard of quality assurance manufacturers are:

a) Vibro-Acoustics Ltd.;

b) Kinetics Noise Control Inc.;

c) Carrier Corp. - Racan;

d) Haakon Industries;

e) Price Industries Inc;

f) or approved equivalent.

2.16. PLENUM ACCESS DOORS

2.16.1. Factory fabricated, double wall insulated access doors, sized as indicated on drawings, and constructed of same material as connecting ductwork in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit operating pressure of the system.

2.17. ROUND TO RECTANGULAR DUCT CONNECTIONS

2.17.1. Flexmaster Canada Ltd. or approved equivalent, galvanized steel, flared, flanged or notched "Spin-On" round duct take-off collars with locking dampers in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.

2.18. SPLITTER DAMPERS

2.18.1. Minimum #20 gauge damper blade constructed of same material as duct, reinforced as required to suit blade size, system velocity, and to prevent "chatter", and complete with operating hardware, DynAir Inc. #Q-50 "DYN-A-QUAD S-S" or approved equivalent, quadrant regulator with RW-50 backup washers to prevent leakage, long square bearing pin, and slide pin.

2.19. AIR TURNING VANES

2.19.1. For square elbows, multiple-radius turning vanes interconnected with bars, adequately reinforced to suit pressure and velocity of system, constructed of same material as duct they are associated with, and in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.

2.19.2. For short branch ducts at grille and diffuser connections, air extractor type each equipped with a matching bottom operated 90° opposed blade volume control damper, constructed of same material as duct it is associated with and in accordance with requirements and details in ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.

2.20. MANUAL BALANCING (VOLUME) DAMPERS

2.20.1. Flanged and drilled, single or parallel blade (depending on damper size) manual balancing dampers, each constructed of same material as connecting ductwork unless otherwise specified, each designed to maintain internal free area of connecting duct, and each complete with:

a) hexagonal or square shaft extension through frame;

b) non-stick, non-corrosive synthetic bearings for rectangular dampers, flange stainless steel bearings for round dampers;

c) blade stops for single blade dampers, designed to prevent blade from moving more than 90°;

d) linkage for multiple blade dampers;

e) locking hand quadrant damper operator with, for insulated ducts 50 mm (2") standoff mounting.

2.20.2. Rectangular Dampers: Nailor Industries Inc. 1800 Series or approved equivalent, maximum size 1.2 m x 1.2 m (4' x 4') for a single damper.

2.20.3. Round Dampers: Nailor Industries Inc. Model 1890 or approved equivalent, maximum 600 mm (24") diameter, equipped with a minimum 200 mm (8") deep frame, and blade stiffeners where required.

2.20.4. Multiple Rectangular Damper Section Assembly: Rectangular assembly supplied with the dampers or site constructed, of same material as damper and designed for tight and secure mounting of individual dampers.

2.20.5. Standard of quality assurance manufacturers are:

a) Nailor Industries Inc.;

b) T.A. Morrison & Co. Inc. "TAMCO";

c) NCA Manufacturing Ltd.;

d) Greenheck Fan Corp.;

e) Ruskin Co;

f) or approved equivalent.

2.21. BACKDRAFT DAMPERS

2.21.1. Nailor Industries Model 1370CB or approved equivalent, counterbalanced backdraft dampers, vertical or horizontal mounting, 50 mm (2") wide, sized as shown and complete with:

a) extruded 6063-T5 aluminum frame, 2.3 mm (0.090") nominal wall thickness, with mitred corners;

b) extruded 6063-T5 aluminum blades, 1.3 mm (0.050") nominal wall thickness on 92 mm (3-5/8") centres, and with extruded PVC blade seals;

c) corrosion-resistant synthetic bearings;

d) adjustable plated steel counterweights mounted internally in the airstream;

e) concealed blade linkage located out of the airstream.

2.21.2. Standard of quality assurance manufacturers are:

a) Nailor Industries Inc.;

b) T.A. Morrison & Co. Inc. "TAMCO";

c) NCA Manufacturing Ltd.;

d) Greenheck Fan Corp.;

e) Ruskin Co;

f) or approved equivalent.

2.22. FUSIBLE LINK DAMPERS

2.22.1. Curtain blade type, dynamic, galvanized steel (unless otherwise specified) fusible link dampers, ULC classified to CAN/ULC S112 and in accordance with NFPA 90A requirements, factory tested for closure under airflow, 1-1/2 hour or 3 hour rated as required, and complete with a constant force type 301 stainless steel closure spring, a blade lock assembly, a steel sleeve, retaining angles, and, unless otherwise specified, a 74°C (165°F) rated standard fusible link.

2.22.2. Fusible link dampers are to be Type "B" or Type "C" (as required) with folded curtain blade out of air stream except where damper size or location requires use of type "A" dampers with curtain blade in air stream.

2.22.3. Standard of quality assurance manufacturers are:

a) Nailor Industries Inc.;

b) Greenheck Fan Corp.;

c) NCA Manufacturing Ltd.;

d) Ruskin Co.;

e) Price Industries (E.H. Price);

f) or approved equivalent.

2.23. COMBINATION FIRE/SMOKE DAMPERS

2.23.1. Nailor Industries Series 1220 or approved equivalent, ULC listed to CAN/ULC S112 and CAN/ULC S112.1, meeting requirements of NFPA 80, 90A, 92, 101 and 105, consisting of type A, B, or C fusible link fire dampers as required and a fail-safe, opposed blade, normally closed, motor operated smoke damper complete with factory installed and tested 120 V electric actuator.

2.23.2. ULC 1-1/2 hour fire rated and ULC Class I leakage rated for smoke, and equipped with a 74°C (165°F) ULC classified fusible link that will cause damper to close and lock independent of actuator when duct temperature reaches maximum temperature of damper assembly.

2.23.3. Supply damper with factory installed sleeves of minimum 400 mm (16") length, field verified by contractor dependent on wall thickness. Caulk sleeves to ULC requirements and constructed of 20 gauge for sizes up to 2.1 m (84") wide and 18 gauge for sizes greater than 2.1 m (84") wide.

2.23.4. Standard of quality assurance manufacturers are:

a) Nailor Industries Inc.;

b) Greenheck Fan Corp.;

c) NCA Manufacturing Ltd.;

d) Ruskin Co.;

e) Price Industries (E.H. Price);

f) or approved equivalent.

2.24. SMOKE DAMPERS

2.24.1. Multi-blade type, fail-safe, dynamic, galvanized steel (unless otherwise specified) smoke dampers, ULC classified to CAN/ULC S112.1, ULC Class I leakage rated for smoke, meeting requirements of NFPA 90A, 92, 101 and 105, normally closed, low pressure drop design, dynamically tested, each complete with jamb and blade seals, linkage concealed in the frame, a steel sleeve to suit the opening, and an electric actuator to automatically close damper upon receiving an external signal, and to automatically open damper when system is reset.

2.24.2. Standard of quality assurance manufacturers are:

a) Nailor Industries Inc.;

b) Greenheck Fan Corp.;

c) NCA Manufacturing Ltd.;

d) Ruskin Co.;

e) Price Industries (E.H Price);

f) or approved equivalent.

2.25. ROOF DUCT SUPPORTS

2.25.1. PHP Systems Design Model PHP-D or approved equivalent, adjustable duct support assemblies sized to suit duct size, each assembly complete with injection moulded recycled plastic and carbon black bases and tubular hot dip galvanized steel framing.

2.26. PRESSURE RELIEF DOORS

2.26.1. Greenheck model PRAD (positive) or VRAD (negative) or approved equivalent, pressure relief doors constructed of same material as duct or plenum they are associated with, each complete with a sealing gasket, special latches, cable assembly with spring to limit door opening to maximum 80° and factory set, field adjustable pressure relief magnet assembly.

2.26.2. Size access doors to match requirements of system so pressure drop through open blow-out door at required flow rate will not exceed rated pressure of duct system.

2.26.3. Standard of quality assurance manufacturers are:

a) Greenheck Fan Corp.;

b) United Enertech;

c) or approved equivalent.

2.27. DUCT ACCESS DOORS

2.27.1. In accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, with sizes suitable in all respects for purpose for which they are provided, and, unless otherwise specified, constructed of same material as duct they are associated with.

2.28. DUCTWORK DRAIN POINTS

2.28.1. Equal to Ductmate Canada Ltd. "Moisture Drain" or approved equivalent, 20 mm (¾") diameter moisture drains with galvanized sheet metal funnel, and chrome plated brass threaded drain, nut and cap.

2.29. INSTRUMENT TEST PORTS

2.29.1. Duro-Dyne of Canada Ltd. or approved equivalent, #IP1 or #IP2 (to suit insulation thickness where applicable), gasketed, leakproof instrument test ports for round or rectangular ducts as required, each complete with a neoprene expansion plug and a plug securing chain.

2.30. WIRE MESH (BIRDSCREEN)

2.30.1. Heavy-gauge galvanized steel or aluminum mesh, 12 mm x 12 mm (½" x ½") secured in a rigid galvanized steel or aluminum framework, sized as indicated on drawings, and constructed so as to be removable.

2.31. LOUVRES

2.31.1. Price Industries Inc. DE439 or DE635 or approved equivalent, 100 mm (4") or 150 mm (6") deep (to suit wall thickness) factory assembled stationary, drainable, storm-proof louvres sized as indicated on drawings, each AMCA water penetration and air performance certified, constructed of welded, extruded, alloy 6063-T5 aluminum with drainable blades, mounting and securing hardware to suit the application, and 12 mm (½") mesh aluminum birdscreen in an aluminum frame.

2.31.2. Acoustical Louvres: Price Industries Inc. Model QA1245 or approved equivalent, 300 mm (12") deep, welded, extruded alloy 3003-H14 aluminum, storm-proof, stationary, drainable acoustical louvers, AMCA water penetration and air performance certified, with high density mineral wool acoustic media secured to blades and protected by perforated aluminum, sound ratings in accordance with ASTM E90 and ASTM E413, and mounting and securing facilities as required.

2.31.3. Louvres are to be factory finished with PPG Industries "Duranar" or approved equivalent, fluoropolymer powder coating over primer with colour as selected from manufacturer's standard colour range.

2.31.4. Standard of quality assurance manufacturers are:

a) Price Industries Inc.;

b) The Airolite Co. LLC;

c) Construction Specialities;

d) Nailor Industries Inc.;

e) Greenheck Fan Corp;

f) or approved equivalent.

2.32. FIRE STOP FLAPS AND THERMAL BLANKET MATERIAL

2.32.1. Rectangular or round, ULC listed and labelled, blade type galvanized steel fire stop flaps in accordance with CAN/ULC S112, Standard Methods of Fire Test of Fire-Damper Assemblies and CAN/ULC S112.2, Standard Method of Fire Test of Ceiling Firestop Flap Assemblies, each complete with #22 gauge G60 galvanized steel blade(s) and frame, a 74°C (165°F) fusible link, and, for dampers 300 mm (12") and larger, ceramic fibre insulation on both sides of the blades.

2.32.2. Ceramic fibre material in accordance with 25/50 flame spread/smoke developed ratings when tested to CAN/ULC S102 and of a thickness to suit required fire rating.

2.33. GRILLES, DIFFUSERS AND REGISTERS

2.33.1. Grilles, diffusers and registers of type, size, capacity, finish, and arrangement as shown on drawings and in accordance with drawing schedule, each equipped with all required mounting and connection accessories to suit mounting location and application.

2.33.2. Diffuser face: perforated, laminar flow face constructed of aluminum with quarter-turn fasteners for removal and access to fan-motor and filter.

2.33.3. Mounting gasket: roll type gasket material supplied with units for site installation on T-bar ceiling members.

2.33.4. Supply Diffusers

a) Of restricted multi-orifice jet induction and air mixing type, consisting of louvered sections with built-in diffusing vanes.

b) Square with neck sizes to match connecting duct size.

c) Assembled for indicated patterns that provide 1-way, 2-way, 3-way or 4-way air discharge with each side delivering a quantity of air proportional to area served.

d) Constructed with an integral leak-proof collar extending minimum 25 mm (1") above the core to accommodate duct connection. Square and rectangular collars have welded corners.

2.33.5. Return and Exhaust Diffusers

a) Square with neck sizes to match connecting duct size.

b) Constructed with an integral leak-proof collar extending minimum 25 mm (1 ") above the core to accommodate duct connection. Square and rectangular collars have welded corners.

2.33.6. Plenum Slot Diffusers

a) Insulated for supply and uninsulated for return and have of the slot widths, number of slots, and lengths as indicated on drawings.

b) Constructed of a minimum of 24 gauge galvanized steel with a black face.

c) Inlets drawn from plenum wall to eliminate leakage and have minimum 25 mm (1 ") duct connection flange.

d) Slot face constructed of double metal thickness to provide rigidity and pattern controller of adjustable type.

e) Provide blank-off baffles for inactive sections where required.

2.33.7. Supply and Return Bar Grille

a) Bar grilles of extruded aluminum construction, nominal 3 mm (1/8 ") wide bars with 0-degree deflection, on maximum 6 mm (1/4 ") centers, or as scheduled.

b) Continuous grilles over 1,800 mm (72 ") in length, butted together using keyed splices for precise alignment.

c) Concealed spring latch fasteners used for attaching grille to plaster frame. No screw holes visible on plaster frame or grille.

d) Provide blank-off baffles for inactive sections of grilles, as noted on drawings.

2.33.8. Egg-Crate Return/Exhaust Grille

a) Aluminum construction, consisting of aluminum 1/2" x 1/2" x 1/2" (13 x 13 x 13) grid (egg crate core) and an extruded aluminum border.

2.33.9. Sidewall Adjustable Supply Register

a) With mitered corners, double deflection adjustable blades, and horizontal front blades.

2.33.10. Low Wall Return/Exhaust Registers

a) Each register with one set of fixed blades, 42 to 45 degree deflection.

b) Mounted 450 mm (18 ") AFF or lower, with mitered corners, fixed blades, horizontal front louvers; frame and blade manufactured of minimum 8 gauge aluminum or 12 gauge steel for rugged use.

2.33.11. Standard of quality assurance manufacturers are:

a) Price Industries Inc.;

b) Anemostat;

c) Krueger Division of Air System Components Inc.;

d) Titus;

e) Nailor Industries Inc.;

f) Tuttle & Bailey;

g) or approved equivalent.

2.34. ROUND LOW SILHOUETTE ROOF MOUNTED VENTILATORS

2.34.1. Spun aluminium, round, gravity roof mounting hoods in accordance with drawing schedule, each complete with:

a) wind band with a rolled bead, and curb cap with one-piece, spun, deep venturi inlet, and pre-punched holes for mounting;

b) galvanized steel bird screen;

c) minimum 300 mm (12") high welded aluminium, insulated roof mounting curb with damper tray;

d) aluminium backdraft damper supplied loose, for site installation in roof curb damper tray;

e) non-corrosive motorized damper supplied loose for site installation in roof curb damper tray, T. A. Morrison TAMCO Series 9000 or approved equivalent, insulated damper with linkage, end switch, and a Belimo or equal motor with voltage to suit control voltage requirements.

2.34.2. Standard of quality assurance manufacturers are:

a) Greenheck Fan Corp.;

b) PennBarry;

c) Twin City Fan and Blower;

d) or approved equivalent.

2.35. LOUVRED PENTHOUSE TYPE VENTILATORS

2.35.1. Low silhouette, rectangular, roof mounting louvred penthouse type hoods in accordance with drawing schedule, each constructed of aluminium, supplied in knock-down form for site assembly, and each complete with:

a) extruded aluminium, welded storm-proof louver blades with mitred corners and stainless steel securing screws;

b) removable cover for internal access, lined with glass fibre insulation material and equipped with stainless steel fasteners;

c) 12 mm x 12 mm (½" x ½") aluminium mesh birdscreen;

d) welded aluminium, minimum 300 mm (12") high insulated roof mounting curb with damper tray and curb seal;

e) aluminium backdraft damper supplied loose, for site installation in roof curb damper tray;

f) non-corrosive motorized damper supplied loose for site installation in roof curb damper tray, T. A. Morrison TAMCO Series 9000 or approved equivalent, insulated damper with linkage, end switch, and a Belimo or equal motor with voltage to suit site control voltage requirements.

2.35.2. Standard of quality assurance manufacturers are:

a) Greenheck Fan Corp.;

b) Twin City Fan and Blower;

c) PennBarry;

d) or approved equivalent.

2.36. HOODED TYPE VENTILATORS

2.36.1. Low silhouette, rectangular, roof mounting hooded penthouse type ventilators in accordance with drawing schedule, each constructed of aluminium, supplied in knock-down form for site assembly, and each complete with:

a) full 360° perimeter hood opening;

b) 12 mm x 12 mm (½" x ½") aluminium mesh bird screen;

c) welded aluminium, minimum 300 mm (12") high insulated roof mounting curb with damper tray and curb seal;

d) aluminium backdraft damper supplied loose for site installation in roof curb damper tray;

e) non-corrosive motorized damper supplied loose for site installation in roof curb damper tray, T. A. Morrison TAMCO Series 9000 or approved equivalent, insulated damper with linkage, end switch, and a Belimo or equal motor with voltage to suit site control voltage requirements.

2.36.2. Standard of quality assurance manufacturers are:

a) Greenheck Fan Corp.;

b) Twin City Fan and Blower;

c) PennBarry;

d) or approved equivalent.

3. EXECUTION

3.1. CLEANLINESS REQUIREMENTS FOR HANDLING AND INSTALLATION OF DUCTWORK

3.1.1. Handle and install ductwork in accordance with SMACNA's Duct Cleanliness for New Construction Guidelines at the Advanced Level.

3.2. FABRICATION AND INSTALLATION OF GALVANIZED STEEL DUCTWORK

3.2.1. Provide required ductwork, rectangular, round and/or flat oval. Where rectangular ductwork is shown, round or flat oval ductwork of equivalent cross-sectional area is acceptable.

3.2.2. It is to be understood that all duct dimensions shown on drawings are clear internal dimensions.

3.2.3. Unless otherwise specified, construct and install ductwork in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit duct pressure class designation of minimum 500 Pa (2" w.c.) positive or negative as applicable, a minimum velocity of 10 m/s (2000 fpm), and so ductwork does not "drum". Flat surfaces of rectangular ductwork are to be cross-broken. Duct system sealing is to meet ANSI/SMACNA Seal Class A requirements.

3.2.4. Variable air volume ductwork from supply fans to boxes is as above but rectangular duct take-offs are double side straight taper type with a take-off length equal to 0.5 times the branch duct width but minimum 150 mm (6") length, and double taper side is to have an included angle of minimum 60°.

3.2.5. Confirm routing of all ductwork at site and site measure ductwork prior to fabrication. Duct dimensions may be revised to suit site routing and building element requirements, if dimension revisions are reviewed with and approved by Consultant. Duct routing and/or dimension revisions to suit conditions at site are not grounds for a claim for an extra cost.

3.2.6. Refer to structural drawings. Where ductwork is to be run within or through open web steel joists, ductwork shown on mechanical drawings is schematic only and is to be altered as required to suit steel joist configuration, spacing, panel points, and cross-bridging at no additional cost.

3.2.7. Wherever ductwork is required at locations where sprayed fireproofing is applied to building construction, install ductwork only after fireproofing work is complete and do not compromise fire rating of sprayed fireproofing.

3.2.8. Install (but do not connect) duct system mounted automatic control components supplied as part of the automatic control work.

3.2.9. Where indicated, provide duct connections to fan powered heat transfer equipment with integral coils.

3.2.10. Flange connect ductwork to hot water reheat coils in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible. Coils will be suspended independent of connecting ductwork as part of the heat transfer work.

3.2.11. Support horizontal rectangular ducts inside building in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, but use trapeze hangers with, unless otherwise specified, galvanized steel channels, and galvanized steel hanger rods for exposed ducts and concealed ducts wider than 500 mm (20"). Support hardware constructed of same material as duct for metal duct, and, unless otherwise specified, type 316 stainless steel for non-metal duct. Supports for "heavy" duct such as cementitious core duct is to be suitable in all respects for the application and approved by Consultant.

3.2.12. Support round and flat oval ducts inside building in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, but, unless otherwise specified, for both uninsulated and insulated ducts exposed in finished areas, use bands and secure at top of duct to a hanger rod, all similar to Ductmate Canada Ltd. type "BA" or approved equivalent. If duct is insulated, size strap to suit diameter of insulated duct. Unless otherwise specified, duct support hardware for metal duct is constructed of same material as duct, and for non-metal duct, type 316 stainless steel.

3.2.13. Where flanged duct joints are used, do not locate joints in wall or slab openings, or immediately at wall or slab openings. Do not use flanged joints for exposed uninsulated ducts in finished areas.

3.2.14. Where watertight horizontal ductwork is required, construct ducts without bottom longitudinal seams. Solder or weld joints of bottom and side sheets. Seal all other joints with duct sealer. Slope horizontal duct to hoods, risers, or drain points. Provide drain points. Provide watertight ductwork for:

a) ductwork outside building or otherwise exposed to the elements;

b) shower exhaust ducts from grilles to duct main or riser;

c) minimum of 3 m (10') upstream and downstream of duct mounted humidifiers or humidifier manifolds;

d) fresh air intakes;

e) wherever else shown.

3.2.15. Seal all ductwork in accordance with SMACNA Seal Class "A", except for round duct with self-sealing gasketed fittings and couplings which does not require site applied sealant. Apply sealants by brush or gun to cleaned metal surfaces. Where bare ductwork is exposed apply neat uniform lines of sealant. Randomly brushed, sloppy looking sealant applications will be rejected and must be repaired or replaced with a neat application of sealant.

3.2.16. Apply sealants by brush or gun to cleaned metal surfaces. Where bare ductwork is exposed apply neat uniform lines of sealant. Randomly brushed, sloppy looking sealant applications will be rejected and must be repaired or replaced with a neat application of sealant.

3.2.17. Clean exterior exposed (uninsulated) ducts and coat with a heavy full coverage of Bakor #410-02 or approved equivalent, black metal paint or approved equivalent.

3.2.18. Where dissimilar metal ducts are to be connected, isolate ducts by means of flexible duct connection material.

3.3. INSTALLATION OF ALUMINUM DUCTWORK

3.3.1. Provide aluminum ductwork, rectangular or round.

3.3.2. Provide aluminium ductwork for:

a) locker/shower room;

b) high relative humidity room exhaust.

3.3.3. Wherever bare aluminum ductwork comes in contact with ferrous metal or copper, paint ferrous metal or copper surface with a heavy, 100% covering coat of zinc chromate paint, asphalt paint or otherwise isolate direct contact with the bare aluminum.

3.3.4. Refer to "Commentary on Aluminum Ducts" in ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, however, do not use drive and S cleats for joining waterproof aluminum ductwork. Use following SMACNA joining methods:

a) T-21 - welded flange;

b) T-22 - companion angle and gasket;

c) T-24A - flanged.

3.3.5. Keep longitudinal joints at top surface of horizontal runs. Provide proper transverse supports to prevent deflection. Ensure duct is rigid.

3.3.6. When mastic is used for sealing such as sealing longitudinal joints, apply mastic to both surfaces before they are mated. When dry, apply mastic again for a water-tight seal.

3.4. INSTALLATION OF FLEXIBLE DUCTWORK

3.4.1. Provide maximum 3 m (10') long lengths of flexible ductwork for connections between galvanized steel duct mains and branches, and necks of ceiling grilles and diffusers. Do not install flexible ductwork through walls, even if shown on drawings.

3.4.2. At rectangular galvanized steel duct, accurately cut holes and provide flanged or "Spin-in" round flexible duct connection collars. Seal joints with duct sealer.

3.4.3. Install flexible ducts as straight as possible and support in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, and secure at each end with nylon or stainless steel gear type clamps, and seal joints. Provide long radius duct bends where they are required.

3.4.4. Do not penetrate fire barriers with flexible duct.

3.5. INSTALLATION OF ACOUSTIC LINING

3.5.1. Provide acoustic lining in ductwork in locations as follows:

a) wherever shown and/or specified on drawings;

b) supply ductwork downstream of air terminal boxes for a distance of 2.4 m (8') measured along duct and outward from box in all directions;

c) all transfer air ducts.

3.5.2. Install lining in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, however, for all installations regardless of velocity, at leading and trailing edges of duct liner sections, provide galvanized steel nosing channel in accordance with detail entitled Flexible Duct Liner Installation found in the ANSI/SMACNA manual referred to above.

3.6. INSTALLATION OF FIRE RATED DUCTWORK

3.6.1. Provide minimum 2 hour fire rated ductwork, but with increased fire rating where required to comply with local governing code and authority requirements for specific applications.

3.6.2. Install ductwork in strict accordance with duct manufacturer's instructions using support hardware supplied with duct.

3.6.3. When installation is complete, arrange, and pay for duct manufacturer to visit site and examine duct installation. Make any revisions requested by manufacturer, and when manufacturer is satisfied with installation, obtain and submit a letter certifying proper installation in accordance with ULC requirements.

3.7. INSTALLATION OF IN-SLAB DUCTWORK

3.7.1. Provide in-slab concrete encased ductwork, complete with required fittings and accessories.

3.7.2. Install duct with support brackets supplied with duct and coordinated with location of reinforcing steel, post tensioning cables, and any other structural slab component. Install duct in strict accordance with manufacturer's installation instructions and requirements of Consultant. Ensure all joints are water-tight.

3.7.3. Confirm finish of exterior discharge fittings with Consultant prior to ordering.

3.8. INSTALLATION OF CASINGS AND PLENUMS

3.8.1. Provide required shop or site fabricated casings and plenums. Unless otherwise specified or shown, construct casings and plenums of same material as connecting duct system.

3.8.2. Construct and install casings and plenums in accordance with Chapter 6 of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit systems' pressure classification. Ensure plenums and casings secured to building structure are gasketed air-tight and equipped with angle reinforcing.

3.8.3. Provide drain pans with accessible trapped drains for fresh air intake plenums, and wherever else shown.

3.9. INSTALLATION OF ACOUSTIC PANELS

3.9.1. Provide acoustic panels for plenums. Integrate acoustic plenums with standard casings and plenums. Install acoustic panels in strict accordance with manufacturer's instructions. Seal panels with acoustic caulking where pipes, ducts or conduit penetrate and make air and watertight.

3.9.2. Provide floor to ceiling high acoustic plenums where shown, each complete with required framing, including framing for access doors and other openings, each structurally designed to resist excessive deflection or bowing, constructed to be air-tight when subjected to a pressure differential of 2.48 kPa (0.36 psi), and designed so any one panel can be removed without dismantling entire plenum.

3.9.3. Provide acoustic type access doors where shown, and provide acoustic caulking at all locations where acoustic plenums abut building walls or slabs, and at all points where pipe, ducts or conduit penetrate acoustic panels.

3.10. INSTALLATION OF CASING AND PLENUM ACCESS DOORS

3.10.1. Provide access doors into all site or shop fabricated casings and plenums requiring access, and wherever shown.

3.10.2. Construct access doors to open in or out to suit positive and negative pressures of system.

3.10.3. Provide pitot tube openings in access doors where required for system air quantity balancing purposes.

3.10.4. Provide suitably sized, engraved, red-white laminated Lamacoid warning nameplates on access doors into casings and plenums where equipment is located, i.e. fans.

3.11. INSTALLATION OF ROUND TO RECTANGULAR DUCT CONNECTIONS

3.11.1. Cut round holes in rectangular ducts and provide round to rectangular lock-in fittings with dampers for connection of flexible round ductwork.

3.12. INSTALLATION OF SPLITTER DAMPERS

3.12.1. Provide splitter dampers in supply ductwork at branch duct connections off supply air mains, and wherever else shown and/or specified on drawings. Install splitter dampers so they cannot vibrate and rattle and so damper operation mechanisms are in an easily accessible and operable location. Ensure operators for dampers in insulated ducts are equipped with stand-off mounting brackets.

3.13. INSTALLATION OF TURNING VANES

3.13.1. Provide turning vanes in ductwork elbows where shown on drawings and wherever else required where, due to site installation routing and duct elbow radius, turning vanes are recommended in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.

3.13.2. Provide volume extractor type turning vanes in short branch supply duct connections off mains to grilles and diffusers where shown and/or specified.

3.14. INSTALLATION OF MANUAL BALANCING (VOLUME) DAMPERS

3.14.1. Provide manual balancing dampers as required to provide a fully balanced system, including but not limited to in all open end ductwork, in all duct mains, and wherever else shown and/or specified.

3.14.2. Install dampers so operating mechanism is accessible and positioned for easy operation, and so dampers cannot move or rattle. Ensure operating mechanisms for dampers in insulated ducts are complete with stand-off mounting brackets.

3.14.3. Confirm exact damper locations with personnel doing air quantity balancing testing work and install dampers to suit. Include for providing 5 additional dampers at no additional cost.

3.15. INSTALLATION OF BACKDRAFT DAMPERS

3.15.1. Provide backdraft dampers.

3.15.2. Install and secure dampers so they cannot move or rattle.

3.16. INSTALLATION OF FUSIBLE LINK DAMPERS

3.16.1. Provide fusible link dampers. Ensure damper rating (1-½ or 3 hr.) is suitable for fire barrier it is associated with.

3.16.2. Install dampers with retaining angles on all 4 sides of sleeve on both sides of damper and connect with ductwork in accordance with damper manufacturer's instructions and details, and Code requirements.

3.16.3. Provide expansion clearance between damper or damper sleeve and opening in which damper is required. Ensure openings are properly sized and located, and all voids between damper sleeve and opening are properly sealed to maintain rating of fire barrier.

3.17. INSTALLATION OF COMBINATION FIRE/SMOKE DAMPERS

3.17.1. Provide combination fire/smoke dampers. Install dampers with retaining angles on all 4 sides of each side of damper, and, where required, connect with ductwork, all in accordance with damper manufacturer's instructions and details, and Code requirements.

3.17.2. Coordinate damper installation with electrical work where electrical connections to damper actuators are specified.

3.18. INSTALLATION OF SMOKE DAMPERS

3.18.1. Provide smoke dampers. Install dampers with retaining angles on all four sides of sleeve on both sides of damper and connect with ductwork in accordance with damper manufacturer's instructions and details, and Code requirements.

3.18.2. Coordinate damper installation with electrical work where electrical connections to damper actuators are specified.

3.19. INSTALLATION OF FLEXIBLE CONNECTION MATERIAL

3.19.1. Provide a minimum of 100 mm (4") of flexible connection material where ducts, plenums, and/or easings connect to fans, and wherever else shown or specified.

3.19.2. Rigidly secure a minimum of 75 mm (3") of duct material (minimum #24 gauge) to each edge of flexible fabric and to fan, duct, plenum, etc., in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible. Ensure connections to flexible fabric material are arranged and supported so as to not impose any external forces on the fabric.

3.19.3. For system of boiler flue use high temperature flameproof flexible connection material.

3.20. INSTALLATION OF ROOF MOUNTED DUCT SUPPORTS

3.20.1. Supply supports for roof mounted ductwork.

3.20.2. Hand adjustable structural supports to roofing trade on roof for installation and flashing into roof construction as part of roofing work. Accurately mark exact locations and spacing of structural supports and supervise installation. Provide properly sized hot dip galvanized structural steel angles between structural supports and secure in place on support studs. Support ductwork on the angles and provide galvanized steel banding to secure ducts to the angles.

3.20.3. Accurately mark location and spacing of roof support assemblies. At each plastic base location, carefully scrape away loose roof ballast (gravel) and all other debris and dirt. Prime existing membrane with a primer which is compatible with existing roofing components. Set bases in adhesive in accordance with manufacturer's installation instructions. Scrape loose ballast back around and on bases. Install framing, and install ductwork on the cross-members. Secure ductwork to cross-members with galvanized steel banding.

3.21. INSTALLATION OF DUCT ACCESS DOORS

3.21.1. Provide access doors in ductwork for access to all components which will or may need maintenance and/or repair, including reheat coils. Install in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.

3.21.2. Identify access doors provided for fusible link damper maintenance with "FLD" stencil painted or marker type red lettering and ensure doors are properly located for damper maintenance.

3.21.3. When requested, submit a sample of proposed duct access doors for review.

3.21.4. Where sectionalized fusible link dampers and/or balancing dampers are provided in large ducts, provide a plenum type access door to suit, and adequately reinforce ductwork to suit access door installed.

3.22. INSTALLATION OF INSTRUMENTS TEST PORTS

3.22.1. Provide instrument test ports in all main ducts at connections to fans, plenums or casings, in all larger branch duct connections to mains, and wherever else required for proper air quantity balancing and testing.

3.22.2. Locate test ports where recommended by personnel performing air quantity testing and balancing work.

3.23. INSTALLATION OF WIRE MESH (BIRDSCREEN)

3.23.1. Provide framed, removable wire mesh panels over openings in ducts and/or walls where shown and/or specified on drawings. Rigidly secure in place but ensure panels are removable.

3.23.2. Provide wire mesh panels for open-end return air ducts in ceiling spaces whether shown on drawings or not.

3.24. INSTALLATION OF LOUVRES

3.24.1. Provide louvres for wall openings.

3.24.2. Install louvre assemblies and secure in place in accordance with manufacturer's instructions and details.

3.24.3. Confirm exact louvre sizes and finish prior to ordering.

3.25. INSTALLATION OF FIRE STOP FLAPS AND THERMAL BLANKETS

3.25.1. Provide fire stop flaps in duct connection necks of grilles and diffusers installed in ULC fire rated suspended ceiling systems where shown on drawings.

3.25.2. Provide thermal blanket material to completely cover grille and/or diffuser pans above suspended ULC fire rated ceilings. Cut, install, and secure in place in accordance with manufacturer's instructions and ULC requirements.

3.26. INSTALLATION OF GRILLES, DIFFUSERS AND REGISTERS

3.26.1. Provide grilles, diffusers and registers. Wherever possible, grilles, diffusers and registers are to be product of same manufacturer.

3.26.2. Unless otherwise specified connect grilles, diffusers and registers in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible.

3.26.3. Exactly locate grilles, diffusers and registers to conform to final architectural reflected ceiling plans and detailed wall elevations, and to conform to final lighting arrangement, ceiling layout, ornamental and other wall treatment.

3.26.4. Equip supply diffusers having a basic 4-way or all round air pattern for operation in 1-, 2-, or 3-way pattern where indicated on drawings.

3.26.5. Attach troffer type diffusers associated with typical ceiling mounted fluorescent lighting fixtures to the fixtures on floor prior to fixture installation in ceiling. When fixtures are installed, connect diffuser boots with flexible ductwork.

3.26.6. Provide sheet metal plenums, constructed of same material as connecting duct, for linear grilles and/or diffusers and registers where required. Construct and install plenums in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible. Where individual sections of linear grilles, diffusers and registers are not equipped with a volume control device, equip duct connection collar(s) with volume control device(s).

3.26.7. Where linear type grilles, diffusers and registers are installed in suspended T-bar ceilings, clip grilles, diffusers and registers in place using clip supplied by grilles, diffusers and registers manufacturer.

3.26.8. Confirm grilles, diffusers and registers finishes prior to ordering.

3.27. SUPPLY OF DOOR GRILLES

3.27.1. Supply door grilles as shown and scheduled.

3.27.2. Hand grilles to appropriate trade at site for installation.

3.28. INSTALLATION OF ROOF MOUNTED GRAVITY VENTILATORS

3.28.1. Provide roof mounted gravity ventilators.

3.28.2. Supply a roof mounting curb with each ventilator and hand curbs to roofing trade on roof for mounting and flashing into roof construction as part of the roofing work. Site assemble gravity ventilators as required, and secure in place on curbs.

3.28.3. Install dampers in curb damper tray and secure in place.

3.29. DUCT SYSTEM PROTECTION, CLEANING AND START-UP

3.29.1. Temporarily cover all open ends of ducts during construction.

3.29.2. Remove all dirt and foreign matter from entire duct systems and clean duct system terminals and interior of air handling units prior to operating fans.

3.29.3. Prior to starting any supply air handling system provide 50 mm (2") thick glass fibre construction filters at fan equipment in place of permanent filters.

3.29.4. Provide cheesecloth over duct system inlets and outlets and run system for 24 hours, after which remove cheesecloth and construction filters, and install new permanent filters.

3.29.5. Include all labour for a complete site walk-through with testing and balancing personnel following route of all duct systems to be tested, adjusted and balanced for the purpose of confirming proper position and attitude of dampers, location of pitot tube openings, and any other work affecting testing and balancing procedures. Perform corrective work required as a result of this walk-through.

END OF SECTION