

## **Part 1 General**

### **1.1 SUMMARY**

- .1 TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for air distribution systems.
- .2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.

### **1.2 QUALIFICATIONS OF TAB PERSONNEL**

- .1 Submit names of personnel to perform TAB to Consultant within 30 days of award of contract.
- .2 Provide documentation confirming qualifications, successful experience.
- .3 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:
  - .1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.
  - .2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-1998.
  - .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing-2002.
- .4 Recommendations and suggested practices contained in the TAB Standard: mandatory.
- .5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.
- .6 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.
- .7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.
- .8 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.
  - .1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.
  - .2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

### **1.3 PURPOSE OF TAB**

- .1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads
- .2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.
- .3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

### **1.4 EXCEPTIONS**

- .1 TAB of systems and equipment regulated by codes, standards to satisfaction of authority having jurisdiction.

### **1.5 CO-ORDINATION**

- .1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule to ensure completion before acceptance of project.
- .2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

### **1.6 START-UP**

- .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
- .2 Follow special start-up procedures specified elsewhere in Division 23.

### **1.7 OPERATION OF SYSTEMS DURING TAB**

- .1 Operate systems for length of time required for TAB and as required by Consultant for verification of TAB reports.

### **1.8 START OF TAB**

- .1 Notify Consultant 7 days prior to start of TAB.
- .2 Start TAB when building is essentially completed, including:
- .3 Installation of ceilings, doors, windows, other construction affecting TAB.
- .4 Application of weather stripping, sealing, and caulking.
- .5 Pressure, leakage, other tests specified elsewhere Division 23.
- .6 Provisions for TAB installed and operational.

- .7 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:

- .1 Proper thermal overload protection in place for electrical equipment.
- .2 Air systems:
  - .1 Filters in place, clean.
  - .2 Duct systems clean.
  - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
  - .4 Correct fan rotation.
  - .5 Fire, smoke, volume control dampers installed and open.
  - .6 Coil fins combed, clean.
  - .7 Access doors, installed, closed.
  - .8 Outlets installed volume control dampers open.

## **1.9 APPLICATION TOLERANCES**

- .1 Do TAB to following tolerances of design values:
  - .1 HVAC systems: plus 5 %, minus 5 %.

## **1.10 ACCURACY TOLERANCES**

- .1 Measured values accurate to within plus or minus 2 % of actual values.

## **1.11 INSTRUMENTS**

- .1 Prior to TAB, submit to Consultant list of instruments used together with serial numbers.
- .2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.
- .3 Calibrate within 3 months of TAB. Provide certificate of calibration to Consultant.

## **1.12 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit, prior to commencement of TAB:
- .2 Proposed methodology and procedures for performing TAB if different from referenced standard.

## **1.13 PRELIMINARY TAB REPORT**

- .1 Submit for checking and approval of Consultant, prior to submission of formal TAB report, sample of rough TAB sheets. Include:
  - .1 Details of instruments used.
  - .2 Details of TAB procedures employed.
  - .3 Calculations procedures.

.4 Summaries.

**1.14 TAB REPORT**

- .1 Format in accordance with referenced standard.
- .2 TAB report to show results in SI units and to include:
  - .1 Project record drawings.
  - .2 System schematics.
- .3 Submit 3 copies of TAB Report to Consultant for verification and approval, in English in D-ring binders, complete with index tabs.

**1.15 VERIFICATION**

- .1 Reported results subject to verification Consultant.
- .2 Provide personnel and instrumentation to verify up to 30 % of reported results.
- .3 Number and location of verified results as directed by Consultant.
- .4 Pay costs to repeat TAB as required to satisfaction of Consultant.

**1.16 SETTINGS**

- .1 After TAB is completed to satisfaction of Consultant, replace drive guards, close access doors, lock devices in set positions, and ensure sensors are at required settings.
- .2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

**1.17 COMPLETION OF TAB**

- .1 TAB considered complete when final TAB Report received and approved by Consultant.

**1.18 AIR SYSTEMS**

- .1 Standard: TAB standards of AABC
- .2 Do TAB including, but not limited to the following systems, equipment, components, and controls:
  - .1 Air Velocity
  - .2 Static pressure
  - .3 Velocity pressure
  - .4 Temperature
  - .5 Cross Sectional Area
  - .6 RPM
  - .7 Election power
    - .1 Voltage
    - .2 Current draw.

- .8 Location of equipment measurements:
  - .1 Inlet and outlet of each:
    - .1 Fan
    - .2 Coil
    - .3 Filter
    - .4 Damper
    - .5 Other auxiliary equipment
- .3 Qualifications: personnel performing TAB current member in good standing of AABC qualified to standards of AABC.
- .4 Quality assurance: perform TAB under direction of supervisor qualified to standards of AABC.
- .5 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .6 Locations of equipment measurements: to include as appropriate:
  - .1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.
  - .2 At controllers, controlled device.
- .7 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

#### **1.19 OTHER TAB REQUIREMENTS**

- .1 General requirements applicable to work specified this paragraph:
  - .1 Qualifications of TAB personnel: as for air systems specified this section.
  - .2 Quality assurance: as for air systems specified this section.
- .2 Building pressure conditions:
  - .1 Adjust HVAC systems, equipment, controls to ensure specified building pressure conditions at all times design conditions.
  - .2 TAB procedures:
    - .1 Perform measurement of each system, then adjust to maintain overall net building positive airflow of 2 % over return/exhaust.

#### **1.20 POST-OCCUPANCY TAB**

- .1 Participate in systems checks twice during Warranty Period - #1 approximately 3 months after acceptance and #2 within 1 month of termination of Warranty Period.

**Part 2        Products**

**2.1        NOT USED**

.1        Not used.

**Part 3        Execution**

**3.1        Air balance required in CFM office space on drawings.**

**END OF SECTION**

**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 23 31 13.01 METAL DUCTS - LOW PRESSURE TO 500 PA.

**1.2 REFERENCES**

- .1 Definitions:
  - .1 For purposes of this section:
    - .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
    - .2 "EXPOSED" - means "not concealed" as previously defined.
    - .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.
  - .2 TIAC Codes:
    - .1 CRD: Code Round Ductwork,
    - .2 CRF: Code Rectangular Finish.
- .2 Reference Standards:
  - .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
    - .1 ANSI/ASHRAE/IESNA 90.1-04, SI; Energy Standard for Buildings except Low-Rise Residential Buildings.
  - .2 ASTM International Inc.
    - .1 ASTM B209M-07, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
    - .2 ASTM C335-05ae1, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
    - .3 ASTM C411-05, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
    - .4 ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
    - .5 ASTM C547-07e1, Standard Specification for Mineral Fiber Pipe Insulation.
    - .6 ASTM C553-02e1, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
    - .7 ASTM C612-04e1, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
    - .8 ASTM C795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

- .9 ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .10 ASTM C1136-12 Standard Specification for Flexible, Low Performance Vapor Retarders for Thermal Insulation.
- .11 ASTM C1290-11, Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC ducts.
- .3 Canadian General Standards Board (CGSB)
  - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
  - .2 CAN/GSB 51.10-92, Mineral Fibre Board Thermal Insulation.
  - .3 CAN/CGSB 51.11-92, Mineral Fibre Blanket Thermal Insulation.
- .4 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).
- .5 Underwriters Laboratories of Canada (ULC)
  - .1 CAN/ULC-S102-03, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
  - .2 CAN/ULC-S701-05, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

### 1.3 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 00 02 - Standard General Requirements.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and datasheets for duct insulation, and include product characteristics, performance criteria, physical size, finish and limitations.
    - .1 Description of equipment giving manufacturer's name, type, model, year and capacity.
    - .2 Details of operation, servicing and maintenance.
    - .3 Recommended spare parts list.
- .3 Shop Drawings:
  - .1 Submit all materials to be used in this section to 1.2.1.1.3 above
- .4 Manufacturers' Instructions:
  - .1 Provide manufacture's written duct insulation jointing recommendations. And special handling criteria, installation sequence, cleaning procedures.



## **1.4 QUALITY ASSURANCE**

- .1 Qualifications:
  - .1 Installer: specialist in performing work of this section, and have at least 3 years successful experience in this size and type of project, qualified to standards member of TIAC.

## **1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle in accordance with Section 01 00 02 - Standard General Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address and ULC markings.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets crates padding packaging materials in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

## **Part 2 Products**

### **2.1 SUSTAINABLE REQUIREMENTS**

- .1 Materials and products in accordance with Section 01 35 21 – LEED Requirements: Construction.

### **2.2 FIRE AND SMOKE RATING**

- .1 To CAN/ULC-S102:
  - .1 Maximum flame spread rating: 25.
  - .2 Maximum smoke developed rating: 50.

### **2.3 INSULATION**

- .1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code C-1: Rigid mineral fibre duct board to ASTM C612 and CGSB 51-GP-10M, minimum R value R4 per inch. Plastic corner bead glued and taped with metallic tape on all corner and edges for mechanical room ducts, plenums and exposed ductwork. Insulation with FSK facing to ASTM A1136 and factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section). Cover all exposed plenum and duct insulation from exterior to equipment with 1577CW aluminium Venture Clad Jacketing system.
- .4 TIAC Code C-2: Mineral fibre blanket to ASTM C553 faced with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).
  - .1 Mineral fibre: to ASTM C553.

- .2 Jacket: to CGSB 51-GP-52Ma.
- .3 Maximum "k" factor: to ASTM C553.

## **2.4 ACCESSORIES**

- .1 Tape: self adhesive, 100 mm wide, aluminum, ULC labelled for less than 25 flame spread and less than 50 smoke developed.
  - .1 Acceptable Manufacturer (or approved equal):
    - .1 Fattal Insultape by S. Fattal Canvas Inc.
- .2 Contact adhesive: quick-setting
  - .1 Asbestos free
  - .2 5m<sup>2</sup>/L
  - .3 Acceptable Manufacturer (or approved equal):
    - .1 Armstrong 520
    - .2 Childers CP.82
    - .3 Forster 85-20
- .3 Lap Seal adhesive: quick-setting for joints and lap sealing of vapour barriers. Water based, fire retardant type, compatible with insulation.
  - .1 Asbestos Free
  - .2 6 m<sup>2</sup>/L
  - .3 Acceptable Manufacturer (or approved equal):
    - .1 Childers CP.80
    - .2 Forster 85-75
- .4 Pins.
  - .1 Weld pins 4 mm diameter, with 35 mm diameter head for installation through insulation. Length to suit thickness of insulation.
  - .2 Acceptable Manufacturer (or approved equal):
    - .1 Duro Dyne
    - .2 Clip-Pin
  - .3 Weld pins, 2 mm diameter, for installation prior to applying insulation. Length to suit thickness of insulation. Nylon retains clips 32 mm square.
  - .4 Acceptable Manufacturer (or approved equal):
    - .1 Duro Dyne spotter pins with spotter clips or stop clips as required
  - .5 Stick on pins will not be accepted.

## **2.5 JACKETS**

- .1 CRD-1:
  - .1 Apply in exposed areas on rigid duct insulation only: Venture Clad 1577 CW.

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**Part 3      Execution**

**3.1      APPLICATION**

- .1      Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

**3.2      PRE-INSTALLATION REQUIREMENTS**

- .1      Pressure test ductwork systems complete, witness and certify.
- .2      Ensure surfaces are clean, dry, and free from foreign material.

**3.3      INSTALLATION**

- .1      Install in accordance with TIAC National Standards.
- .2      Install in accordance with ANSI/NFPA 90A and ANSI/NFPA 90B
- .3      Apply materials in accordance with manufacturer's instructions and as indicated.
- .4      Use 2 layers with staggered joints when required nominal thickness exceeds 75 mm.
- .5      Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
  - .1      Ensure hangers, and supports are outside vapour retarder jacket.
- .6      Hangers and supports in accordance with Section 22 05 29 - Hangers and Supports for HVAC Piping and Equipment.
  - .1      Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .7      Fasteners: install at 300 mm on centre in horizontal and vertical directions, minimum 2 rows each side.
- .8      Use stand-offs for duct mounted control accessories.
- .9      Apply 1mm thick galvanized sheet metal corners to ductwork in mechanical rooms.

### 3.4 DUCTWORK INSULATION SCHEDULE (NEW DUCTWORK ONLY)

- .1 Insulation types and thicknesses: conform to following table:

| Duct:  | TIAC Code | Vapour Retarder | Thickness (mm) | Finish |
|--|-----------|-----------------|----------------|--------|
| Fresh air intake from intake louver to AHU and exhaust ductwork from AHU or fan to exhaust louver. | C-1       | yes             | 50             | CRD-1  |
| All exhaust ducts from fans to exhaust louvers.  | C-1       | yes             | 50             | CRD-1  |
| Intake and Exhaust plenums.  | C-1       | yes             | 75             | CRD-1  |
| Exhaust duct 20ft from exterior  | C-1       | yes             | 25             |        |

### 3.5 CLEANING

- .1 Clean in accordance with Section 01 00 02 - Standard General Requirements.
- .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal

**END OF SECTION**

**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 23 07 13 - DUCT INSULATION.
- .2 Section 23 33 00 - AIR DUCT ACCESSORIES.

**1.2 REFERENCES**

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
- .2 ASTM International
  - .1 ASTM A480/A480M-12, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
  - .2 ASTM A635/A635M-09b, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.
  - .3 ASTM A653/A653M-11, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3 National Fire Protection Association (NFPA)
  - .1 NFPA 90A-12, Standard for the Installation of Air-Conditioning and Ventilating Systems.
  - .2 NFPA 90B-12, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
  - .3 NFPA 96-11, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
  - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.
  - .2 SMACNA HVAC Air Duct Leakage Test Manual, 2012.
  - .3 IAQ Guideline for Occupied Buildings Under Construction 2007.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 00 02 - Standard General Requirements.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for metal ducts and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:

- .1 Submit drawings for all duct metal and fittings.
- .2 Submit duct installation drawings indicating coordination with other trades.
- .4 Test and Evaluation Reports:
  - .1 Certification of Ratings:
    - .1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .5 Sustainable Design Submittals:
  - .1 Construction Waste Management:
    - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.
    - .2 Submit calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating that required % of construction wastes were recycled or salvaged.
  - .2 Recycled Content:
    - .1 Submit listing of recycled content products used, including details of required percentages or recycled content materials and products, showing their costs and percentages of post-consumer post-industrial content, and total cost of materials for project.
  - .3 Regional Materials: submit evidence that project incorporates required percentage % of regional materials and products, showing their cost, distance from project to furthest site of extraction or manufacture, and total cost of materials for project.
  - .4 Construction IAQ Management Plan:
    - .1 Submit Indoor Air Quality (IAQ) Plan for construction pre-occupancy phases of building.
    - .2 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings Under Construction.

#### **1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 00 02 - Standard General Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect metal ducts from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

## **Part 2 Products**

### **2.1 ROUND DUCTWORK**

- .1 Shall be spiral type with flat seam.

### **2.2 SEAL CLASSIFICATION**

- .1 Classification as follows:

| Maximum Pressure Pa | SMACNA Seal Class |
|---------------------|-------------------|
| 500                 | C                 |
| 250                 | C                 |
| 125                 | C                 |

- .2 Seal classification:

- .1 Class C: transverse joints and connections made air tight with gaskets, sealant tape, or combination thereof. Longitudinal seams unsealed.

### **2.3 SEALANT**

- .1 Seal all ductwork
- .2 Sealant: water soluble, flexible, non toxic. Sealant to be used with woven fabric tape. Temperature range of minus 20 degrees C to plus 93 degrees C.
- .3 Maximum flame spread rating: 25
- .4 Smoke development rating: 50
- .5 Solvent based sealant will not be accepted.
- .6 Duct tape will not be accepted as primary sealant.
- .7 Acceptable Manufacturer (or approved equal).
  - .1 Transcontinental multipurpose
  - .2 United Metal Unigrip

### **2.4 TAPE**

- .1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide.
- .2 Acceptable Manufacturer (or approved equal).
  - .1 Duro Dyne FT-2

### **2.5 DUCT LEAKAGE**

- .1 In accordance with SMACNA HVAC Air Duct Leakage Test Manual.

## **2.6 FITTINGS**

- .1 Fabrication: to ASHRAE and SMACNA .
- .2 Radiused elbows:
  - .1 Rectangular: centreline radius: 1.5 times width of duct.
  - .2 Round: centreline radius: 1.5 times diameter.
- .3 Mitred elbows, rectangular:
  - .1 To 400 mm: with single thickness turning vanes.
  - .2 Over 400 mm: with double thickness turning vanes.
- .4 Branches:
  - .1 Rectangular main and branch: with 45 degrees entry on branch.
  - .2 Round main and branch: enter main duct at 45 degrees with conical connection.
  - .3 Provide volume control damper in branch duct near connection to main duct.
  - .4 Main duct branches: with splitter damper.
- .5 Transitions:
  - .1 Diverging: 20 degrees maximum included angle.
  - .2 Converging: 30 degrees maximum included angle.
- .6 Offsets:
  - .1 Short radiused elbows.
- .7 Obstruction deflectors: maintain full cross-sectional area.
  - .1 Maximum included angles: as for transitions.

## **2.7 FIRE STOPPING**

- .1 Retaining angles around duct, on both sides of fire separation in accordance with Section 07 84 00 - Fire Stopping.
- .2 Fire stopping material and installation must not distort duct.

## **2.8 GALVANIZED STEEL**

- .1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to ASHRAE and SMACNA.
- .3 Joints: to ASHRAE and SMACNA.



## 2.9 HANGERS AND SUPPORTS

- .1 Hangers and Supports: in accordance with Section 22 05 29 - Hangers and Supports for HVAC Piping and Equipment.
  - .1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.
    - .1 Maximum size duct supported by strap hanger: 500.
  - .2 Hanger configuration: to ASHRAE and SMACNA.
  - .3 Hangers: ~~black~~ galvanized steel angle with ~~black~~ galvanized steel rods to ASHRAE, SMACNA and the following table:
  - .4

| Duct Size<br>(mm) | Angle Size<br>(mm) | Rod Size<br>(mm) |
|-------------------|--------------------|------------------|
| up to 750         | 25 x 25 x 3        | 6                |
| 751 to 1050       | 40 x 40 x 3        | 6                |

- .5 Upper hanger attachments:
  - .1 For concrete: manufactured concrete inserts.
  - .2 For steel joist: manufactured joist clamp or steel plate washer.
  - .3 For steel beams: manufactured beam clamps:

## Part 3 Execution

### 3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for metal duct installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate
  - .2 Inform General Contractor of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied.

### 3.2 GENERAL

- .1 Do work in accordance with NFPA 90A, NFPA 90B, ASHRAE, SMACNA, and as indicated.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods.
  - .1 Insulate strap hangers 100 mm beyond insulated duct and Ensure diffuser is fully seated.
- .3 Support risers in accordance with ASHRAE and SMACNA and as indicated.
- .4 Install breakaway joints in ductwork on sides of fire separation.
- .5 Install fire dampers and fire stop flaps to NFPA 90A

- .6 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .7 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining where indicated.
- .8 Install balancing dampers at all branch ducts and as indicated.
- .9 Mount dampers according to damper manufacturer's recommendations.
- .10 At completion of project dents in exposed ductwork will not be accepted. Dented ductwork will result in the entire length being replaced by this contractor.

### 3.3 HANGERS

- .1 Strap hangers: install in accordance with SMACNA.
- .2 Angle hangers: complete with locking nuts and washers.
- .3 Hanger spacing: in accordance with ASHRAE SMACNA as follows:

| Duct Size<br>(mm) | Spacing<br>(mm) |
|-------------------|-----------------|
| to 1500           | 3000            |

### 3.4 WATERTIGHT DUCT

- .1 Provide watertight duct for:
  - .1 Fresh air intake.
  - .2 Minimum 3000 mm from duct mounted humidifier in all directions.
  - .3 As indicated.
- .2 Form bottom of horizontal duct without longitudinal seams.
  - .1 Weld joints of bottom and side sheets.
  - .2 Seal other joints with duct sealer.
- .3 Slope horizontal branch ductwork down towards fume hoods served.
  - .1 Slope header ducts down toward risers.
- .4 Fit base of riser with 150 mm deep drain sump and 32 mm drain connected, with deep seal trap and valve trap primer and discharging to open funnel drain as indicated.

### 3.5 SEALING AND TAPING

- .1 Apply sealant in accordance with SMACNA to manufacturer's recommendations.
- .2 All duct joints to be sealed with duct sealant and porous tape imbedded in sealant.
- .3 Bed tape in sealant and recoat with minimum of 2 coat of sealant to manufacturers recommendations.
- .4 Duct tape will not be accepted.

- .5 Do not insulate duct until sealant work is approved by Engineer.

### **3.6 LEAKAGE TESTS**

- .1 Refer to Section 23 05 94 - Pressure Testing of Ducted Air Systems.
- .2 In accordance with SMACNA HVAC Duct Leakage Test Manual.
- .3 Ductwork to be constructed to withstand 1-1/2 times working static pressure with leakage rate of 1.5% maximum and designed for less than 2" S.P. operating pressure
- .4 Do leakage tests in sections.
- .5 Make trial leakage tests as instructed to demonstrate workmanship.
- .6 Do not install additional ductwork until trial test has been passed.
- .7 Test section minimum of 30 m long with not less than three branch takeoffs and two 90 degrees elbows.
- .8 Complete test before performance insulation or concealment Work.

### **3.7 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 00 02 - Standard General Requirements.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 02 - Standard General Requirements.
- .3 Waste Management: separate waste materials for reuse recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 23 31 13 – Metal Ducts – Low Pressure to 500 PA.

**1.2 REFERENCES**

- .1 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
  - .1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 2005.

**1.3 SUBMITTALS**

- .1 Submit in accordance with Section 01 00 02 - Standard General Requirements.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for air duct accessories and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Indicate:
    - .1 Flexible connections.
    - .2 Duct access doors.
    - .3 Turning vanes.
    - .4 Instrument test ports.
    - .5 Dangers

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 00 02 - Standard General Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect air duct accessories from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

## **Part 2 Products**

### **2.1 GENERAL**

- .1 Manufacture in accordance with SMACNA - HVAC Duct Construction Standards.

### **2.2 FLEXIBLE CONNECTIONS**

- .1 Frame: galvanized sheet metal frame 2 mm thick with fabric clenched by means of double locked seams.
- .2 Material:
  - .1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40 degrees C to plus 90 degrees C, density of 1.3 kg/m<sup>2</sup>.

### **2.3 ACCESS DOORS IN DUCTS**

- .1 Non-Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.
- .2 Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.
- .3 Gaskets: neoprene foam rubber.
- .4 Hardware:
  - .1 Up to 300 x 300 mm: two sash locks complete with safety chain.
  - .2 301 to 450 mm: four sash locks complete with safety chain.
  - .3 451 to 1000 mm: piano hinge and minimum two sash locks.
  - .4 Doors over 1000 mm: piano hinge and two handles operable from both sides.
  - .5 Hold open devices.
  - .6 300 x 300 mm glass viewing panels.

### **2.4 TURNING VANES**

- .1 Factory or shop fabricated single thickness or double thickness with trailing edge, to recommendations of SMACNA and as indicated.

### **2.5 INSTRUMENT TEST**

- .1 1.6 mm thick steel zinc plated after manufacture.
- .2 Cam lock handles with neoprene expansion plug and handle chain.
- .3 28 mm minimum inside diameter. Length to suit insulation thickness.
- .4 Neoprene mounting gasket.

## **2.6 SPIN-IN COLLARS**

- .1 Conical galvanized sheet metal spin-in collars with lockable butterfly damper.
- .2 Sheet metal thickness to co-responding round duct standards.

## **2.7 SINGLE BLADE BALANCING DAMPERS**

- .1 Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.
- .2 Size and configuration to recommendations of SMACNA, except maximum height as indicated 100 mm.
- .3 Locking quadrant with shaft extension to accommodate insulation thickness.
- .4 Inside and outside nylon or bronze end bearings.
- .5 Channel frame of same material as adjacent duct, complete with angle stop.

## **2.8 MULTI-BLADED BALANCING DAMPERS**

- .1 Factory manufactured of material compatible with duct.
- .2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.
- .3 Maximum blade height: as indicated 100 mm.
- .4 Bearings: pin in bronze bushings or self-lubricating nylon.
- .5 Linkage: shaft extension with locking quadrant.
- .6 Channel frame of same material as adjacent duct, complete with angle stop.
- .7 Maximum leakage: 2 % at 1000 Pa.

## **2.9 BACKDRAFT DAMPERS**

- .1 Automatic, gravity-operated, multi-blade, galvanized steel construction with nylon bearings centre-pivoted, spring assisted.

## **2.10 ACOUSTIC INSULATION**

- .1 Fiber free, non-particulating, formal-dehyde free, PDBE-free, low V.O.C. black flexible closed-cell elastomeric acoustic duct insulation, in sheet form for rectangular duct, and roll form for round duct, self-adhesive sheet, thickness shall be 1" unless noted otherwise.
- .2 Performance:
  - .1 Thermal conductivity: 0.25 BTU.in.hr.ft<sup>2</sup>.°F
  - .2 Water absorption: 0.2%
  - .3 Temperature range: -297°F to 180°F
  - .4 Resistant to 10,000 fpm air velocity without flaking.

- .3 Acceptable Material:
  - .1 Armacell "AP Armaflex"
  - .2 Approved Equal

## **Part 3 Execution**

### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for air duct accessories installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate
  - .2 Inform General Contractor of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied.

### **3.2 INSTALLATION**

- .1 Flexible Connections:
  - .1 Install in following locations:
    - .1 Inlets and outlets to supply air units and fans.
    - .2 Inlets and outlets of exhaust and return air fans.
    - .3 As indicated.
  - .2 Length of connection: 100 mm.
  - .3 Minimum distance between metal parts when system in operation: 75 mm.
  - .4 Install in accordance with recommendations of SMACNA.
  - .5 When fan is running:
    - .1 Ducting on sides of flexible connection to be in alignment.
    - .2 Ensure slack material in flexible connection.
- .2 Access Doors and Viewing Panels:
  - .1 Size:
    - .1 24" x 24" mm for person size entry.
    - .2 17" x 12" mm for servicing entry.
    - .3 6" x 6" mm for viewing.
    - .4 As indicated.
  - .2 Locations:
    - .1 Fire and smoke dampers.
    - .2 Control dampers.
    - .3 Devices requiring maintenance.

- .4 Required by code.
    - .5 Reheat coils.
    - .6 Elsewhere as indicated.
- .3 Instrument Test Ports:
  - .1 General:
    - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
  - .2 Locate to permit easy manipulation of instruments.
  - .3 Install insulation port extensions as required.
  - .4 Locations:
    - .1 For traverse readings:
      - .1 Ducted inlets to roof and wall exhausters.
      - .2 Inlets and outlets of other fan systems.
      - .3 Main and sub-main ducts.
      - .4 And as indicated.
    - .2 For temperature readings:
      - .1 At outside air intakes.
      - .2 In mixed air applications in locations as approved by Departmental Representative DCC Representative Consultant.
      - .3 At inlet and outlet of coils.
      - .4 Downstream of junctions of two converging air streams of different temperatures.
      - .5 And as indicated.
- .4 Turning Vanes:
  - .1 Install in accordance with recommendations of SMACNA and as indicated.

### 3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 02 - Standard General Requirements.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 02 - Standard General Requirements.



- .3 Waste Management: separate waste materials for reuse recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American National Standards Institute/Air Movement and Control Association (ANSI/AMCA)
  - .1 ANSI/AMCA Standard 99-2010, Standards Handbook.
  - .2 ANSI/AMCA Standard 210-2007/(ANSI/ASHRAE 51-07), Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
  - .3 ANSI/AMCA Standard 300-2008, Reverberant Room Method for Sound Testing of Fans.
  - .4 ANSI/AMCA Standard 301-1990, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .2 The Master Painters Institute (MPI)
  - .1 Architectural Painting Specification Manual - current edition.
    - .1 MPI #18, Primer, Zinc Rich, Organic.

**1.2 SUBMITTALS**

- .1 Submit in accordance with Section 01 00 02 - Standard General Requirements.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for HVAC fans and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Indicate:
    - .1 Motors, sheaves, bearings, shaft details.
    - .2 Minimum performance achievable with variable speed controllers variable inlet vanes as appropriate.

**1.3 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Extra Materials:
  - .1 Submit in accordance with Section 01 00 02 - Standard General Requirements.
    - .1 Provide:
      - .1 Matched spare sets of belts.
      - .2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:
        - .1 Bearings and seals.
        - .2 Addresses of suppliers.
        - .3 List of specialized tools necessary for adjusting, repairing or replacing.

#### **1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 00 02 - Standard General Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect HVAC fans from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

#### **1.5 STANDARD OF ACCEPTANCE**

- .1 Greenheck fans have been selected as standard of acceptance for this project. The following material will also be acceptable, provided the specifications are met: Penn, Acme.

### **Part 2 Products**

#### **2.1 SYSTEM DESCRIPTION**

- .1 Performance Requirements:
  - .1 Refer to fan schedule on ventilation drawing.

#### **2.2 INLINE FANS – BELT DRIVEN**

- .1 Belt-driven in line fan with galvanized steel housing with bolted access panels backward-inclined aluminum wheel, duct flanges, corrosion-resistant fasteners, NGMA1 toggle disconnect switch mounted in wired junction box.
- .2 Ball bearing motor with adjustable motor pulley and plate, for mounted in ball bearing pillow block, adjustable V-belt drive, and static resistant belts.
- .3 Electrics: All 120V/1Ph/60Pz unless noted otherwise.
- .4 Performance: As per fan schedule
- .5 Acceptable Material:
  - .1 Greenheck
  - .2 PENN
  - .3 ACME
  - .4 Approved Equal

**Part 3 Execution**

**3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for HVAC fans installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate.
  - .2 Inform General Contractor of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied.

**3.2 FAN INSTALLATION**

- .1 Provide sheaves and belts required for final air balance.
- .2 Bearings and extension tubes to be easily accessible.
- .3 Access doors and access panels to be easily accessible.

**3.3 ANCHOR BOLTS AND TEMPLATES**

- .1 Size anchor bolts to withstand seismic acceleration and velocity forces as specified.

**3.4 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 00 02 - Standard General Requirements.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 02 - Standard General Requirements.
- .3 Waste Management: separate waste materials for reuse recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 23 31 13 - . METAL DUCTS - LOW PRESSURE TO 500 PA

**1.2 REFERENCES**

- .1 American National Standards Institute/Air Movement and Control Association (ANSI/AMCA)
  - .1 ANSI/AMCA Standard 210-2007/ (ANSI/ASHRAE 51-07), Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
- .2 Canada Green Building Council (CaGBC)
  - .1 LEED Canada-NC Version 1.0-2004, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package for New Construction and Major Renovations (including Addendum 2007).
- .3 International Organization of Standardization (ISO)
  - .1 ISO 3741-2010, Acoustics-Determination of Sound Power Levels of Noise Sources Using Sound Pressure - Precision Methods for Reverberation Rooms.
- .4 National Fire Protection Association (NFPA)
  - .1 NFPA 90A-12, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .5 Underwriter's Laboratories (UL)
  - .1 UL 181-2005(R2008), Factory-Made Air Ducts and Air Connectors.

**1.3 SUBMITTALS**

- .1 Submit in accordance with Section 01 00 02 - Standard General Requirements.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for air terminal units and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Indicate the following:
    - .1 Capacity.
    - .2 Pressure drop.
    - .3 Noise rating.
    - .4 Leakage.

- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Test and Evaluation Reports:
  - .1 Test data: to ANSI/AMCA Standard 210.
    - .1 Submit published test data on DIN (Direct Internal Noise), in accordance with ISO 3741 made by independent testing agency for 0, 2.5 and 6 m/s branch velocity or inlet velocity.
    - .2 Sound power level with minimum inlet pressure 1 kPa in accordance with ISO 3741 for 2nd through 7th octave band, also made by independent testing agency.
    - .3 Pressure loss through silencer shall not exceed 60% of inlet velocity pressure maximum.

#### **1.4 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 00 02 - Standard General Requirements.
- .2 Operation and Maintenance Data: submit operation and maintenance data for air terminal units for incorporation into manual.

#### **1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 00 02 - Standard General Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect air terminal units from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

### **Part 2 Products**

#### **2.1 SYSTEM DESCRIPTION**

- .1 Performance Requirements:
  - .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from certified ADC (Air Diffusion Council) testing agency signifying adherence to codes and standards.

#### **2.2 MANUFACTURED UNITS**

- .1 Terminal units of the same type to be product of one manufacturer.

## **2.3 VARIABLE VOLUME BOXES**

- .1 Pressure independent factory reset to air flow between zero and maximum air volume.
- .2 Sizes, capacities, differential pressures and sound ratings: as indicated.
- .3 Differential pressure not to exceed 25 Pa at inlet air velocity of 10 m/s.
- .4 Sound ratings of assembly not to exceed 25 NC at 1000 Pa.
- .5 Complete with:
  - .1 Operator and controller: as specified under Section 25 05 01 - EMCS.
  - .2 Sound attenuator: included
  - .3 Multiport outlet adapter: as indicated.
  - .4 Reheat coil: as indicated; hydronic
  - .5 Pneumatic controller to operate damper operator between independent of maximum or minimum air volume settings:
- .6 Minimum 35 kPa reset span.
- .7 Adjustable reset start point.
- .8 Adjustable reset span to maximum 70 kPa when supplied with minimum 140 kPa main control air.
- .9 No control air bleed off through inlet sensor.
- .10 Operator to be factory mounted and calibrated:
  - .1 Gauge taps for balancing with standard pressure gauge.
  - .2 Controller to have adjustable flow settings.
- .11 Casing: constructed of thick galvanized steel, internally lined with 25 mm, 0.7 kg density fibrous glass, to UL181 NFPA 90A. Mount control components inside protective metal shroud.
- .12 Damper: thick galvanized steel with peripheral gasket and self lubricating bearings. Air leakage past closed damper not to exceed 2% of nominal rating at 750 Pa inlet static pressure, in accordance with Air Diffusion Council test procedure.

## **Part 3 Execution**

### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for air terminal unit's installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate.
  - .2 Inform General Contractor of unacceptable conditions immediately upon discovery.

- .3 Proceed with installation only after unacceptable conditions have been remedied.

### **3.2 INSTALLATION**

- .1 Install in accordance with manufacturers recommendations.
- .2 Support independently of ductwork.
- .3 Install with at least and minimum of eight duct diameters of straight inlet duct, same size as inlet.
- .4 Locate controls, dampers and access panels for easy access.

### **3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 00 02 - Standard General Requirements.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 02 - Standard General Requirements.

**END OF SECTION**



**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 23 31 13 - METAL DUCTS - LOW PRESSURE TO 500 PA.

**1.2 REFERENCES**

- .1 Not used.

**1.3 SUBMITTALS**

- .1 Submit in accordance with Section 01 00 02 - Standard General Requirements.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for diffusers, registers and grilles and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Indicate following:
    - .1 Capacity.
    - .2 Throw and terminal velocity.
    - .3 Noise criteria.
    - .4 Pressure drop.
    - .5 Neck velocity.

**1.4 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Extra Materials:
  - .1 Provide maintenance materials in accordance with Section 01 00 02 - Standard General Requirements.
  - .2 Include:
    - .1 Keys for volume control adjustment.
    - .2 Keys for air flow pattern adjustment.

**1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 00 02 - Standard General Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

- .2 Store and protect diffuser, registers and grilles from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

## **Part 2 Products**

### **2.1 SYSTEM DESCRIPTION**

- .1 Performance Requirements:
  - .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

### **2.2 GENERAL**

- .1 To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity as indicated.
- .2 Frames:
  - .1 Full perimeter gaskets.
  - .2 Plaster frames where set into plaster or gypsum board and as specified.
  - .3 Concealed fasteners.
- .3 Colour: standard as directed by Consultant.

### **2.3 MANUFACTURED UNITS**

- .1 Grilles, registers and diffusers of same generic type, products of one manufacturer.

### **2.4 SUPPLY GRILLES AND REGISTERS**

- .1 General: with opposed blade dampers.
- .2 Refer to diffuser schedule.

### **2.5 RETURN DIFFUSER AND EXHAUST GRILLES AND REGISTERS**

- .1 General: with opposed blade dampers.
- .2 Refer to diffuser schedule.

### **2.6 DIFFUSERS**

- .1 General: volume control dampers with flow straightening devices and blank-off quadrants and gaskets.

- .2 Refer to diffuser schedule.

## **Part 3 Execution**

### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for diffuser, register and grille installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate
  - .2 Inform General Contractor of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied.

### **3.2 INSTALLATION**

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

### **3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 00 02 - Standard General Requirements.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 02 - Standard General Requirements.
- .3 Waste Management: separate waste materials for reuse recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 ASTM International
  - .1 ASTM E90-09, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- .2 Canada Green Building Council (CaGBC)
  - .1 LEED Canada-NC Version 1.0-2004, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package for New Construction and Major Renovations (including Addendum 2007).
- .3 National Fire Protection Association (NFPA)
  - .1 NFPA 96-11, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
- .5 Society of Automotive Engineers (SAE)

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 00 02 - Standard General Requirements.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for louvers, intakes and vents and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Indicate following:
    - .1 Pressure drop.
    - .2 Face area.
    - .3 Free area.
- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Test Reports: submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E90.

**1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 00 02 - Standard General Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:

- .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Store and protect louvers, intakes and vents from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

## **Part 2 Products**

### **2.1 SYSTEM DESCRIPTION**

- .1 Performance Requirements:
  - .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

### **2.2 FIXED LOUVRES - ALUMINUM**

- .1 Greenheck K6774X or Approved equal.

## **Part 3 Execution**

### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for louvers, intakes and vents installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate
  - .2 Inform General Contractor of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied.

### **3.2 INSTALLATION**

- .1 In accordance with manufacturer's and SMACNA recommendations.
- .2 Reinforce and brace as indicated.
- .3 Anchor securely into opening. Seal with caulking to ensure weather tightness.

### **3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 00 02 - Standard General Requirements.

- .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 02 - Standard General Requirements.
- .3 Waste Management: separate waste materials for reuse recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American National Standards Institute/Air-Conditioning, Heating and Refrigeration Institute (ANSI/AHRI)
  - .1 ANSI/AHRI 430-10, Performance Rating of Central Station Air-Handling Units.
- .2 American National Standards Institute/American Society of Heating, Refrigeration and Air Condition Engineers/Illuminating Engineering Society (ANSI/ASHRAE/IES)
  - .1 ANSI/ASHRAE 52.2-2012, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
  - .2 ANSI/ASHRAE/IES 90.1-2010, Energy Standard for Buildings except Low-Rise Residential Buildings.

**1.2 SUBMITTALS**

- .1 Submit in accordance with Section 01 00 02 - Standard General Requirements.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for insulation, filters, adhesives, and paints and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Indicate on drawings: fan curves showing point of operation motor drive bearings filters mixing box dampers VAV coil; include performance data.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 00 02 - Standard General Requirements.
- .2 Operation and Maintenance Data: submit operation and maintenance data for air handling equipment for incorporation into manual.

**1.4 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Submit in accordance with Section 01 00 02 - Standard General Requirements.
- .2 Provide 1 spare set of filters.
- .3 Provide list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.

- .4 Spare filters: in addition to filters installed immediately prior to acceptance by Consultant, supply 1 complete set of filters for each filter unit or filter bank for owner's stock.

## **1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 00 02 - Standard General Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect air handling equipment from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

## **Part 2 Products**

### **2.1 AIR HANDLING UNITS – AHU-1**

- .1 **General**
  - .1 Air Handling Units shall be factory prefabricated systems, manufactured in sections to be assembled at site, to the requirements specified in this section and as indicated on the drawings.
  - .2 Units shall be constructed for single-side access to all components as indicated on the drawings.
- .2 **Unit Construction**
  - .1 Fabricate unit with heavy gauge channel posts and panels secured with mechanical fasteners. All panels, access doors, and ship sections shall be sealed with permanently applied bulb-type gasket.
  - .2 Panels and access doors shall be constructed as a 2-inch nominal thickness; thermally broken double wall assembly, injected with foam insulation with an R-value of not less than R-13.
  - .3 The inner liner shall be constructed of G90 galvanized steel.
  - .4 The outer panel shall be constructed of G90 galvanized steel.
  - .5 The floor plate shall be constructed as specified for the inner liner.
  - .6 A sound baffle shall be secured to the inner liner of selected fan, plenum, access, and manual sections. It shall be constructed of G90 galvanized perforated steel filled with 3 pound per cubic foot density, neoprene coated, glass fiber insulation.
  - .7 The casing leakage rate shall not exceed .5 cfm per square foot of cabinet area at 5 inches of positive static pressure or 6 inches of negative



static pressure (.0025 m3/s per square meter of cabinet area at 1.24 kPa static pressure).

- .8 Module to module field assembly shall be accomplished with an overlapping, full perimeter internal splice joint sealed with bulb type gasketing on both mating modules.
- .9 Access doors shall be flush mounted to cabinetry, with minimum of two six inch long stainless steel piano-type hinges, latch and full size handle assembly. Access doors shall swing outward for unit sections under negative pressure. Access doors on positive pressure sections, shall have a secondary latch.
- .10 A 6-inch formed G60 galvanized steel base rail shall be provided.

**.3 Fan Assemblies**

- .1 Supply fan assembly shall be double width, double inlet, belt-driven type, airfoil dynamically balanced as an assembly. Maximum fan RPM shall be below first critical fan speed. Fan assemblies shall be dynamically balanced by the manufacturer on all three planes and at all bearing supports. Lubrication lines shall be provided and extend from the bearings and attached with grease fittings to the fan base assembly near access door. Mount fans internally on a isolated steel base. Factory mount motor on slide base that can be slid out the side of unit if removal is required. Provide access to motor, drive, and bearings through hinged access door.

**.4 Cooling Coil**

- .1 As per schedule.

**.5 Filters**

- .1 As per schedule.

**.6 Electrical**

- .1 As per schedule.

**.7 AIR HANDLING UNIT – PERFORMANCE**

**See schedule on Drawing**

**.8 Acceptable Material:**

- .1 York
- .2 DAIKIN – McQuay
- .3 Engineered Air

**Part 3 Execution**

**3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for air handling equipment installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate.
  - .2 Inform General Contractor of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied.

**3.2 INSTALLATION**

- .1 Provide appropriate protection apparatus.
- .2 Install units in accordance with manufacturer's instructions and as indicated.
- .3 Ensure adequate clearance for servicing and maintenance.

**3.3 FANS**

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

**3.4 DRIP PANS**

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

**3.5 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 00 02 - Standard General Requirements.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 02 - Standard General Requirements.
- .3 Waste Management: separate waste materials for reuse recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

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**Part 1            General**

**1.1            RELATED WORK**

- .1       Heating controls: Built-in thermostat.

**1.2            PRODUCT DATA**

- .1       Submit product data in accordance with Section 26 05 00.
- .2       Product data to include:
  - .1       Suspension of heating element
  - .2       Physical size
  - .3       Finish: White
  - .4       KW rating, voltage, phase
  - .5       Cabinet thickness
  - .6       Cabinet surface temperature.

**Part 2           Products**

**2.1           BASEBOARD CONVECTORS**

- .1       Heaters: convector baseboard, standard wattage density as indicated with connection box both ends.
- .2       Single tubular, stainless steel sheathed element locked to cabinet and supported with non-metallic supports to allow for expansion.
- .3       Cabinet: 22-gauge steel casing; 16-gauge steel connection boxes; finished in 100% white-polyester paint, baked enamel, glossy finish.
- .4       Knockouts for 12mm dia. conduit connection.
- .5       120V, 1Ø, wattage as indicated.
- .6       10-year warranty for the element; 1-year warranty for other components.

**2.2           MANUFACTURERS**

- .1       Acceptable manufacturers:
  - .1       Chromalox
  - .2       Stelpro #B0501W (500W)
  - .3       Ouellet

**Part 3            Execution**

**3.1                INSTALLATION**

- .1        Install baseboard heaters and wire as indicated, (all heaters to be installed above baseboards).
- .2        Make power connections as indicated.

**3.2                TESTS**

- .1        Perform tests in accordance with Section 26 05 00.
- .2        Ensure that heaters and controls operate correctly.

**END OF SECTION**