

PART 1 - GENERAL

- 1.1 SUBMITTALS
- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
  - .2 Shop drawings; submit drawings stamped and signed by professional engineer registered or licensed in Province of New Brunswick, Canada.
  - .3 Shop drawings to show:
    - .1 Mounting arrangements.
    - .2 Operating and maintenance clearances.
  - .4 Shop drawings and product data accompanied by:
    - .1 Detailed drawings of bases, supports, and anchor bolts.
    - .2 Acoustical sound power data, where applicable.
    - .3 Points of operation on performance curves.
    - .4 Manufacturer to certify current model production.
    - .5 Certification of compliance to applicable codes.
  - .5 Closeout Submittals:
    - .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
    - .2 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.
    - .3 Operation data to include:
      - .1 Control schematics for systems including environmental controls.
      - .2 Description of systems and their controls.
      - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
      - .4 Operation instruction for systems and component.
      - .5 Description of actions to be taken in event of equipment failure.
      - .6 Valves schedule and flow diagram.
      - .7 Colour coding chart.
    - .4 Maintenance data to include:
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- 1.1 SUBMITTALS (Cont'd)
- .5 Closeout Submittals:(Cont'd)
    - .4 Maintenance data to include:(Cont'd)
      - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
      - .2 Data to include schedules of tasks, frequency, tools required and task time.
    - .5 Performance data to include:
      - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
      - .2 Equipment performance verification test results.
      - .3 Special performance data as specified.
      - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
    - .6 Additional data:
      - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
    - .7 Site records:
      - .1 Departmental Representative will provide 1 set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
      - .2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.
      - .3 Use different colour waterproof ink for each service.
      - .4 Make available for reference purposes and inspection.
    - .8 As-built drawings:
      - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
      - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED"  
(Signature of Contractor) (Date).
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- 1.1 SUBMITTALS .5 Closeout Submittals:(Cont'd)  
(Cont'd)
- .8 As-built drawings:(Cont'd)
  - .3 Submit to Departmental Representative Engineer Consultant for approval and make corrections as directed.
  - .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
  - .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
  - .9 Submit copies of as-built drawings for inclusion in final TAB report.
- 1.2 QUALITY ASSURANCE .1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.
- 1.3 MAINTENANCE .1 Furnish spare parts in accordance with Section 01 78 00 - Closeout Submittals as follows:
- .1 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.
- PART 3 - EXECUTION
- 3.1 PAINTING REPAIRS AND RESTORATION .1 Prime and touch up marred finished paintwork to match original.
- .2 Restore to new condition, finishes which have been damaged.
- 3.2 CLEANING .1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units.
- 3.3 DEMONSTRATION .1 Departmental Representative will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
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- 3.3 DEMONSTRATION .2 Trial usage to apply to following equipment  
(Cont'd) and systems:
- .1 Mini split system
  - .2 Fresh air supply, return and exhaust.
- .3 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .4 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- 3.4 PROTECTION .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

PART 1 - GENERAL

- 1.1 SUMMARY .1 Section includes:  
.1 Hangers and supports for mechanical piping, ducting and equipment.
- .2 Related Section:  
.1 Fresh air ductwork, exhaust and return air.  
.2 Section 23 31 13.01 - Metal Ducts - Low Pressure to 500 Pa.
- 1.2 REFERENCES .1 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)  
.1 MSS SP 58-2002, Pipe Hangers and Supports - Materials, Design and Manufacture.  
.2 MSS SP 69-2003, Pipe Hangers and Supports - Selection and Application.  
.3 MSS SP 89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .2 Underwriter's Laboratories of Canada (ULC)
- 1.3 ACTION AND INFORMATIONAL SUBMITTALS .1 Design Requirements:  
.1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.  
.2 Ensure that support, guides, anchors do not transmit excessive quantities of heat to building structure.  
.3 Design hangers and supports to support system under all conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.  
.4 Provide for vertical adjustments after erection and during commissioning.

PART 2 - PRODUCTS

- 2.1 GENERAL .1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS SP58.
- 2.2 PIPE HANGERS .1 Finishes:  
.1 Pipe hangers and supports: carbon steel.  
.2 Ensure steel hangers in contact with copper piping are copper plated.
- .2 Upper attachment structural: suspension from lower flange of I-Beam:  
.1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.  
.1 Rod: 9 mm UL listed.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:  
.1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed.  
.2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed FM approved.
- .4 Upper attachment to concrete:  
.1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.  
.2 Concrete inserts: wedge shaped body with knockout protector plate UL listed.
- .5 Hanger rods: threaded rod material to MSS SP 58:  
.1 Ensure that hanger rods are subject to tensile loading only.
- .6 Pipe attachments: material to MSS SP 58:  
.1 Attachments for steel piping: carbon steel black.  
.2 Attachments for copper piping: copper plated black steel.  
.3 Use insulation shields for hot pipework.  
.4 Oversize pipe hangers and supports.



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- 3.3 HANGER SPACING (Cont'd)
- .3 Copper piping: up to NPS 1/2: every 1.5 m.
  - .4 Flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.
  - .5 Within 300 mm of each elbow.

<u>Maximum Pipe Size : NPS</u>	<u>Maximum Spacing Steel</u>	<u>Maximum Spacing Copper</u>
up to 1-1/4	2.4 m	1.8 m
1-1/2	3.0 m	2.4 m
2	3.0 m	2.4 m
2-1/2	3.7 m	3.0 m
3	3.7 m	3.0 m
3-1/2	3.7 m	3.3 m
4	3.7 m	3.6 m
5	4.3 m	
6	4.3 m	
8	4.3 m	
10	4.9 m	

- .6 Pipework greater than NPS 12: to MSS SP 69.

- 3.4 HANGER INSTALLATION
- .1 Install hanger so that rod is vertical under operating conditions.
  - .2 Adjust hangers to equalize load.
  - .3 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.

- 3.5 HORIZONTAL MOVEMENT
- .1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4 degrees from vertical.
  - .2 Where horizontal pipe movement is less than 13 mm, offset pipe hanger and support so that rod hanger is vertical in the hot position.

3.6 FINAL  
ADJUSTMENT

- .1 Adjust hangers and supports:
  - .1 Ensure that rod is vertical under operating conditions.
  - .2 Equalize loads.
- .2 Adjustable clevis:
  - .1 Tighten hanger load nut securely to ensure proper hanger performance.
  - .2 Tighten upper nut after adjustment.
- .3 C-clamps:
  - .1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.
- .4 Beam clamps:
  - .1 Hammer jaw firmly against underside of beam.

3.7 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.

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 HVAC.
  - .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 Departmental Representative within 90 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.
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- 1.2 QUALIFICATIONS OF TAB PERSONNEL (Cont'd) .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.
- 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.
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- 1.7 OPERATION OF SYSTEMS DURING TAB .1 Operate systems for length of time required for TAB and as required for verification of TAB reports.
- 1.8 START OF TAB .1 Notify Departmental Representative.
- .2 Start TAB when building is essentially completed.
- .3 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 10 %, minus 10 %.
- 1.10 ACCURACY TOLERANCES .1 Measured values accurate to within plus or minus 2 % of actual values.
- 1.11 INSTRUMENTS .1 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.
- .2 Calibrate within 3 months of TAB. Provide certificate of calibration to Departmental Representative.
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- 1.12 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 6 copies of TAB Report to Departmental Representative for verification and approval, in English in D-ring binders, complete with index tabs.
- 1.13 VERIFICATION .1 Reported results subject to verification by Departmental Representative.
- .2 Provide personnel and instrumentation to verify up to 30 % of reported results.
- .3 Number and location of verified results as directed by Departmental Representative.
- .4 Pay costs to repeat TAB as required to satisfaction of Departmental Representative.
- 1.14 SETTINGS .1 After TAB is completed to satisfaction of Departmental Representative, replace drive guards, close access doors, lock devices in set positions, 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.
- 1.15 COMPLETION OF TAB .1 TAB considered complete when final TAB Report received and approved by Departmental Representative.
- 1.16 AIR SYSTEMS .1 Standard: TAB to most stringent of TAB standards of AABC SMACNA ASHRAE.
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- 1.16 AIR SYSTEMS  
(Cont'd)
- .2 Do TAB of systems, equipment, components, controls specified Division 23 following systems, equipment, components, controls:
    - .1 Supply air and return.
    - .2 Exhaust air.
  - .3 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.
  - .4 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.
  - .5 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

PART 1 - GENERAL

- 1.1 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)
  - .2 ASTM International Inc.
    - .1 ASTM C 547-07e1, Standard Specification for Mineral Fiber Pipe Insulation.
    - .2 ASTM C 553-02e1, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
  - .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.
  - .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.

- 1.2 ACTION AND INFORMATIONAL SUBMITTALS
- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
  - .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 Provide drawings stamped and signed by professional engineer registered or licensed in Province of New Brunswick, Canada.

PART 2 - PRODUCTS

- 2.1 FIRE AND SMOKE RATING
- .1 To CAN/ULC-S102:
    - .1 Maximum flame spread rating: 25.
    - .2 Maximum smoke developed rating: 50.
- 2.2 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 C 335.
  - .3 TIAC Code C-1: Rigid mineral fibre board to ASTM C 612, with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).
  - .4 TIAC Code C-2: Mineral fibre blanket to ASTM C 553 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 C 553.
    - .2 Jacket: to CGSB 51-GP-52Ma.
    - .3 Maximum "k" factor: to ASTM C 553.

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- 2.3 JACKETS .1 Canvas:  
.1 220 gm/m<sup>2</sup> cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
- .2 Lagging adhesive: compatible with insulation.
- 2.4 ACCESSORIES .1 Vapour retarder lap adhesive:  
.1 Water based, fire retardant type, compatible with insulation.  
.1 Maximum VOC limit 50 170 200 g/L to SCAQMD Rule 1168 GSES GS-36.
- .2 Insulating Cement: hydraulic setting on mineral wool, to ASTM C 449.
- .3 ULC Listed Canvas Jacket:  
.1 220 gm/m<sup>2</sup> cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C 921.

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 Ensure surfaces are clean, dry, free from foreign material.
- 3.3 INSTALLATION .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturers instructions and as indicated.
- .3 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.  
.1 Ensure hangers, and supports are outside vapour retarder jacket.
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3.3 INSTALLATION  
(Cont'd)

- .4 Hangers and supports in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
- .5 Fasteners: install at 300 mm on centre in horizontal and vertical directions, minimum 2 rows each side.

3.4 DUCTWORK  
INSULATION SCHEDULE

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

	TIAC Code	Vapour Retarder	Thickness (mm)
Rectangular cold and dual temperature supply air ducts	C-1	yes	25
Round cold and dual temperature supply air ducts	C-2	yes	25
Rectangular warm air ducts	C-1	no	25
Round warm air ducts	C-1	no	25
Exhaust duct between dampers and louvres	C-1	no	25

- .2 Use TIAC code C-1 insulation, scored to suit diameter of duct.

.1 Finishes: conform to following table:

	TIAC Code	
Indoor, concealed	Rectangular none	Round none
Indoor, exposed within mechanical room	CRF/1	CRD/2
Indoor, exposed elsewhere	CRF/2	CRD/3

3.5 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.

PART 1 - GENERAL

- 1.1 SUMMARY .1 Section Includes:
- .1 Materials and installation for copper tubing and fittings for refrigerant.
  - .2 Sustainable requirements for construction and verification:
- 1.2 REFERENCES .1 American Society of Mechanical Engineers (ASME)
- .1 ASME B16.22-01, Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings.
  - .2 ASME B16.24-02, Cast Copper Pipe Flanges and Flanged Fittings: Class 150, 300, 400, 600, 900, 1500 and 2500.
  - .3 ASME B16.26-88, Cast Copper Alloy Fittings for Flared Copper Tubes.
  - .4 ASME B31.5-01, Refrigeration Piping and Heat Transfer Components.
- .2 American Society for Testing and Materials International (ASTM)
- .1 ASTM A 307-04, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  - .2 ASTM B 280-03, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- .3 Canadian Standards Association (CSA International)
- .1 CSA B52-99, Mechanical Refrigeration Code.
- .4 Environment Canada (EC)
- .1 EPS 1/RA/1-96, Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.
- .5 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
- .1 Material Safety Data Sheets (MSDS).
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- 1.3 SUBMITTALS .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:  
.1 Submit manufacturer's printed product literature, specifications and datasheet for piping, fittings and equipment.
- 1.4 QUALITY ASSURANCE .1 Pre-Installation Meeting:  
.1 Convene pre-installation meeting one week prior to beginning on-site installations.  
.1 Verify project requirements.  
.2 Review installation conditions.  
.3 Co-ordination with other building subtrades.  
.4 Review manufacturer's installation instructions and warranty requirements.
- .2 Health and Safety:  
.1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- 1.5 DELIVERY, STORAGE AND HANDLING .1 Waste Management and Disposal:  
.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.  
.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.  
.3 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan (WMP).  
.4 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.
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PART 2 - PRODUCTS

- 2.1 TUBING .1 Processed for refrigeration installations, deoxidized, dehydrated and sealed.  
.1 Hard copper: to ASTM B 280, type ACR B.  
.2 Annealed copper: to ASTM B 280, with minimum wall thickness as per CSA B52 and ASME B31.5.
- 2.2 FITTINGS .1 Service: design pressure 2070 kPa and temperature 121 degrees C.  
.2 Brazed:  
.1 Fittings: wrought copper to ASME B16.22.  
.2 Joints: silver solder, 15% Ag-80% Cu-5%P or copper-phosphorous, 95% Cu-5%P and non-corrosive flux.  
.3 Flanged:  
.1 Bronze or brass, to ASME B16.24, Class 150 and Class 300.  
.2 Gaskets: suitable for service.  
.3 Bolts, nuts and washers: to ASTM A 307, heavy series.  
.4 Flared:  
.1 Bronze or brass, for refrigeration, to ASME B16.26.
- 2.3 PIPE SLEEVES .1 Hard copper or steel, sized to provide 6 mm clearance around between sleeve and uninsulated pipe or between sleeve and insulation.
- 2.4 VALVES .1 22 mm and under: Class 500, 3.5 Mpa, globe or angle non-directional type, diaphragm, packless type, with forged brass body and bonnet, moisture proof seal for below freezing applications, brazed connections.  
.2 Over 22 mm: Class 375, 2.5 Mpa, globe or angle type, diaphragm, packless type, back-seating, cap seal, with cast bronze body and bonnet, moisture proof seal for below freezing applications, brazed connections.

PART 3 - EXECUTION

- 3.1 MANUFACTURER'S INSTRUCTIONS .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.
- 3.2 GENERAL .1 Install in accordance with CSA B52, EPS1/RA/1 and ASME B31.5.
- 3.3 BRAZING PROCEDURES .1 Bleed inert gas into pipe during brazing.  
.2 Remove valve internal parts, solenoid valve coils, sight glass.  
.3 Do not apply heat near expansion valve and bulb.
- 3.4 PIPING INSTALLATION .1 General:  
.1 Soft annealed copper tubing: bend without crimping or constriction Hard drawn copper tubing: do not bend. Minimize use of fittings.  
.2 Hot gas lines:  
.1 Pitch at least 1:240 down in direction of flow to prevent oil return to compressor during operation.  
.2 Provide trap at base of risers greater than 2400 mm high and at each 7600 mm thereafter.  
.3 Provide inverted deep trap at top of risers.  
.4 Provide double risers for compressors having capacity modulation.  
.1 Large riser: install traps as specified.  
.2 Small riser: size for 5.1 m/s at minimum load. Connect upstream of traps on large riser.
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3.5 PRESSURE AND  
LEAK TESTING

- .1 Close valves on factory charged equipment and other equipment not designed for test pressures.
- .2 Leak test to CSA B52 before evacuation to 2MPa and 1MPa on high and low sides respectively.
- .3 Test Procedure: build pressure up to 35 kPa with refrigerant gas on high and low sides. Supplement with nitrogen to required test pressure. Test for leaks with electronic or halide detector. Repair leaks and repeat tests.

3.6 FIELD QUALITY  
CONTROL

- .1 Site Tests/Inspection:
  - .1 Close service valves on factory charged equipment.
  - .2 Ambient temperatures to be at least 13 degrees C for at least 12 hours before and during dehydration.
  - .3 Use copper lines of largest practical size to reduce evacuation time.
  - .4 Use two-stage vacuum pump with gas ballast on 2nd stage capable of pulling 5Pa absolute and filled with dehydrated oil.
  - .5 Measure system pressure with vacuum gauge. Take readings with valve between vacuum pump and system closed.
  - .6 Triple evacuate system components containing gases other than correct refrigerant or having lost holding charge as follows:
    - .1 Twice to 14 Pa absolute and hold for 4 h.
    - .2 Break vacuum with refrigerant to 14 kPa.
    - .3 Final to 5 Pa absolute and hold for at least 12 h.
    - .4 Isolate pump from system, record vacuum and time readings until stabilization of vacuum.
    - .5 Submit test results to Departmental Representative.

3.6 FIELD QUALITY CONTROL  
(Cont'd)

- .7 Charging:  
.1 Charge system through filter-drier and charging valve on high side. Low side charging not permitted.  
.2 With compressors off, charge only amount necessary for proper operation of system. If system pressures equalize before system is fully charged, close charging valve and start up. With unit operating, add remainder of charge to system.  
.3 Re-purge charging line if refrigerant container is changed during charging process.
- .8 Checks:  
.1 Make checks and measurements as per manufacturer's operation and maintenance instructions.  
.2 Record and report measurements to Departmental Representative.

3.7 CLEANING

- .1 Perform cleaning operations in accordance with manufacturer's recommendations.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

PART 1 - GENERAL

- 1.1 SUMMARY
- .1 Section Includes:
    - .1 Materials and installation of low-pressure metallic ductwork, joints and accessories.
  - .2 Related Sections:
    - .1 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
    - .2 Section 23 33 14 - Dampers - Balancing.
    - .3 Section 23 37 13 - Diffusers, Registers and grilles.
- 1.2 REFERENCES
- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
  - .2 American Society for Testing and Materials International, (ASTM).
    - .1 ASTM A 480/A 480M-03c, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
    - .2 ASTM A 635/A 635M-02, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.
    - .3 ASTM A 653/A 653M-03, 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-02, Standard for the Installation of Air-Conditioning and Ventilating Systems.
    - .2 NFPA 90B-02, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
  - .4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
    - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2nd Edition 1995 and Addendum No. 1, 1997.
    - .2 SMACNA HVAC Air Duct Leakage Test Manual, 1985, 1st Edition.
    - .3 IAQ Guideline for Occupied Buildings Under Construction 1995, 1st Edition.
-

- 1.3 SUBMITTALS .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.

PART 2 - PRODUCTS

- 2.1 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.

- 2.2 SEALANT .1 Sealant: oil resistant, water borne, polymer type flame resistant duct sealant. Temperature range of minus 30 degrees C to plus 93 degrees C.

- 2.3 TAPE .1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide.

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

- 2.5 FITTINGS .1 Fabrication: to SMACNA.  
.2 Radiused elbows.  
.1 Rectangular: standard radius Centreline radius: 1.5 times width of duct  
.2 Round: smooth radius five piece. Centreline radius: 1.5 times diameter.  
.3 Mitred elbows, rectangular:  
.1 To 400 mm: with single double thickness turning vanes.

2.5 FITTINGS  
(Cont'd)

- .3 Mitred elbows, rectangular:(Cont'd)
  - .2 Over 400 mm with double thickness turning vanes.
- .4 Branches:
  - .1 Rectangular main and branch: with radius on branch 1.5 times width of duct 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 Full short radiused elbows.
- .7 Obstruction deflectors: maintain full cross-sectional area.
  - .1 Maximum included angles: as for transitions.

2.6 FIRE STOPPING

- .1 Retaining angles around duct, on both sides of fire separation.
- .2 Fire stopping material and installation must not distort duct.

2.7 GALVANIZED STEEL

- .1 Lock forming quality: to ASTM A 653/A 653M, Z90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to ASHRAE SMACNA.
- .3 Joints: to ASHRAE SMACNA.

2.8 KITCHEN  
EXHAUST SYSTEMS

- .1 Construct in accordance with NFPA 96.
- .2 Material: and fabrication as indicated.

2.9 HANGERS AND  
SUPPORTS

- .1 Hangers and Supports: in accordance with Section 23 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 SMACNA.
    - .3 Hangers: galvanized steel angle with galvanized steel rods to SMACNA:

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25 x 25 x 3	6
751 to 1050	40 x 40 x 3	6
1051 to 1500	40 x 40 x 3	10

- .4 Upper hanger attachments:
  - .1 For concrete: manufactured concrete inserts.
  - .2 For steel joist: manufactured joist clamp.
  - .3 For steel beams: manufactured beam clamps:

PART 3 - EXECUTION

3.1 GENERAL

- .1 Do work in accordance with NFPA 90A NFPA 90B SMACNA.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods.
  - .1 Insulate strap hangers 100 mm beyond insulated duct Ensure diffuser is fully seated.
- .3 Support risers in accordance with SMACNA.
- .4 Install breakaway joints in ductwork on sides of fire separation.
- .5 Manufacture duct line lengths and diametre to accommodate installation of accoustic duct lining.

3.2 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:

<u>Duct Size</u>	<u>Spacing</u>
(mm)	(mm)
to 1500	3000

3.3 SEALING AND TAPING

- .1 Apply sealant to outside of joint to manufacturer's recommendations.
- .2 Bed tape in sealant and recoat with minimum of one coat of sealant to manufacturers recommendations.

PART 1 - GENERAL

- 1.1 SUMMARY .1 Section Includes:  
.1 Materials and installation for duct accessories including flexible connections, access doors, vanes and collars.  
.2 Sustainable requirements for construction and verification.
- .2 Related Sections:  
.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, 95.
- 1.3 SUBMITTALS .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:  
.1 Submit manufacturer's printed product literature, specifications and data sheet. Indicate the following:  
.1 Flexible connections.  
.2 Duct access doors.  
.3 Turning vanes.

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 mm thick with fabric clenched by means of double locked seams.
- .2 Material:  
.1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature
-

2.2 FLEXIBLE CONNECTIONS (Cont'd) .2 Material:(Cont'd)  
.1 (Cont'd)  
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.  
.4 Hardware:  
.1 Up to 300 x 300 mm: two sash locks.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and data sheet.

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.

- 3.2 INSTALLATION .2 Access Doors and Viewing Panels:  
(Cont'd)
- .1 Size:
    - .1 300 x 300mm for servicing entry.
  - .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 Turning vanes:
    - .1 Install in accordance with recommendations of SMACNA and as indicated.
- 3.3 CLEANING .1 Perform cleaning operations as specified in Section and in accordance with manufacturer's recommendations.

PART 1 - GENERAL

- 1.1 SUMMARY .1 Section Includes:  
.1 Balancing dampers for mechanical forced  
air ventilation and air conditioning systems.
- 1.2 REFERENCES .1 Sheet Metal and Air Conditioning National  
Association (SMACNA)  
.1 SMACNA HVAC Duct Construction Standards,  
Metal and Flexible-1985.

PART 2 - PRODUCTS

- 2.1 GENERAL .1 Manufacture to SMACNA standards.
- 2.2 SPLITTER  
DAMPERS .1 Fabricate from same material as duct but one  
sheet metal thickness heavier, with  
appropriate stiffening.  
.2 Single Double thickness construction.  
.3 Control rod with locking device and position  
indicator.  
.4 Rod configuration to prevent end from  
entering duct.  
.5 Pivot: piano hinge.  
.6 Folded leading edge.
- 2.3 SINGLE BLADE  
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 100 mm.  
.3 Locking quadrant with shaft extension to  
accommodate insulation thickness.  
.4 Inside and outside nylon bronze end bearings.

2.3 SINGLE BLADE .5 Channel frame of same material as adjacent  
DAMPERS duct, complete with angle stop.  
(Cont'd)

PART 3 - EXECUTION

3.1 MANUFACTURER'S .1 Compliance: comply with manufacturer's  
INSTRUCTIONS written recommendations or specifications,  
including product technical bulletins,  
handling, storage and installation  
instructions, and datasheet.

3.2 INSTALLATION .1 Install where indicated.  
.2 Install in accordance with recommendations of  
SMACNA and in accordance with manufacturer's  
instructions.  
.3 Locate balancing dampers in each branch duct,  
for supply, return and exhaust systems.  
.4 Runouts to registers and diffusers: install  
single blade damper located as close as  
possible to main ducts.  
.5 Dampers: vibration free.  
.6 Ensure damper operators are observable and  
accessible.  
.7 Corrections and adjustments conducted by  
Departmental Representative.

3.3 CLEANING .1 Upon completion and verification of  
performance of installation, remove surplus  
materials, excess materials, rubbish, tools  
and equipment.

PART 1 - GENERAL

- 1.1 SUMMARY .1 Section Includes:
- .1 Fire and smoke dampers, and fire stop flaps.
  - .2 Sustainable requirements for construction and verification.
- 1.2 REFERENCES .1 American National Standards Institute/National Fire Protection Association (ANSI/NFPA)
- .1 ANSI/NFPA 90A-2002, Standard for the Installation of Air Conditioning and Ventilating Systems.
  - .2 Underwriters Laboratories of Canada (ULC)
    - .1 CAN4-S112-M1990, Fire Test of Fire Damper Assemblies.
    - .2 CAN4-S112.2-M84, Standard Method of Fire Test of Ceiling Firestop Flap Assemblies.
    - .3 ULC-S505-1974, Fusible Links for Fire Protection Service.
- 1.3 SUBMITTALS .1 Product Data:
- .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
  - .2 Indicate the following:
    - .1 Fire dampers.
    - .2 Smoke dampers.
    - .3 Fire stop flaps.
    - .4 Operators.
    - .5 Fusible links.
-

PART 2 - PRODUCTS

- 2.1 FIRE DAMPERS
- .1 Fire dampers: arrangement Type B, listed and bear label of ULC, meet requirements of provincial fire authority Fire Commissioner of Canada (FCC) authorities having jurisdiction. Fire damper assemblies fire tested in accordance with CAN4-S112.
  - .2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
    - .1 Fire dampers: 1-1/2 hour fire rated unless otherwise indicated.
  - .3 Top hinged: multi-blade hinged; guillotine type; sized to maintain full duct cross section as indicated.
  - .4 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.
  - .5 40 x 40 x 3 mm retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.
  - .6 Equip fire dampers with steel sleeve or frame installed disruption ductwork or impair damper operation.
  - .7 Equip sleeves or frames with perimeter mounting angles attached on both sides of wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce ceiling to conform with ULC.
  - .8 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area.
  - .9 Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition of floor slab depth or thickness.
  - .10 Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC

- 2.1 FIRE DAMPERS .10 (Cont'd)  
(Cont'd)  
and in manufacturer's instructions for fire dampers shall be followed.
- PART 3 - EXECUTION
- 3.1 MANUFACTURER'S INSTRUCTIONS .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.
- 3.2 INSTALLATION .1 Install in accordance with ANSI/NFPA 90A and in accordance with conditions of ULC listing.
- .2 Maintain integrity of fire separation.
- .3 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.
- .4 Install access door adjacent to each damper. S.e Section 23 33 00 - Air Duct Accessories
- .5 Co-ordinate with installer of firestopping.
- .6 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible.
- .7 Install break-away joints of approved design on each side of fire separation.
- 3.3 CLEANING .1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

PART 1 - GENERAL

- 1.1 SUMMARY
- .1 Section Includes:
    - .1 Materials and installation of flexible ductwork, joints and accessories.
    - .2 Sustainable requirements for construction and verification.
    - .3 Related Sections:
      - .1 Section 23 37 13 - Diffusers, Registers and grilles.
- 1.2 REFERENCES
- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
  - .2 National Fire Protection Association (NFPA).
    - .1 NFPA 90A-02, Standard for the Installation of Air-Conditioning and Ventilating Systems.
    - .2 NFPA 90B-02, Standard for Installation of Warm Air Heating and Air-Conditioning Systems.
  - .3 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA).
    - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 95 (Addendum No.1, November 1997).
    - .2 SMACNA IAQ Guideline for Occupied Buildings under Construction, 1st Edition 1995.
  - .4 Underwriters' Laboratories of Canada (ULC).
    - .1 CAN/ULC-S110-1986(R2001), Fire Tests for Air Ducts.
- 1.3 SUBMITTALS
- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
  - .2 Indicate the following:
    - .1 Thermal properties.
    - .2 Friction loss.
    - .3 Acoustical loss.
    - .4 Leakage.
    - .5 Fire rating.

- 1.4 INDOOR AIR QUALITY (IAQ) MANAGEMENT PLAN .1 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings under Construction.

PART 2 - PRODUCTS

- 2.1 GENERAL .1 Factory fabricated to CAN/ULC-S110.  
.2 Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.  
.3 Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50.

- 2.2 METALLIC - UNINSULATED .1 Type 1: spiral wound flexible aluminum stainless steel, as indicated.  
.2 Performance:  
.1 Factory tested to 2.5 kPa without leakage.  
.2 Maximum relative pressure drop coefficient: 3.

- 2.3 NON-METALLIC - INSULATED .1 Type 4: non-collapsible, coated mineral base fabric aluminum foil/mylar type mechanically bonded to, and helically supported by, external steel wire with factory applied, 37 mm thick flexible mineral fibre thermal insulation with vapour barrier and vinyl jacket.  
.2 Performance:  
.1 Factory tested to 2.5 kPa without leakage.  
.2 Maximum relative pressure drop coefficient: 3.

PART 3 - EXECUTION

3.1 DUCT  
INSTALLATION

- .1 Install in accordance with: CAN/ULC-S110  
UL-181 NFPA 90A NFPA 90B SMACNA.

PART 1 - GENERAL

- 1.1 SUMMARY .1 Section Includes:  
.1 Supply, return and exhaust grilles and registers, diffusers and linear grilles, for commercial and residential use.
- 1.2 SUBMITTALS .1 Product Data:  
.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.  
.2 Indicate following:  
.1 Capacity.  
.2 Throw and terminal velocity.  
.3 Noise criteria.  
.4 Pressure drop.  
.5 Neck velocity.

PART 2 - PRODUCTS

- 2.1 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 Concealed manual volume control damper operators.  
.4 Colour: standard as directed by Departmental Representative.
- 2.2 MANUFACTURED UNITS .1 Grilles, registers and diffusers of same generic type, products of one manufacturer.

2.3 SUPPLY GRILLES  
AND REGISTERS .1 General: see schedule on drawings.

2.4 RETURN AND  
EXHAUST GRILLES AND  
REGISTERS .1 General: see schedule on drawings.

PART 3 - EXECUTION

3.1 MANUFACTURER'S  
INSTRUCTIONS .1 Compliance: comply with manufacturer's  
written recommendations or specifications,  
including product technical bulletins,  
handling, storage and installation  
instructions, and datasheet.

3.2 INSTALLATION .1 Install in accordance with manufacturers  
instructions.  
.2 Install with secure fasteners.  
.3 Bolt grilles, registers and diffusers, in  
place.

3.3 CLEANING .1 Upon completion and verification of  
performance of installation, remove surplus  
materials, excess materials, rubbish, tools  
and equipment.