

PART 1 - GENERAL

- 1.1 TRIAL USAGE .1 Departmental Representative may use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
.1 Trial usage to apply to systems only after prior approval of the Departmental Representative.
- 1.2 PROTECTION OF OPENINGS .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.
.2 Seal all ductwork openings with 6 mil plastic to protect it from dirt, dust, and foreign materials during the course of the day's installation. Further ensure that at the end of the day, all open joints are closed off. Tape all plastic with duct tape. Cover and protect all un-installed ductwork before it is installed.
.3 Protect all existing ductwork to be re-used, closing off openings with 6 mil plastic.
- 1.3 SPARE PARTS .1 Furnish spare parts in accordance with Section 01 78 00 as follows:
.1 One (1) set of belts for each piece of machinery.
.2 Three (3) sets of filters for each filter bank.
- 1.4 SPECIAL TOOLS .1 Provide one (1) set of special tools required to service equipment as recommended by manufacturers.
- 1.5 DEMONSTRATION AND OPERATING AND MAINTENANCE .1 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, troubleshooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
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1.5 DEMONSTRATION
AND OPERATING AND
MAINTENANCE
(Cont'd)

- .2 Where specified elsewhere in Division 23, manufacturers to provide demonstrations and instructions.
- .3 Use operation and maintenance manual, as-built drawings, audio visual aids, etc. as part of instruction materials.

1.6 CLOSEOUT
SUBMITTALS

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00.
 - .2 Operation and maintenance manual to be approved by the Departmental Representative, and final copies deposited with, the Departmental Representative before final inspection.
 - .3 Operation data to include:
 - .1 Control schematics for each system.
 - .2 Description of each system and its controls.
 - .3 Description of operation of each system at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for each system and each component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .4 Maintenance data to include:
 - .1 Servicing, maintenance, operation and troubleshooting instructions for each item of equipment and parts list.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
 - .5 Performance data to include:
 - .1 Equipment manufacturer's performance data sheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified elsewhere.
 - .4 Testing, adjusting and balancing reports as specified in Section 23 05 95 Testing, Adjusting and Balancing.
 - .6 Approvals:
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1.6 CLOSEOUT
SUBMITTALS
(Cont'd)

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.1 Submit copies of draft Operation and Maintenance Manual to the Departmental Representative for approval. Submission of individual data will not be accepted unless so directed by the Departmental Representative.

.2 Make changes as required and resubmit as directed by the Departmental Representative.

.7 Additional data:

.1 Prepare and insert into operation and maintenance manual when need for same becomes apparent during demonstrations and instructions specified above.

1.7 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Section 01 33 00.

.2 Shop drawings and product data to show:

- .1 Mounting arrangements.
- .2 Operating and maintenance clearances. eg. access door swing spaces.
- .3 Installation requirements and procedures.

.3 Accompany shop drawings and product data with:

- .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 as to current model production.
- .5 Certification of compliance to applicable codes.

.4 In addition to transmittal letter referred to in Section 01 33 00. Identify section and paragraph number.

1.8 CLEANING

.1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units.

- 1.9 PROJECT RECORD DRAWINGS
- .1 Site records:
 - .1 Departmental Representative to provide one (1) set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of the work. Mark there on all changes as work progresses and as changes occur. This includes changes to existing mechanical systems, control systems and low voltage control wiring.
 - .2 Transfer information to reproducibles, revising reproducibles to show all work as actually installed.
 - .3 Use different colour waterproof ink for each service.
 - .4 Make available for reference purposes and inspection at all times.
 - .2 Project Record drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing (TAB), finalize production of as-built drawings.
 - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: "Project Record drawings: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (date).
 - .3 Submit to the Departmental Representative for approval and make corrections as directed.
 - .4 TAB to be performed using Project Record drawings.
 - .5 Submit completed reproducible Project Record drawings with Operating and Maintenance Manuals.
 - .3 Submit copies of Project Record drawings for inclusion in final TAB report.
- 1.10 WASTE MANAGEMENT AND DISPOSAL
- .1 Separate and recycle waste materials in accordance with Section 01 74 21.
- 1.11 ELECTRICAL
- .1 Electrical work to conform to Division 26 including the following:
 - .1 Starters, motor protection and manual control devices are specified and indicated in Division 26 except where otherwise indicated or specified. Wiring to packaged mechanical equipment is indicated on electrical drawings. Coordinate as required.
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| <u>1.11 ELECTRICAL</u>
<u>(Cont'd)</u> | .2 | Supplier and installer responsibility is indicated on electrical drawings and related mechanical responsibility as indicated on mechanical equipment schedules on mechanical drawings or in specifications. |
| | .3 | Control wiring 50 V and greater, specified and installed by Division 26. Control wiring 50 V or less, is responsibility of EMCS contractor, except as indicated elsewhere in the specifications. |
| <u>1.12 EQUIPMENT</u>
<u>SUPPORTS</u> | .1 | Provide equipment supports direct from the equipment manufacturer in Division 23. |

PART 2 - PRODUCTS

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| <u>2.1 NOT USED</u> | .1 | Not applicable. |
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PART 3 - EXECUTION

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| <u>3.1 NOT USED</u> | .1 | Not applicable. |
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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.
- .3 TAB agency to be present to assist the commissioning authority during the commissioning of HVAC systems. Coordinate and pay for a TAB agency to measure entering and leaving air temperature at all coils to calibrate EMCS and for setting the DHW balancing valves.

1.2 QUALIFICATIONS
OF TAB PERSONNEL

- .1 Submit names of personnel certified to AABC or NEBB to perform TAB to the Departmental Representative within 90 days of award of contract.
 - .2 Provide documentation confirming qualifications, successful experience. TAB contractor must have a minimum of five (5) years experience to AABC, NEBB or SMACNA.
 - .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.
 - .2 National Environmental Balancing Bureau (NEBB) TABS, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.
 - .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing.
 - .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.
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1.2 QUALIFICATIONS
OF TAB PERSONNEL
(Cont'd)

- .7 Where instrument manufacturer calibration recommendations are more stringent than those listed in the 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 SMACNA), 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 so as 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 be to satisfaction of authority having jurisdiction.

1.5 COORDINATION

- .1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule so as 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.
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- 1.6 PRE-TAB REVIEW
- .1 Review contract documents before project construction is started and confirm in writing to the Departmental Representative adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.
 - .2 Review specified standards and report to the Departmental Representative in writing all proposed procedures which vary from standard.
 - .3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.
- 1.7 START-UP
- .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
 - .2 Follow special start-up procedures specified elsewhere in other Divisions.
- 1.8 OPERATION OF SYSTEMS DURING TAB
- .1 Operate systems for length of time required for TAB and as required by the Departmental Representative for verification of TAB reports.
- 1.9 START OF TAB
- .1 Notify the Departmental Representative seven (7) days prior to start of TAB.
 - .2 Start TAB when work is essentially completed, including:
 - .1 Installation of ceilings, doors, windows, other construction affecting TAB.
 - .2 Application of weatherstripping, sealing, caulking.
 - .3 All pressure, leakage, other tests specified elsewhere in other Divisions.
 - .4 All provisions for TAB installed and operational.
 - .3 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems as applicable affecting TAB including but not limited to:
 - .1 Proper thermal overload protection in place for electrical equipment.
 - .2 Air systems:
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- 1.9 START OF TAB .3 (Cont'd)
- (Cont'd) .2 (Cont'd)
- .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.
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- 1.10 APPLICATION TOLERANCES .1 Do TAB to following tolerances of design values:
- .1 HVAC systems: plus 5%, minus 5%.
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- 1.11 ACCURACY TOLERANCES .1 Measured values to be accurate to within plus or minus 2% of actual values.
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- 1.12 INSTRUMENTS .1 Prior to TAB, submit to the Departmental Representative list of instruments to be 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 three (3) months of TAB. Provide certificate of calibration to the Departmental Representative.
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- 1.13 TAB REPORT .1 Format to be 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 three (3) copies of TAB Report to the Departmental Representative for verification and approval, in English in D- ring binders, complete with index tabs.
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- 1.14 VERIFICATION
- .1 Reported results subject to verification by the Departmental Representative.
 - .2 Provide manpower and instrumentation to verify up to 30% of reported results.
 - .3 Number and location of verified results to be at discretion of the Departmental Representative.
 - .4 Bear costs to repeat TAB as required to satisfaction of the Departmental Representative.
- 1.15 SETTINGS
- .1 After TAB is completed to satisfaction of the 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. Markings not to be eradicated or covered in any way.
- 1.16 COMPLETION OF TAB
- .1 TAB to be considered complete when final TAB Report received and approved by the Departmental Representative.
- 1.17 AIR SYSTEMS
- .1 Standard: TAB to be to most stringent of this section or TAB standards of AABC or NEBB.
 - .2 Do TAB of systems, equipment, components, controls specified in other Divisions.
 - .3 Qualifications: personnel performing TAB to be qualified to standards of AABC or NEBB.
 - .4 Quality assurance: Perform TAB under direction of supervisor qualified to standards of AABC or NEBB.
 - .5 Measurements: to include, but not limited to, following 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, amperage and volts for each stage of electrical heating coils.
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- 1.17 AIR SYSTEMS
(Cont'd)
- .6 Locations of equipment measurements: To include, but not be limited to, following as appropriate:
- .1 Inlet and outlet of dampers, filter, coil, fan, other equipment causing changes in conditions.
 - .2 At controllers, controlled device.
- .7 Locations of systems measurements to include, but not be limited to, following as appropriate: Main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

PART 2 - PRODUCTS

- 2.1 NOT USED
- .1 Not applicable.

PART 3 - EXECUTION

- 3.1 NOT USED
- .1 Not applicable.

PART 1 - GENERAL

1.1 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.

1.2 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM B209M-2014, Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric).
 - .2 ASTM C335-2010e1, Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
 - .3 ASTM C449-07(R2013), Standard Specification for Mineral Fiber Hydraulic Setting Thermal Insulating and Finishing Cement.
 - .4 ASTM C553-2013, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .5 ASTM C612-14, Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .6 ASTM C921-10(R2015), Standard Practice for Determining Properties of Jacketing Materials for Thermal Insulation.
- .2 Canadian General Standards Board (CGSB)
 - .1 CGSB 51GP52Ma-1989, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .3 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.
- .4 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC S102-2010, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC S701-2011, Thermal Insulation Polystyrene, Boards and Pipe Covering.

1.3 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" will mean "not concealed" as defined herein.
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- 1.3 DEFINITIONS
(Cont'd)
- .1 (Cont'd)
 - .3 Insulation systems insulation material, fasteners, jackets, and other accessories.
 - .2 TIAC Codes:
 - .1 CRD: Commercial Round Ductwork,
 - .2 CRF: Commercial Rectangular Finish.
 - .3 CEF: Commercial Rigid Insulation External Application.
- 1.4 SHOP DRAWINGS
- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Submit for approval manufacturer's catalogue literature related to installation, fabrication for duct jointing recommendations.
- 1.5 SAMPLES
- .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on 12 mm plywood board. Affix typewritten label beneath sample indicating service.
- 1.6 MANUFACTURERS' INSTRUCTIONS
- .1 Submit manufacturer's installation instructions in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Installation instructions to include procedures used and installation standards achieved.
- 1.7 QUALIFICATIONS
- .1 Installer: specialist in performing work of this section and qualified to standards of TIAC.
- 1.8 DELIVERY, STORAGE AND HANDLING
- .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
 - .2 Protect from weather and construction traffic.
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| 1.8 DELIVERY,
STORAGE AND
HANDLING
(Cont'd) | .3 | Protect against damage from any source. |
| | .4 | Store at temperatures and conditions recommended by manufacturer. |

PART 2 - PRODUCTS

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| 2.1 FIRE AND SMOKE
RATING | .1 | In accordance with CAN/ULCS102:
.1 Maximum flame spread rating: 25.
.2 Maximum smoke developed rating: 50. |
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| 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 C mean temperature when tested in accordance with ASTM C335. |
| | .3 | TIAC Code C1: Rigid mineral fibre board to ASTM C612, with factory applied vapour retarder jacket to CGSB 51GP52Ma (as scheduled in PART 3 of this Section). |
| | .4 | TIAC Code C2: Mineral fibre blanket to ASTM C553 faced with factory applied vapour retarder jacket to CGSB 51GP52Ma (as scheduled in PART 3 of this section).
.1 Mineral fibre: to ASTM C553.
.2 Jacket: to CGSB 51GP52Ma.
.3 Maximum "k" factor: to ASTM C553. |

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| 2.3 JACKETS | .1 | Canvas:
.1 220 gm/m2 cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
.2 Lagging adhesive: Compatible with insulation. |
| | .2 | Aluminum:
.1 To ASTM B209 with moisture barrier as scheduled in PART 3 of this section.
.2 Thickness: 0.40 mm sheet.
.3 Finish: Stucco embossed or corrugated.
.4 Jacket banding and mechanical seals: 12 mm wide, 0.5 mm thick stainless steel. |
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2.3 JACKETS

(Cont'd)

- .3 Stainless steel:
 - .1 Type: 304 or 316 where additional corrosion protection is required.
 - .2 Thickness: 0.25 mm sheet.
 - .3 Finish: Corrugated or stucco embossed.
 - .4 Jacket banding and mechanical seals: 12mm wide, 0.5 mm thick stainless steel.
- .4 Self adhesive weather barrier membrane:
 - .1 Flexible SBS modified membrane impermeable to air, moisture vapour and water. UV light resistant, flame free adhesion.

2.4 ACCESSORIES

- .1 Vapour retarder lap adhesive:
 - .1 Water based, fire retardant type, compatible with insulation.
 - .2 Indoor Vapour Retarder Finish:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
 - .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.
 - .4 ULC Listed Canvas Jacket:
 - .1 220 gm/m2 cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
 Outdoor Vapour Retarder Mastic:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
 - .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m2.
 - .5 Tape: self-adhesive, aluminum, reinforced, 75 mm wide minimum.
 - .6 Contact adhesive: quick-setting.
 - .7 Canvas adhesive: washable.
 - .8 Tie wire: 1.5 mm stainless steel.
 - .9 Banding: 12 mm wide, 0.5 mm thick stainless steel.
 - .10 Facing: 25 mm galvanized steel hexagonal wire mesh stitched on one face of insulation.
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| 2.4 ACCESSORIES
(Cont'd) | .11 | Fasteners: 4 mm diameter pins with 35 mm diameter or square clips, length to suit thickness of insulation. |
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PART 3 - EXECUTION

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| 3.1 PREINSTALLATION
REQUIREMENTS | .1 | Pressure testing of ductwork systems complete, witnessed and certified. |
| | .2 | Surfaces clean, dry, free from foreign material. |

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| 3.2 INSTALLATION | .1 | Install in accordance with TIAC National Standards. |
| | .2 | Apply materials in accordance with manufacturer's instructions and as indicated. |
| | .3 | Use two layers with staggered joints when required nominal thickness exceeds 75 mm. |
| | .4 | Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes. |
| | .1 | Hangers, supports to be outside vapour retarder jacket. |
| | .5 | Supports, Hangers in accordance with Section 23 05 29 Bases, Hangers and Supports. |
| | .1 | Apply high compressive strength insulation where insulation may be compressed by weight of ductwork. |
| | .6 | Fasteners: At 300 mm oc in horizontal and vertical directions, minimum two rows each side. |

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| 3.3 DUCTWORK
INSULATION SCHEDULE | .1 | Insulation types and thicknesses: Conform to following Table: |
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INSULATION SCHEDULE
(Cont'd)

	<u>TIAC Code</u>	<u>Vapour Retarder</u>	<u>Thickness (mm)</u>
Rectangular cold and dual temperature supply air ducts (exposed)	C1	Yes	50
Round cold and dual temperature supply air ducts (concealed)	C2	Yes	50
Rectangular warm air ducts (exposed)	C1	No	25
Round warm air ducts (exposed)	C1	No	25
Rectangular cold and dual temperature supply air ducts (concealed)	C2	Yes	25
Round cold and dual temperature supply air ducts (exposed)	C1	Yes	50
Rectangular warm air ducts (concealed)	C2	No	25
Round warm air ducts (concealed)	C2	No	25
Supply, return and exhaust ducts exposed in space being served	none		
Outside air ducts to mixing Plenum	C1	Yes	50
Intake and exhaust plenums	C1	Yes	50
Exhaust duct between dampers and louvers	C1	No	50
Rectangular ducts outside	C1	special	75
Round ducts outside	C1	special	75

- .2 Jackets: Exposed round ducts 600mm and larger, smaller sizes where subject to abuse:
.1 Use TIAC code C1 insulation , scored to suit diameter of duct.

3.3 DUCTWORK .2 (Cont'd)
INSULATION SCHEDULE .2 Finishes: Conform to following table:

(Cont'd)	TIAC Code	
	Rectangular	Round
Indoor, concealed	None	None
Indoor, exposed within mechanical room	CRF/ Canvas	CRD/ Canvas
Indoor, exposed elsewhere	CRF/ Aluminum CRF/Self	CRD/ Aluminum CRD/Self
Outdoor, exposed	adhesive weather barrier membrane	adhesive weather barrier membrane

PART 1 - GENERAL

1.1 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00

1.2 REFERENCES

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM B209M-14, Specification for Aluminum and Aluminum Alloy Sheet and Plate Metric.
 - .2 ASTM C335-10e1, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation
 - .3 ASTM C449/C449M-07(R2013), Standard Specification for Mineral FibreHydraulicSetting Thermal Insulating and Finishing Cement.
 - .4 ASTM C533-11, Standard specification for Calcium Silicate Insulation Block and Pipe.
 - .5 ASTM C534-16, Standard Specification for Preformed Elastomeric Cellular Thermal Insulation in Sheet And Tubular Form.
 - .6 ASTM C547-15, Standard Specification for Mineral Fibre Pipe Insulation.
 - .7 ASTM C921-10(R2015), Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .2 Canadian General Standards Board (CGSB)
 - .1 CGSB 51GP52Ma-1989, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .2 CAN/CGSB51.53, Poly (Vinyl Chloride) Jacketting Sheet, for Insulated Pipes, Vessels and Round Ducts.
- .3 Manufacturer's Trade Associations
 - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.
- .4 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULCS102-10, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULCS701-11 Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - .3 CAN/ULCS702-09, Thermal Insulation, Mineral Fibre, for Buildings

1.3 DEFINITIONS

- .1 For purposes of this section:

- 1.3 DEFINITIONS .1 (Cont'd)
- (Cont'd)
- .1 "CONCEALED" means insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.
- .2 "EXPOSED" means "not concealed" as specified.

- 1.4 SHOP DRAWINGS .1 Submit shop drawings in accordance with Section 01 33 00.

- 1.5 QUALIFICATIONS .1 Installer to be specialist in performing work of this Section and qualified to standards of TIAC.

- 1.6 DELIVERY, STORAGE AND HANDLING
- .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Protect from weather, construction traffic.
- .3 Protect against damage from any source.
- .4 Store at temperatures and conditions required by manufacturer.

PART 2 - PRODUCTS

- 2.1 FIRE AND SMOKE RATING .1 In accordance with CAN/ULC S102.
- .1 Maximum flame spread rating: 25.
- .2 Maximum smoke developed rating: 50.

- 2.2 INSULATION .1 TIAC Code A6: Flexible unicellular tubular elastomer.
- .1 Insulation: with vapour retarder jacket to ASTM C534.
- .2 Jacket: to CGSB 51GP52Ma.
- .3 Maximum "k" factor: 0.039 W/m - °C.
- .4 To be certified by manufacturer to be free of potential stress corrosion cracking corrodants
- .5 Flame spread index less than 25, and smoke developed index less than 50.
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2.3 VAPOUR RETARDER LAP ADHESIVE	.1	Water based, fire retardant type, compatible with insulation.
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	.2	For Type A6 insulation to manufacturer's recommendation.
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PART 3 - EXECUTION

3.1 PRE- INSTALLATION REQUIREMENT	.1	Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.
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	.2	Surfaces clean, dry, free from foreign material.
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3.2 INSTALLATION	.1	Install in accordance with TIAC National Standards.
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	.2	Apply materials in accordance with manufacturers instructions and this specification.
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	.3	Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
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	.1	Hangers, supports to be outside vapour retarder jacket.
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	.4	Supports and Hangers:
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	.1	Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.
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3.3 INSTALLATION OF ELASTOMERIC INSULATION	.1	Insulation to remain dry at all times. Overlaps to manufacturers instructions. Provide tight joints.
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	.2	Provide vapour retarder as recommended by manufacturer.
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3.4 PIPING .1 Schedule:
 INSTALLATION
 SCHEDULES

Application	Temp °C	TIAC code	Pipe sizes (NPS) and insulation thickness(mm)					
			Run out	to 1	1 1/4 to 2	2 1/2 to 4	5 to 6	8&over
Refrigerant Hot Gas, Liquid, Suction	4-13	A-6	25	25	25	25	25	25
Refrigerant Hot Gas, Liquid, Suction	below 4	A-6	25	25	25	25	25	25
Cooling Coil cond. Drain		A-3	25	25	25	25	25	25

.2 Finishes:

- .1 Exposed indoors: PVC jacket.
- .2 Exposed in mechanical rooms: PVC jacket.
- .2 Concealed, indoors: canvas on valves, fittings.
No further finish.
- .3 Use vapour retarder jacket on TIAC code A3
insulation compatible with insulation.
- .4 Outdoors: Waterproof Aluminum or SS jacket.
- .5 Finish attachments: SS screws or bands, at 150
mm oc. Seals: wing or closed.
- .6 Installation: To appropriate TIAC code CPF/1
through CPF/5.

PART 1 - GENERAL

- | | | |
|-----------------------|----|------------------------------------------------------------------------------------|
| <u>1.1 REFERENCES</u> | .1 | American Society for Testing and Materials |
| | .1 | ASTM E202-12, Test Methods for Analysis of Ethylene Glycols and Propylene Glycols. |

PART 2 - PRODUCTS

- | | | |
|-------------------------------|----|-----------------------------------------------------|
| <u>2.1 CLEANING SOLUTIONS</u> | .1 | Low foaming detergent at all temperatures |
| | .2 | No pH neutralization required |
| | .3 | Designed for use on most metals including aluminium |
| | .4 | Biodegradable |
| | .5 | Phosphate Free |
| | .6 | Nitrite Free |

PART 3 - EXECUTION

- | | | |
|---------------------|----|-----------------|
| <u>3.1 NOT USED</u> | .1 | Not applicable. |
|---------------------|----|-----------------|

PART 1 - GENERAL

1.1 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.22-2013, Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings.
 - .2 ASME B16.24-2016, Cast Copper Pipe Flanges and Flanged Fittings: Class 150, 300, 400, 600, 900, 1500 and 2500.
 - .3 ASME B16.26-2013, Cast Copper Alloy Fittings for Flared Copper Tubes.
 - .4 ASME B31.5-2016, Refrigeration Piping and Heat Transfer Components.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A 307-14, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .2 ASTM B 280-16, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- .3 Canadian Standards Association (CSA International)
 - .1 CSA B52-13, 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).

1.2 ACTION AND INFORMATIONAL 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.
 - .2 Submit WHMIS MSDS in accordance with Section 01 33 00. Indicate VOC's for adhesive and solvents during application and curing.
-

1.2 ACTION AND
INFORMATIONAL
SUBMITTALS
(Cont'd)

- .3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Instructions: submit manufacturer's installation instructions.
- .6 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.3 DELIVERY,
STORAGE AND
HANDLING

- .1 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - 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 and packaging material in appropriate on-site bins for recycling.
 - .4 Separate for reuse and recycling and place in designated containers.
 - .5 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.

PART 2 - PRODUCTS

2.1 TUBING

- .1 Processed for refrigeration installations, deoxidized, dehydrated and sealed.
 - .1 Hard copper: to ASTM B 280, type 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.

2.2 FITTINGS
(Cont'd)

- .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, 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.

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.
-

3.6 FIELD QUALITY
CONTROL

(Cont'd)

- .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.
- .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 RELATED
SECTIONS

- .1 Submittal Procedures: Section 01 33 00

1.2 REFERENCES

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM A480/A480M-16b, Specification for General Requirements for FlatRolled Stainless and HeatResisting Steel Plate, Sheet and Strip.
 - .2 ASTM A635/A635M-15, Specification for Steel, Sheet and Strip, Heavy Thickness Coils, Carbon, Hot Rolled.
 - .3 A653/A653M-15E1, Specification for Steel Sheet, Zinc Coated (Galvanized) or ZincIron Alloy Coated (Galvannealed) by the HotDip Process.
- .2 National Fire Protection Agency (NFPA)
 - .1 NFPA 90A-2015, Installation of Air Conditioning and Ventilating Systems.
 - .2 NFPA 90B-2015, Installation of Warm Air Heating and Air Conditioning Systems.
 - .3 NFPA 91-2015, Standard for Exhaust System for Air Conveying of Vapours, Gases, Mists, and Noncombustible Particle Solids.
 - .4 NFPA 96-2017, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible.
 - .2 SMACNA HVAC Duct Leakage Test Manual.

1.3 SHOP DRAWINGS
AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00.
 - .2 Indicate following:
 - .1 Sealants.
 - .2 Tape.
 - .3 Proprietary Joints.
-

<u>1.4 CERTIFICATE OF RATINGS</u>	.1	Catalogue or published ratings must be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
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<u>1.5 WASTE MANAGEMENT AND DISPOSAL</u>	.1	Separate and recycle waste materials in accordance with municipal regulations and Section 01 74 21.
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PART 2 - PRODUCTS

<u>2.1 SEAL CLASSIFICATION</u>	.1	Classification as follows:
	.2	Seal classification:
	.1	Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.
	.2	Class B: longitudinal seams, transverse joints and connections made airtight with sealant tape or combination thereof.
	.3	Class C: transverse joints and connections made air tight with gaskets sealant tape or combination thereof. Longitudinal seams unsealed.

<u>2.2 SEALANT</u>	.1	Sealant: oil resistant, polymer type flame resistant duct sealant. Temperature range of minus 30°C to plus 93°C.
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<u>2.3 TAPE</u>	.1	Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide.
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<u>2.4 DUCT LEAKAGE</u>	.1	In accordance with SMACNA HVAC Duct Leakage Test Manual.
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<u>2.5 FITTINGS</u>	.1	Fabrication: to SMACNA.
	.2	Radiused elbows:

- 2.5 FITTINGS
(Cont'd)
- .2 (Cont'd)
 - .1 Rectangular: Centreline radius: 1.5 times width of duct.
 - .2 Round: smooth radius or five piece. 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 radius on branch 1.5 times width of duct or 450mm entry on branch.
 - .2 Round main and branch: enter main duct at 450mm with conical connection.
 - .3 Provide volume control damper in branch duct near connection to main duct.
 - .4 Main duct branches: with volume control damper.
 - .5 Transitions:
 - .1 Diverging: 200 degree maximum included angle.
 - .2 Converging: 300 degree maximum included angle.
 - .6 Offsets:
 - .1 Full short radiused elbows as indicated.
 - .7 Obstruction deflectors: maintain full crosssectional area. Maximum included angles: as for transitions.
- 2.6 FIRE STOPPING
- .1 Retaining angles around duct, on both sides of fire separation only if required by authority having jurisdiction.
 - .2 Firestopping material and installation must not distort duct.
- 2.7 GALVANIZED STEEL
- .1 Lock forming quality: to ASTM A653, G90 zinc coating.
 - .2 Thickness, fabrication and reinforcement: to SMACNA.
 - .3 Joints: to SMACNA or proprietary manufactured duct joint. Proprietary manufactured flanged duct joint to be considered to be a class A seal.
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- 2.8 STAINLESS STEEL
- .1 To ASTM A480/A480M, Type 304.
 - .2 Finish: No 4. finish on exposed side of duct in finished area's, No. 3 finish or lower where concealed.
 - .3 Thickness, fabrication and reinforcement: to SMACNA.
 - .4 Joints: to SMACNA and continuously inert gas welded.

- 2.9 ALUMINUM
- .1 To SMACNA. Aluminum type: 3003H14.
 - .2 Thickness, fabrication and reinforcement: to SMACNA.
 - .3 Joints: to SMACNA and continuously welded.

- 2.10 BLACK STEEL
- .1 To ASTM A635/A635M.
 - .2 Thickness: 1.2 mm
 - .3 Fabrication: ducts and fittings or SMACNA.
 - .4 Reinforcement: to SMACNA.
 - .5 Joints: continuous weld.

- 2.11 HANGERS AND SUPPORTS
- .1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct. Maximum size duct supported by strap hanger: 500 mm.

- .2 Hanger configuration: to SMACNA.
- .3 Hangers: galvanized steel angle with black steel rods to ASHRAE or SMACNA following table:

Duct Size	Angle Size	Rod Size
(mm)	(mm)	(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
1501 to 2100	50 x 50 x 3	10
2101 to 2400	50 x 50 x 5	10
2401 and over	50 x 50 x 6	10

- .4 Upper hanger attachments:
-

2.11 HANGERS AND SUPPORTS

(Cont'd)

- .1 For concrete: manufactured concrete inserts.
- .2 For steel joist: manufactured joist clamp steel plate washer.
- .3 For steel beams: manufactured beam clamps:

PART 3 - EXECUTION

3.1 GENERAL

- .1 Do work in accordance with NFPA 90A, NFPA 90B, and SMACNA.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods. Insulate strap hangers 100 mm beyond insulated duct.
- .3 Support risers in accordance with SMACNA.
- .4 Install breakaway joints in ductwork on sides of fire separation. Do not place fire stopping material in expansion space between damper sleeve and fire partition.
- .5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .6 Manufacture duct in lengths and diameter to accommodate installation of acoustic 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 SMACNA or as follows:

Duct Size	Spacing
(mm)	(mm)
to 1500	3000
1501 and over	2500

3.3 WATERTIGHT DUCT

- .1 Provide watertight duct for:
 - .1 Fresh air intake.

3.3 WATERTIGHT DUCT
(Cont'd)

- .1 (Cont'd)
- .2 Minimum 3000 mm from duct mounted humidifier in all directions.
- .3 As indicated.
- .2 Form bottom of horizontal duct without longitudinal seams. Solder or weld joints of bottom and side sheets. Seal other joints with duct sealer.
- .3 Slope horizontal branch ductwork down towards fume hoods served. Slope header ducts down toward risers.
- .4 Fit base of riser with 150 mm deep drain sump and NPS 1 ½ drain connected, with deep seal trap and valve and discharging to open funnel drain or service sink or as approved by Departmental Representative.

3.4 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. Sealant and tape to be applied to full perimeter of duct.

3.5 LEAKAGE TESTS

- .1 In accordance with SMACNA HVAC Duct Leakage Test Manual.
- .2 Do leakage tests in sections.
- .3 Make trial leakage tests as instructed to demonstrate workmanship.
- .4 Install no additional ductwork until trial test has been passed.
- .5 Test section minimum of 30 m long with not less than three branch takeoffs and two 90 degree elbows.
- .6 Complete test before insulation or concealment.

PART 1 - GENERAL

1.1 RELATED SECTIONS .1 Submittal Procedures: Section 01 33 00

1.2 REFERENCES .1 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
.1 SMACNA HVAC Duct Construction Standards Metal and Flexible.

1.3 PRODUCT DATA .1 Submit product data in accordance with Section 01 33 00.
.2 Indicate the following:
.1 Flexible connections.

1.4 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.

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 0.66 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 400C to plus 900 degrees C, density of 1.3 kg/m².

2.3 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.

2.4 WALL CAPS .1 Galvanized steel, 90° turndown hood complete with bug screen.

PART 3 - EXECUTION

3.1 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 Allow for slack material in flexible connection.

PART 1 - GENERAL

- | | | |
|-----------------------------|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.1 RELATED SECTIONS</u> | .1 | Submittal Procedures: Section 01 33 00 |
| | .2 | Closeout Submittals: Section 01 78 00 |
| <u>1.2 PRODUCT DATA</u> | .1 | Submit product data in accordance with Section 01 33 00. |
| | .2 | Indicate the following: <ul style="list-style-type: none">.1 Capacity..2 Throw and terminal velocity..3 Noise criteria..4 Pressure drop..5 Neck velocity. |
| <u>1.3 SAMPLES</u> | .1 | Submit samples in accordance with Section 01 33 00. |
| <u>1.4 CERTIFICATIONS</u> | .1 | Catalogued or published ratings must be those obtained from tests carried out by manufacturer or from independent testing agency signifying adherence to codes and standards. |
| <u>1.5 EXTRA MATERIALS</u> | .1 | Provide maintenance materials in accordance with Section 01 78 00. |
| | .2 | Include: <ul style="list-style-type: none">.1 Keys for volume control adjustment..2 Keys for air flow pattern adjustment. |

PART 2 - PRODUCTS

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|--------------------|----|----------------------------------------------------------------------------------------|
| <u>2.1 GENERAL</u> | .1 | To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity. |
| | .2 | Frames: <ul style="list-style-type: none">.1 Full perimeter gaskets. |
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- | | | |
|--------------------------------|----|-----------------------------------------------------------------|
| <u>2.1 GENERAL</u>
(Cont'd) | .2 | (Cont'd) |
| | .2 | Plaster frames where set into plaster or gypsum board. |
| | .3 | Concealed fasteners. |
| | .3 | Concealed manual volume control damper operators as indicated. |
| | .4 | Colour: standard or as directed by Departmental Representative. |

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|-------------------------------|----|--------------------------------------------------------|
| <u>2.2 MANUFACTURED UNITS</u> | .1 | Grilles, registers and diffusers of same generic type. |
| | .2 | Use the products of one (1) manufacturer throughout. |

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|-----------------------------------------|----|---------------|
| <u>2.3 SUPPLY GRILLES AND REGISTERS</u> | .1 | See Schedule. |
|-----------------------------------------|----|---------------|

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|-----------------------------------------------------|----|---------------|
| <u>2.4 RETURN AND EXHAUST GRILLES AND REGISTERS</u> | .1 | See Schedule. |
|-----------------------------------------------------|----|---------------|

- | | | |
|----------------------|----|---------------|
| <u>2.5 DIFFUSERS</u> | .1 | See Schedule. |
|----------------------|----|---------------|

- | | | |
|---------------------------|----|---------------|
| <u>2.6 LINEAR GRILLES</u> | .1 | See Schedule. |
|---------------------------|----|---------------|

PART 3 - EXECUTION

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|-------------------------|----|--------------------------------------------------------------------------------------------------------------------|
| <u>3.1 INSTALLATION</u> | .1 | Install in accordance with manufacturers instructions. |
| | .2 | Install with flat head stainless steel or cadmium plated screws in countersunk holes where fastenings are visible. |
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3.1 INSTALLATION <u>(Cont'd)</u>	.3	Provide concealed safety chain on each grille, register and diffuser in gymnasium and similar game rooms and elsewhere.
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PART 1 - GENERAL

1.1 REFERENCES

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 84-2013, Method of Testing Air-to-Air Heat/Energy Exchangers (ANSI Approved).
- .2 AHRI 1060 - Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment, 2014.
- .3 NFPA 90A-2015, Installation of Air Conditioning and Ventilating Systems.
- .4 NFPA 90B-2015, Standard Specification for the Installation of Warm Air Heating and Air-Conditioning Systems.
- .5 UL 723-2008, Test for Surface Burning Characteristics of Building Materials.
- .6 UL 1812-2013, Ducted Heat Recovery Ventilators.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for energy recovery ventilator and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Test Reports:
 - .1 Catalogued or published ratings: obtained from tests carried out by manufacturer or those ordered from independent testing agency signifying adherence to codes and standards in force.

1.3 MAINTENANCE MATERIAL SUBMITTALS

- .1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Furnish list of individual manufacturer's recommended spare parts for equipment include:
 - .1 Two (2) sets of filters.
-

1.4 DELIVERY,
STORAGE AND
HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

- .2 Storage and Handling Requirements:
.1 Store materials indoors and in a clean, dry location and protect equipment from damage.
.2 Replace defective or damaged materials with new.

1.5 WARRANTY

.1 Warranty that expressly states the ERV core will be free of manufacturing defects and will retain its functional characteristics, under circumstances of normal use, for a period of ten (10) years from the date of installation. Also provide a warranty for the balance-of-unit to be free of manufacturing defects and to retain its functional characteristics, under circumstances of normal use, for a period of two (2) years from the date of purchase.

1.6 QUALITY
ASSURANCE

.1 Provide evidence of independent testing of the core by Underwriters Laboratory (UL), verifying a maximum flame spread index (FSI) of 25 and a maximum smoke developed index (SDI) of 50 thereby meeting NFPA 90A and NFPA 90B requirements for materials in a compartment handling air intended for circulation through a duct system. The method of test must be UL Standard 723.

PART 2 - PRODUCTS

2.1 AIR TO AIR
FIXED PLATE
EXCHANGER

.1 Energy Recovery Ventilator (ERV): packaged unit that transfers both sensible and latent energy using static plate core technology.

.2 AHRI published certifications must confirm manufacturer's published performance for airflow, static pressure, temperature and total effectiveness, purge air (OACF) and exhaust air leakage (EATR). Products that are not currently AHRI Certified will not be accepted. OACF must be no more than 1.02 and EATR must be at 0% against balanced airflow.

2.1 AIR TO AIR
FIXED PLATE
EXCHANGER

(Cont'd)

- .3 Unit must be listed under UL 1812 and comply with CSA Standard 22.2. Some exceptions to UL Listing may apply.
- .4 The ERV must be capable of transferring both sensible and latent energy between airstreams. Latent energy transfer shall be accomplished by direct water vapor transfer from one airstream to the other, without exposing transfer media in succeeding cycles directly to the exhaust air and then to the fresh air.
- .5 The ERV core must perform without condensing or frosting under normal operating conditions (defined as outside temperatures above -23.3°C) and inside relative humidity below 40%. Occasional more extreme conditions must not affect the usual function, performance or durability of the core. No condensate drains will be allowed.
- .6 Unit to have the capacity to operate continuously without the need for bypass, recirculation, pre-heaters or defrost cycles under normal operating conditions.
- .7 Water vapor transfer to be through molecular transport by hygroscopic resin and must not be accomplished by "porous plate" mechanisms. Exhaust and fresh airstreams will travel at all times in separate passages, and airstreams must not mix. No metal separators or metal core material will be acceptable.
- .8 Airflow through the ERV core to be laminar over the products entire operating airflow range, avoiding deposition of particulates on the interior of the energy exchange plate material.
- .9 The energy recovery component must be of fixed-plate cross-flow construction, with no moving parts.
- .10 No condensate drain pans or drains will be allowed and unit must be capable of operating in both winter and summer conditions without generating condensate.
- .11 Provide the unit case constructed of G90 galvanized, 0.81mm (20-gauge) steel, with lapped corners and zinc-plated screw fasteners.

2.1 AIR TO AIR
FIXED PLATE
EXCHANGER
(Cont'd)

- .12 Access doors to provide easy access to blowers, ERV cores, and filters. Doors to have an airtight compression seal using closed cell foam gaskets. Pressure taps, with captive plugs, Provide allowing cross-core pressure measurement allowing for accurate airflow measurement.
- .13 Insulate case walls and doors with 25mm, 1.81 kg density, foil/scrim faced, high-density fiberglass board insulation, providing a cleanable surface and eliminating the possibility of exposing the fresh air to glass fibers, and with minimum RSI value of 0.7572 m²x°C/W (R value = 4.3 hr x ft² x F°/BTU). EV450IN case walls and doors shall be insulated with 22.23mm, expanded polystyrene foam insulation faced with a cleanable foil face on all exposed surfaces.
- .14 Protect ERV cores by a MERV-8 rated, 50mm nominal, pleated, disposable filter in both airstreams.
- .15 Unit to have single-point power connection and a single-point 24 VAC contactor control connection.
- .16 Blower motors to be ECM motors, EISA compliant for energy efficiency. The blower motors must be totally enclosed (TEFC) Direct drive models must be EISA-compliant for energy efficiency with open drip proof design and integral thermal protection.
- .17 Blowers to be quiet running, forward curve type and be either direct drive or belt drive. Provide belt drive motors with adjustable pulleys and motor mounts allowing for blower speed adjustment, proper motor shaft orientation and proper belt tensioning.
- .18 Unit electrical box to include a factory installed, non-fused disconnect switch and a 24 VAC, Class II transformer/relay package.
- .19 Provide the ERV "inverter-ready" allowing for applications of inverters supplied and installed by others.
- .20 Units are available single or three phase at a full range of operating voltages. See project schedule.
- .21 Provide motor horsepower as specified in project schedule.
- .22 Provide factory installed disconnect fuses.

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|---------------------------------------------------------------|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2.1 AIR TO AIR
FIXED PLATE
EXCHANGER
<u>(Cont'd)</u> | .23 | Provide MERV-13 filters for final installation after construction phase. |
| | .24 | Provide ECM controlled motors allowing either two (2) preset speeds or variable speed operation with a 0-10 volt DC control signal. |
| | .25 | Provide factory installed isolation dampers for either or both air streams. The insulated dampers must be of a low leakage design and shall not restrict the airstream, reducing airflow, in any way. The dampers to be opened with a motor actuator powered by the standard unit transformer package and have a spring return for low off- position power consumption. |
| | .26 | Controls: Wall mounted carbon dioxide control, with the following characteristics:
.1 Adjustable control from 600-2000mg/kg (600-2000 PPM).
.2 Digital display.
.3 24 VAC power requirement.
.4 Self calibrates during periods of low occupancy. |

PART 3 - EXECUTION

- | | | |
|-------------------------|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>3.1 EXAMINATION</u> | .1 | Verification of Conditions: verify conditions of substrate are acceptable for energy recovery equipment installation in accordance with manufacturer's written instructions. |
| <u>3.2 INSTALLATION</u> | .1 | Install in accordance with manufacturers recommendations. |
| | .2 | Support independently of adjacent ductwork with flexible connections. |
| | .3 | Locate, orient, and connect ductwork per AMCA, ASHRAE, and SMACNA guidelines. Provide service clearances as indicated on the plans. Locate units distant from sound critical occupancies. |
| | .4 | Provide a structurally suitable support for the base of any wall mounted or hung units. |
-

3.2 INSTALLATION
(Cont'd)

- .5 Provide rubber or spring type isolators appropriately sized for corner weights of the specific unit.
- .6 Provide flexible duct connections at unit duct flanges.
- .7 Design, construct, seal and support ductwork in accordance with SMACNA HVAC Duct Construction Standards and pressure classifications.
- .8 At a minimum all duct runs to the outdoors to be thermally insulated at levels appropriate to the local climate. Provide a continuous vapor barrier on warm surface of the insulation.
- .9 To control sound associated with the two (2) blower outlets:
 - .1 Provide straight, gradual transition ductwork for a minimum of 63.5mm duct diameters downstream from the blower outlet for air velocities of less than 12.7m/s.
 - .2 Provide continuous acoustic insulation treatment of the duct until after the first elbow or tee.
 - .3 Provide engineered sound attenuation ductwork to meet noise criteria (NC) requirements.
- .10 Test and Balancing may not begin until 100% of the installation is complete and fully functional.
- .11 Follow National Environmental Balancing Bureau (NEBB) air test and balance procedures specific to energy recovery devices. Provide balancing reports to the Departmental Representative.
- .12 Face and By-pass damper actuators are equipped with the ability to balance the airflow between ventilation and by-pass operation.

3.3 FIELD QUALITY
CONTROL

- .1 Tests:
 - .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
 - .2 Include: confirmation of fan rotation.

PART 1 - GENERAL

- | | | |
|--------------------|----|--------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.1 SUMMARY</u> | .1 | Materials and installation for self-contained multizone and single zone, gas, electric, hot water and refrigeration packaged rooftop HVAC units. |
|--------------------|----|--------------------------------------------------------------------------------------------------------------------------------------------------|
-
- | | | |
|-----------------------------|----|--------------------------------------------------------------------------|
| <u>1.2 RELATED SECTIONS</u> | .1 | Section 01 33 00 - Submittal Procedures |
| | .2 | Section 01 35 29 - Health and Safety Requirements |
| | .3 | Section 01 45 00 - Quality Control |
| | .4 | Section 01 74 21 - Construction/Demolition Waste Management and Disposal |
| | .5 | Section 01 78 00 - Operation and Maintenance Manuals. |
-
- | | | |
|-----------------------|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>1.3 REFERENCES</u> | .1 | American National Standards Institute (ANSI)/Air Conditioning and Refrigeration Institute (ARI):
.1 ANSI/ARI 210/240-2008, Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
.2 ARI 270-2008, Sound Rating of Outdoor Unitary Equipment. |
| | .2 | ANSI/UL 1995-2015, Standard for Heating and Cooling Equipment. |
| | .3 | Canadian Standards Association (CSA):
.1 CSA B52-13, Mechanical Refrigeration Code.
.2 CSA C22.1-15, Canadian Electrical Code. |
| | .4 | Health Canada / Workplace Hazardous Materials Information System (WHMIS):
.1 Material Safety Data Sheets (MSDS). |
| | .5 | National Roofing Contractors Association (NRCA). |
| | .6 | National Fire Protection Association (NFPA):
.1 NFPA 90A-2015, Installation of Air Conditioning and Ventilating Systems. |
| | .7 | American Bearing Manufacturer's Association (ABMA):
.1 ANSI/ABMA 9:2015, Load Ratings and Fatigue Life for Ball Bearings. |
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1.3 REFERENCES

(Cont'd)

- .7 (Cont'd)
 - .2 ANSI/ABMA 11:2014, Load Ratings and Fatigue Life for Roller Bearings.
- .8 Air Movement and Control Association (AMCA):
 - .1 AMCA 300-14, Reverberant Room Method for Sound Testing of Fans.
- .9 National Electrical Manufacturer's Association (NEMA):
 - .1 NEMA MG1-2016 Motors and Generators.
 - .2 NEMA ICS 7-2006 Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.
- .10 Provincial Boiler, Pressure Vessel and Compressed Gas Regulations.

1.4 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 packaged rooftop HVAC units.
 - .3 Shop Drawings:
 - .1 Submit shop drawings to indicate project layout and dimensions; indicate:
 - .1 Equipment, piping, and connections, together with valves, strainers, control assemblies, thermostatic controls, auxiliaries and hardware, and recommended ancillaries which are mounted, wired and piped ready for final connection to building system, its size and recommended bypass connections.
 - .2 Piping, valves, fittings shipped loose showing final location in assembly.
 - .3 Control equipment shipped loose, showing final location in assembly.
 - .4 Complete internal panel pneumatic tube piping and wiring and external panel pneumatic tube piping and wiring, both as schematics and as actually assembled.
-

1.4 SUBMITTALS
(Cont'd)

- .3 (Cont'd)
 - .1 (Cont'd)
 - .5 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, mounting curb details, sizes and location of mounting bolt holes; include mass distribution drawings showing point loads.
 - .6 Detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices of ancillaries, accessories, controllers.
 - .7 Pump and fan performance curves.
 - .8 Details of vibration isolation.
 - .9 Estimate of sound levels to be expected across individual octave bands in dB referred to A rating.
 - .10 Type of refrigerant used.
 - .4 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
 - .5 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .6 Instructions: submit manufacturer's installation instructions.
 - .7 Manufacturer's Field Reports: manufacturer's field reports specified.
 - .8 Submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Operation and Maintenance Manual include data as follows:
 - .1 Indicate: brief description of unit, indexed, with details of function, operation, control, and service for components.
 - .2 Provide for units, manufacturer's name, type, year, number of units, and capacity.
-

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 Separate for reuse and recycling and place in designated containers steel, metal, plastic waste in accordance with Waste Management Plan (WMP).
 - .5 Handle and dispose of hazardous materials in accordance with Canadian Environmental Protection Act (CEPA), Transportation of Dangerous Goods Act (TDGA), Regional and Municipal, regulations.
 - .6 Divert unused metal materials from landfill to metal recycling facility as approved by the Departmental Representative.

1.6 WARRANTY

- .1 Provide a warranty that expressly states the packaged rooftop HVAC units and refrigeration compressors will function and operate for a minimum 24 months and any malfunction will be 100% covered by the manufacturer including expenses.

PART 2 - PRODUCTS

2.1 GENERAL

- .1 Roof mounted, self-contained single zone unit with electric heating elements and DX heat pump refrigeration and bear label of CSA.
 - .2 Units to consist of cabinet and frame, supply fan, control, air filter, refrigerant cooling coil, compressor, condenser coil and fans, heating coil, economizer as indicated in schedule.
 - .3 Prefabricated roof curb to conform to requirements of National Roofing Contractors Association (NRCA), minimum height 450 mm.
 - .4 Conform to ANSI/ARI 210/240, rating for unit larger than 40 kW nominal.
-

2.2 CABINET

- .1 Cabinets: weatherproofing tested and soundproofing tested to ARI 270, dbA at 3m free field.
- .2 Framing and supports: 2mm thick welded steel, galvanized after manufacture, with lifting lugs at top of unit and/or fork lift slots at bottom.
- .3 Outer casing: weathertight galvanized steel with baked enamel finish.
- .4 Access: removable gasketted hinged doors or panels with locking door handle type or screwdriver operated flush cam type fasteners.
- .5 Insulation: neoprene coated glass fiber on surfaces, 50 mm thick, 32 kg/m³ density.

2.3 FAN

- .1 Centrifugal, forward curved impellers, backward inclined, or airfoil, statically and dynamically balanced. Multi V-belt drive with adjustable variable pitch motor pulley, rubber spring isolated hinge mounted motor fan, and motor integrally mounted on isolation base, separated from unit casing with flexible connections and spring isolators. Vibration isolators: 95% efficiency.

2.4 AIR FILTERS

- .1 50 mm thick, MERV 8, metal framed, replaceable media or throwaway.
- .2 To meet NFPA 90A, air filter requirements type Class 1 or type Class 2.

2.5 ELECTRIC HEATERS

- .1 Nickel chromium electric resistant type, 64.6 kW/m² stage maximum density at 2.6 m/s.
 - .2 Controls:
 - .1 Panel board with multi- stage or modulating SCR controller.
 - .2 Indicating light centre.
 - .3 Remote thermostats as indicated.
 - .4 Fuseblocks (one per step unless otherwise specified).
 - .5 Built-in control transformer.
 - .6 Thermal cut outs: manual reset disc types, one per circuit, one linear bulb type automatic reset.
-

2.5 ELECTRIC
HEATERS

(Cont'd)

- .2 (Cont'd)
 - .7 Built-in un-fused disconnect switch.
 - .8 Elements control: accessible with protection against no air flow, short and grounds, and of self checking type.
 - .9 High limit temperature control: de-energize heating elements to protect against over heating.
 - .10 Supply fan: start before electric elements are energized and continue operating until temperature reaches minimum setting. Include switch for continuous fan operation.
 - .11 Conform to Canadian Electrical Code CSA C22.1.

2.6 REFRIGERATION

- .1 Conform to CSA B52 and ANSI/UL 1995 requirements.
- .2 Compressor/condenser section:
 - .1 Semi-hermetic or hermetic compressors, vibration isolated with flexible suction and discharge connections, oil sight glass, oil pressure switch, crankcase heater, and automatic pump down system with control to liquid line solenoid valve.
 - .2 Fans: propeller type with single piece spun venturi outlets and zinc plated guards. Motors shall be sequenced for head pressure control.
 - .3 Electrical system shall have operating controls, oil and refrigerant pressure protection, motor overload protection, weatherproof electrical wiring with weatherproof, rain tight disconnect.
 - .4 Include refrigerant piping with, sight glass, filter drier and valves.
 - .5 Condenser: staggered copper tube, aluminum fin coil assembly with sub-cooling rows to provide 6°C sub-cooling.
 - .6 Capacity reduction: cylinder unloading. Provide flooding for head pressure control for low ambient operation down to 0°C ambient temperature.
 - .7 Refrigerant: R410A.
- .3 Evaporator:
 - .1 Rated to ANSI/ARI 210/240.
 - .2 Thermostatic expansion valve, with adjustable super heat and external equalizer.
 - .3 Coil: NPS 1/2 or NPS 5/8 staggered seamless copper tubes expanded into aluminum fins and insulated condensation pan.

2.6 REFRIGERATION .3 (Cont'd)
 (Cont'd)

 .4 Cooling coil condensate drain pans: designed to avoid standing water, to be easily cleaned or removable for cleaning. Drain connection to have deep seal trap (adequate height of base rail to accommodate).

2.7 CONTROLS

 .1 In addition to safety controls, provide smoke sensors in return to NFPA standards, low limit on supply and freeze protection on water coils.

 .2 Single Zone Heat-Cool Unit:
 .1 Low voltage, adjustable room thermostat controls, heater stages in sequence with delay between stages, compressor and supply fan shall maintain room temperature setting.
 .2 Thermostat: include system selector switch day-night, heat-cool-auto-off and fan control switch (on-auto).
 .3 Economizer controls: provide economizer controller to override cooling when OA conditions allow.

 .3 Night mode: unit cycles as unit heater with 100% recirculation on winter cycles.

 .4 Night set-back: 15°C.

2.8 REMOTE PANEL

 .1 Provide remote readout panel for each unit containing:
 .1 Signal lights indicating system status, heating system failure cooling system failure and dirty filters.
 .2 Check switches proving signal light operation.
 .3 System on-off switch.
 .4 Fan on-off switch.
 .5 Manual 6 h timer to override night-set back control.

 .2 Provide gauges in remote panel indicating outside air, mixed air, return air and discharge air temperatures for each deck before heat exchangers.

2.9 CAPACITY .1 Capacity: see schedule.

PART 3 - EXECUTION

- | | | |
|----------------------------------------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>3.1 MANUFACTURER'S INSTRUCTIONS</u> | .1 | Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet. |
| <u>3.2 INSTALLATION</u> | .1 | Install as per manufacturers' instructions on roof curbs provided by manufacturer. |
| | .2 | Manufacturer's representative to certify installation, supervise start-up and commission unit. |
| | .3 | Run drain line from cooling coil condensate drain pan to discharge over roof. |
| <u>3.3 FIELD QUALITY CONTROL</u> | .1 | Manufacturer's Field Services:
.1 Have manufacturer's representative of products supplied under this Section review work involved in handling, installation/application, protection and cleaning of its products, and submit written reports, in acceptable format, to verify compliance of work with Contract.
.2 Provide manufacturer's field services, consisting of product use recommendations and periodic site visits for inspection of product installation, in accordance with manufacturer's instructions.
.3 Schedule site visits to review work at stages listed:
.1 After delivery and storage of products, and when preparatory work on which work of this Section depends is complete, but before installation begins.
.2 Twice during progress of work at 25% and 60% complete.
.3 Upon completion of work, after cleaning is carried out. |
| | .2 | Obtain reports within three (3) working days of review and submit immediately to the Departmental Representative. |
-

3.3 FIELD QUALITY
CONTROL
(Cont'd)

- .3 Verify accessibility, serviceability of components including motorized dampers, filters coils, fans, motors, operators, humidifiers, sensors, electrical disconnects.
- .4 Verify accessibility, cleanability, drainage of drain pans for coils, humidifiers.
- .5 Performance Verification:
 - .1 General:
 - .1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems, supplemented as specified herein.
 - .2 Rooftop Air Handling Units:
 - .1 Set zone mixing dampers for full cooling, except that where diversity factor forms part of design set that % of zone dampers to full heating.
 - .2 Set outside air and return air dampers for minimum outside air.
 - .3 Set face and bypass dampers so face dampers are fully open and bypass dampers are fully closed.
 - .4 Check for smooth, vibrationless correct rotation of supply fan impeller.
 - .5 Measure supply fan capacity.
 - .6 Adjust impeller speed as necessary and repeat measurement of fan capacity.
 - .7 Measure pressure drop for each component of air handling unit.
 - .8 Set outside air and return air dampers for the % of outside air required by design and repeat measurements of fan capacity.
 - .9 Reduce differences between fan capacity at minimum and maximum outside air less than 5%.
 - .10 Set face and bypass dampers to full bypass and repeat measurement of fan capacity.
 - .11 Reduce difference between fan capacity with F&BPD fully closed to bypass and fully open to bypass to less than 5%.
 - .12 Reduce difference between fan capacity at full cooling and fan capacity at full heating to less than 5%.
 - .13 OAD: verify for proper stroking, interlock with RAD.
 - .14 Measure DBT, WBT of SA, RA, EA.
 - .15 Measure air cooled condenser discharge DBT.
 - .16 Measure flow rates (minimum and maximum) of SA, RA, EA, relief air.

- 3.3 FIELD QUALITY .5 (Cont'd)
- CONTROL .2 (Cont'd)
- (Cont'd)
- .17 Simulate maximum cooling load and measure refrigerant hot gas and suction temperatures and pressures.
 - .18 Use smoke test to verify no short-circuiting of EA, relief air to outside air intake or to condenser intake.
 - .19 Simulate maximum heating load and:
 - .1 Verify temperature rise across heat exchanger.
 - .2 Perform flue gas analysis. Adjust for peak efficiency.
 - .3 Verify combustion air flow to heat exchanger.
 - .4 Simulate minimum heating load and repeat measurements.
 - .20 Measure radiated and discharge sound power levels under maximum heating demand and under maximum cooling demand with compressors running.
 - .21 Verify operating control strategies, including:
 - .1 Heat exchanger operating and high limit.
 - .2 Early morning warm-up cycle.
 - .3 Freeze protection.
 - .4 Economizer cycle operation, temperature of change-over.
 - .5 Alarms.
 - .6 Voltage drop across thermostat wiring.
 - .7 Operation of remote panel including pilot lights, failure modes.
 - .22 Set zone mixing dampers for full heating and repeat measurements.
 - .23 Measure leakage past zone mixing dampers by taking temperature measurements. Reduce leakage to less than 5%.
 - .24 Measure return fan capacity.
 - .25 Adjust impeller speed as necessary and repeat measurement of return fan capacity.
 - .26 Check capacity of heating unit.
 - .27 Measure DX refrigeration system performance as specified Section.
 - .28 Refer to other sections of these specifications for PV procedures for other components.
- .3 Start-Up:
-

- 3.3 FIELD QUALITY .5 (Cont'd)
CONTROL .3 (Cont'd)
(Cont'd) .1 General: in accordance with Section 23 08
02 - Cleaning and Start-up of Mechanical Piping
Systems.
.4 Verify accessibility, serviceability of
components including motorized dampers, filters,
coils, fans, motors, operators, humidifiers,
sensors, electrical disconnects.
.5 Verify accessibility, cleaning, drainage of
drain pans for coils and humidifiers.
- 3.4 CLEANING .1 On completion and verification of performance of
installation, remove surplus materials, excess
materials, rubbish, tools and equipment.

PART 1 - GENERAL

1.1 RELATED
SECTIONS

- .1 Submittal Procedures: Section 01 33 00
- .2 Waste Management and Disposal: Section 01 74 21
- .3 Refrigerant Piping: Section 23 23 00
- .4 HVAC Controls: Field Control Devices: Section 25 30 02

1.2 REFERENCES

- .1 Air-Conditioning and Refrigeration Institute (ARI)
 - .1 ARI 210/240-2008, Standard for Unitary Air Conditioning and Air-Source Heat Pump Equipment.
- .2 American National Standards Institute/National Fire Protection Association (ANSI/NFPA)
 - .1 ANSI/NFPA 90A-2015, Installation of Air Conditioning and Ventilating Systems.
- .3 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE Standard 15-2016, Safety Standard for Refrigeration Systems.
- .4 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-C13256-2-01 (R2015), Performance of Ground and Water Source Heat Pumps.
 - .2 CAN/CSA-C656-14, Performance Standard for Single Package Central Air Conditioners and Heat Pumps.
- .5 Environment Canada, (EC)/Environmental Protection Services (EPS)
 - .1 EPS 1/RA/2-1996, Code of Practice for Elimination of Fluorocarbons Emissions from Refrigeration and Air Conditioning Systems.
 - .2 Environment Canada-1994, Ozone-Depleting Substances Alternatives and Suppliers List.

1.3 SHOP DRAWINGS
AND PRODUCT DATA

- .1 Submit shop drawings in accordance with Sections 01 33 00.
- .2 Indicate:
 - .1 Capacities.

1.3 SHOP DRAWINGS
AND PRODUCT DATA
(Cont'd)

- .2 (Cont'd)
- .2 ARI Ratings.
- .3 Sound Power levels.
- .4 Installation instructions.
- .5 Start-up Instructions.
- .6 O&M, Instructions.

1.4 WASTE
MANAGEMENT AND
DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21.
- .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.
- .4 Divert unused metal and wiring materials from landfill to metal recycling facility approved by the Departmental Representative.

1.5 WARRANTY

- .1 Provide a warranty that expressly states the heat pumps are comprehensively covered for a period of six (6) years.

PART 2 - PRODUCTS

2.1 GENERAL

- .1 Heat pumps/AC units: CSA approved and carry ARI or CSA certification seal.
- .2 Provide any additional accessories and controls required for a complete working system as indicated on drawings.

2.2 REFRIGERANTS

- .1 Type of Refrigerant: R410A.

2.3 DRAIN PANS

- .1 Design and construct condensate drain pans under indoor coils so that no water can accumulate and install to allow for easy cleaning.
-

2.3 DRAIN PANS .2 Include condensate pumps as required.
(Cont'd)

2.4 AIR-SOURCE HEAT .1 As per schedules.
PUMP/AC

2.5 ZONE .1 Wired wall mount controller complete with 7-day
CONTROLLERS schedule, heating/cooling/auto modes.

PART 3 - EXECUTION

3.1 INSTALLATION .1 Install where indicated and in accordance with the
manufacturer's instructions.

.2 Install outdoor units in accordance with
manufacturer's instructions.

.3 Secure with hold-down bolts.

.4 Make duct connections through flexible connections.

.5 Level unit with fans running. Align ductwork.
flexible connections. Misalignment with fan stopped
not to strain or damage flexible connection.

.6 Make piping connections.

.7 Allow for nothing to obstruct ready access to
components or to prevent removal of components for
servicing.

.8 Provide complete controls for this system as
specified in this Section and Division 25.

3.2 DRAIN PANS .1 Install so that no water can accumulate and arrange
for easy access for cleaning.

3.3 CONTROLS .1 Provide wiring and programming as required for a
complete working system.

3.4 START-UP AND COMMISSIONING

- .1 Manufacturer to certify installation and performance. Submit written report to the Departmental Representative.
- .2 Demonstrate to the Departmental Representative operation of system, including sequences of operation, startup, shutdown, schedules, etc.

3.5 MAINTENANCE SERVICE DURING WARRANTY PERIOD

- .1 Provide services, materials, and equipment to maintain HVAC controls system for warranty period of one (1) year after date of substantial completion. Provide detailed preventative maintenance schedule for system components as described in Submittal article.
 - .2 Emergency Service Calls:
 - .1 Initiate service calls when controls system is not functioning correctly.
 - .2 Qualified control personnel to be available during warranty period to provide service to "CRITICAL" components whenever required at no extra cost.
 - .3 Furnish the Departmental Representative with telephone number where service personnel may be reached at any time.
 - .4 Service personnel to be on site ready to service system after receiving request for service.
 - .5 Perform work continuously until system restored to reliable operating condition.
 - .3 Operation: foregoing and other servicing to provide proper sequencing of equipment and satisfactory operation of system based on original design conditions and as recommended by manufacturer.
 - .4 Work requests: record each service call request, when received separately on approved form and include:
 - .1 Serial number identifying component involved.
 - .2 Location, date and time call received.
 - .3 Nature of trouble.
 - .4 Names of personnel assigned.
 - .5 Instructions of work to be done.
 - .6 Amount and nature of materials used.
 - .7 Time and date work started.
 - .8 Time and date of completion.
 - .5 Provide system modifications in writing.
-

3.5 MAINTENANCE	.5	(Cont'd)
SERVICE DURING		.1 No system modification, including operating
WARRANTY PERIOD		parameters and control settings, to be made without
(Cont'd)		prior written approval of Departmental

Representative.