

**Part 1            General**

**1.1                DEFINITIONS**

- .1    Provide means supply and install.
- .2    Work means material and labour.
- .3    Consultant means WSP CANADA Inc.

**1.2                GENERAL SCOPE**

- .1    Provide the work indicated in the contract documents and as required to provide complete, tested and fully operational systems including all work not normally indicated but necessary for a complete and operational installation.
- .2    The Contractor is expected to be experienced and competent and knowledgeable about the trades and applicable codes, ordinances and industry standards and shall perform the work accordingly, on schedule and fully coordinated with all other trades.
- .3    The Contract Documents for this Division are an integral part of the complete contract documents for the project and will be interpreted in conjunction with all other Divisions.

**1.3                CODES, REGULATIONS AND STANDARDS**

- .1    The work of this Section shall conform to the edition of Codes, Regulations and Standards in effect at the time of award of Contract, and conform to the requirements of the Authorities Having Jurisdiction.

**1.4                LIABILITY**

- .1    Be responsible for layout of work and for any damage caused by improper execution of work.
- .2    Be responsible for condition of materials and equipment supplied and protect all work until work completed and accepted.

**1.5                PERMITS AND FEES**

- .1    Obtain all required permits and pay all fees including service connection fees as applicable to the work of this Section. Comply with all Provincial, Municipal and other legal regulations and bylaws applicable to the work.
- .2    Where Authorities Having Jurisdiction provide inspection, arrange for their inspection of all work. On completion of the work, furnish final unconditional certificates of approval by the inspecting authorities.

**1.6                DRAWINGS AND MEASUREMENTS**

- .1    Except where precisely indicated, the contract documents are diagrammatic and generally indicate the scope of work and general arrangement and establish minimum quality and performance requirements. Where there are conflicting requirements the Contractor shall allow for and provide the better quality and/or greater quantity unless the conflicting requirements are interpreted otherwise in writing by the Consultant.
- .2    Consult the Architectural drawings for exact locations of fixtures and equipment.

### **1.7 WARRANTY**

- .1 Provide the Owner with a written warranty that the equipment installed and the work performed under this contract will remain in serviceable condition for one (1) year from the date of final acceptance. Warranty shall include parts and labour.

### **1.8 WORKMANSHIP**

- .1 Workmanship shall be in accordance with well-established practice and with standards accepted and recognized by the Consultant and the Trade.
- .2 The Consultant may reject any work not conforming to the Contract Documents or to accepted standards of performance, quietness of operation, finish or appearance.
- .3 Employ only tradesmen with valid Provincial Trade Qualification Certificates to perform only work permitted by their certificates.

### **1.9 SHOP DRAWINGS**

- .1 Shop drawings/product data shall be reviewed, signed and processed as described by the Mechanical Contractors Association of British Columbia.
- .2 Provide shop drawings of all equipment on the drawings and specifications to the Consultant for review.
- .3 Review or non-review of shop drawings does not alter the requirements of the equipment and materials provided to conform to the specification.

### **1.10 ASBESTOS**

- .1 All material/products provided shall be free of asbestos.

### **1.11 SEISMIC RESTRAINT**

- .1 Provide seismic restraints for the piping and ductwork systems and all equipment specified in this Section to meet the requirements of the Building Code, to be in general conformance to SMACNA Guidelines, to keep the equipment in place during a seismic event, to minimize damage to the systems and equipment from a seismic event, to prevent systems and equipment from causing personal injury during a seismic event.
- .2 Arrange and pay for the services of a structural Professional Engineer registered in British Columbia referred to here as the Seismic Engineer. The Seismic Engineer shall review, seal and sign all submittals required for all components, assemblies, attachments and installation procedures for the seismic restraint of all piping, ductwork and equipment installed under this Section. The Seismic Engineer shall provide all necessary direction to the contractor during installation of the seismic restraint installation and submit a statutory declaration that the final seismic restraint installation conforms to the submittal documents sealed by the Seismic Engineer and satisfies all regulatory requirements.
- .3 The Seismic Engineer shall submit Letters of Assurance Schedules S-B and S-C for the seismic restraint to the Consultant.
- .4 The Seismic Engineer shall coordinate attachment to the equipment with the equipment manufacturer to ensure the method and location of attachment of the seismic restraint to the equipment does not compromise the structural integrity of the equipment.
- .5 It is the entire responsibility of equipment manufacturers to design their equipment so that the strength and anchorage of the mounting points and internal components of the

equipment exceeds the force level used to restrain and anchor the unit itself to the supporting structure during a seismic event of code design magnitude.

#### **1.12 ACCESS DOORS**

- .1 Provide suitably sized flush mounted access doors in non-accessible type ceilings and walls, where necessary for access to service and/or to inspect mechanical equipment and accessories, life safety devices and where specifically indicated.
- .2 Provide stainless steel access doors in wet areas.
- .3 Size access doors to accommodate the required access.

#### **1.13 MISCELLANEOUS METAL**

- .1 Be responsible for all miscellaneous steel work relative to this Section of the Specifications, including but not limited to:
  - .1 Support of equipment.
  - .2 Hanging, supporting, anchoring, guiding and related work as it applies to piping, ductwork and mechanical equipment.
  - .3 Earthquake restraint devices.
- .2 All exterior miscellaneous steel shall be hot-dipped galvanized.
- .3 All steel work not galvanized shall be primed, undercoat painted and finish painted. On galvanized materials, which are subsequently welded, apply Galvicon.

#### **1.14 SPARE PARTS**

- .1 Provide spare parts as follows:
  - .1 One set of V-belts for each V-belt drive.
  - .2 One set of filters for each filter or filter bank installed

#### **1.15 COORDINATION**

- .1 Examine all contract drawings to verify space and headroom limitations for the required work. Coordinate the work with all trades and modify without changing the design intent to facilitate a satisfactory installation. Make no changes involving extra cost to the Owner without the Consultant's prior written approval.
- .2 Work out jointly all interference problems on the site and coordinate all work before fabricating, or installing any material or equipment. No consideration of payment will be made for additional work due to fabrication or installation of materials before a coordination issue was identified and resolved.
- .3 Coordinate deliveries with the General Contractor.

#### **1.16 EQUIPMENT INSTALLATION AND ACCESSIBILITY**

- .1 Provide unions and flanges to permit equipment maintenance, disassembly or removal, to minimize disturbance to piping and duct systems and to avoid interfering with building structure or other equipment.
- .2 All work shall be readily accessible for adjustment, operation and maintenance. Supply access doors where required in building surfaces for installation by building trades.
- .3 Ensure that equipment does not transmit noise or vibration to other parts of the building as a result of poor installation practices.

**1.17 CUTTING, PATCHING, DIGGING, CANNING AND CORING**

- .1 Lay out all cutting, patching, digging, canning and coring required to accommodate the mechanical services. Coordinate with other Divisions. Be responsible for correct location and sizing of all openings required under this Section. Allow oversized openings for firestopping, pipe penetrations where continuous insulation is specified and fire dampers.
- .2 Verify the location of existing service runs and structural components within existing concrete floor and walls prior to core drilling and/or cutting. The Contractor is responsible to repair existing services and structural components damaged as a result of core drilling and cutting.
- .3 Openings through structural members of the building shall not be made without the approval of the Consultant.

**1.18 ESCUTCHEONS AND PLATES**

- .1 Provide on pipes passing through walls, partitions, floors and ceilings where exposed to view in finished areas.
- .2 Plates shall be stamped steel, split type, chrome plated or stainless steel, concealed hinge, complete with springs, suitable for external dimensions of piping/insulation. Secure to pipe or finished surface. Outside diameter shall cover opening or sleeve.

**1.19 DUCT AND PIPE MOUNTED CONTROL EQUIPMENT**

- .1 Automatic control dampers will be supplied by the Controls Trade but shall be installed by the appropriate trade.

**1.20 CLEANING AND FINAL ADJUSTMENT**

- .1 Submit a letter certifying that the interior and exterior of all systems including filters are clean.

**1.21 PAINTING AND IDENTIFICATION**

- .1 Apply a coat of rust inhibiting primer to all exposed, bare steel provided under this Section.
- .2 Where mechanical services are visible from an occupied space through a grille, paint all visible surfaces matte black.
- .3 Make good any damage to factory finishes on equipment supplied under this Section.
- .4 Piping Identification
  - .1 Each system shall be labelled including directional flow arrows. Obtain from the Consultant the Pipe Identification Schedule.
  - .2 Identify piping adjacent to valves, at least once in each room, at 15 m [50 ft.] maximum spacing in open areas, both sides where piping passes through walls, partitions and floors, at penetration of each pipe chase or confined space, at each access opening.
  - .3 Identification labels may be stencilled or be vinyl cloth (Brady B500) or vinyl film (Brady B946), with adhesive compatible with the surface temperature.

- .5 Valve Tags
  - .1 Provide valve identification tags appropriately secured. Tags may be of brass, aluminum, metalphoto, laminated plastic or fiberglass, stamped or engraved, 25 mm [1"] minimum diameter.
  - .2 Schedule the valve numbers using a sequential numbering system to the building standard and continuing from the last listed valve. Provide a valve tag list indicating valve number, system, location, normal operating position (open or closed) and the area it serves.
- .6 Secure engraved laminated plastic identification tags (black face and white letters) on the following items:
  - .1 Temperature control instruments, gauges and panels, coordinated with control diagrams identification.

## **1.22 OPERATION AND MAINTENANCE MANUALS**

- .1 Provide one suitably sized 3-ring binder with suitable label with all required materials inside to the Consultants as a draft copy for review. Make all required changes and resubmit the one binder to the Consultant. Repeat until accepted. Then submit three (four) manuals identical to the accepted copy to the Owner. Obtain a receipt and send a copy of the receipt to the Consultant.
- .2 Provide an index and tab each section and the manual shall include:
  - .1 Layman's description of all systems and their operation.
  - .2 List of local source of supply.
  - .3 Maintenance, lubrication and filter schedules.
  - .4 Air and water balance report.
  - .5 Commissioning report.
  - .6 Copy of any required approvals, certifications, acceptance by Authorities Having Jurisdiction.
  - .7 All shop drawings.
  - .8 Manufacturer's operating and maintenance literature and wiring and control diagrams.
- .3 Provide the Consultant with a flash drive, CD or DVD containing an electronic version of the entire accepted manual in an unprotected PDF format, with hierarchical bookmarks for all sections (e.g. Shop Drawings → Plumbing Fixtures → Sinks → S-1). Make all required changes and resubmit to the Consultant. Repeat until accepted. Then submit three copies identical to the accepted copy to the Owner. Obtain a receipt and send a copy of the receipt to the Consultant.

## **1.23 RECORD DRAWINGS**

- .1 Keep a set of contract prints on site for the sole purpose of keeping an up-to-date, accurate record marked in red of the installation of mechanical services where they vary from the drawings.
- .2 Dimension the locations and inverts of buried or concealed services before they are concealed.
- .3 Submit the drawings to the Consultant. Make noted changes and corrections.

- .4 Upon completion of the Engineer's review, submit final Record Drawings to the Engineer. Final record drawings shall include revised CAD files prepared by a qualified draftsman to the same standards as the original drawings.

#### **1.24 DEMONSTRATION AND INSTRUCTION TO OWNER**

- .1 Provide certified personnel to demonstrate and provide maintenance instructions for each mechanical system to the Owner's operating staff. Provide adjustments of mechanical equipment and any changes or modification in equipment made under terms of guarantee.
- .2 Finalize demonstration and instructions by obtaining a signed statement from the Owner that the demonstration and instructions have been given satisfactorily.

#### **1.25 BALANCING AND COMMISSIONING**

- .1 Employ a Balancing Agency to:
  - .1 Prepare Operation and Maintenance Manuals.
  - .2 Commission each mechanical system.
  - .3 Adjust duct and terminal balance dampers and adjust or change drive sheaves to balance supply, return and exhaust air systems to provide the design air quantities (within +10%/-5%) at each outlet and inlet and to maintain the design relationship between the supply, return and exhaust air system quantities.
  - .4 Permanently mark the final balance position on all balance dampers.
  - .5 Submit a report to the Consultant indicating:
    - .1 Air Side: final fan speed, motor operating amperages, system static pressure, filter static pressure, design air quantities and final air quantities obtained.

#### **1.26 SUBSTANTIAL PERFORMANCE**

- .1 The work will not be considered to be ready for use or substantially complete until the following requirements have been met:
  - .1 All reported deficiencies have been corrected.
  - .2 Testing and balancing completed.
  - .3 Operation and Maintenance Manuals completed.
  - .4 Record Drawings ready for review.
  - .5 System Commissioning has been completed and verified.
  - .6 All demonstrations to the Owner have been completed.
- .2 Work under this Section which is still outstanding when substantial performance is certified will be considered deficient and hold-back will be established to be withheld until Total Performance and will be equal to at least twice the Consultant's cost estimate of completing that work.

### **Part 2 Insulation**

#### **2.1 GENERAL**

- .1 Apply insulation and accessories so that the finished product is smooth and neat and with longitudinal seams concealed from view. Apply insulation, accessories and finishes in accordance with the manufacturer's recommendations.

- .2 Insulation and vapour barrier shall be continuous through all non-rated separations.
- .3 Finish and seal insulation at hangers, supports, access doors fire dampers and other insulation protrusions.
- .4 Where exposed, terminate piping insulation 75 mm [3"] back from all uninsulated fittings for working clearance and around the base of thermometer wells, pressure gauges, flow switches and pressure and control sensors and bevel insulation at 45° and finish with a hard coat insulating cement to match the adjacent insulation.
- .5 Where concealed, terminate piping insulation 75 mm [3"] back from all uninsulated fittings, with heavy coat of vapour barrier coating to secure glass fibres.

## 2.2 PIPING INSULATION

- .1 Materials:
  - .1 Mineral Fibre - Low and Medium Temperature, vapour barrier jacket. Maximum thermo conductivity: 0.033 W/m-°C at 24°C [0.23 Btu-in/(hr-ft<sup>2</sup>-°F) at 75°F]:
  - .2 Flexible Foamed Elastomeric Insulation.
  - .3 Flexible Closed Cell Insulation.
  - .4 Flexible elastomeric and flexible closed cell insulation adhesive.
  - .5 Flexible elastomeric and flexible closed cell insulation finish coating.
  - .6 Vapour barrier jacket adhesive.
  - .7 PVC Jacket and Fitting Covers: Staples and PVC self-adhesive tape, plastic pop rivets, staples.
  - .8 Aluminum Jacket:
    - .1 22 ga. corrugated or smooth aluminum jacketing.
    - .2 Longitudinal slip joints and 50 mm [2"] end laps.
    - .3 Factory applied protective liner on interior surface.
- .2 Scope: Warm/Hot Piping
  - .1 All domestic hot water supply - 25 mm [1"] thickness
  - .2 Installation:
    - .1 Mineral fibre insulation
    - .2 Spreading staples at 75 mm centres.
    - .3 Tape over all joints and secure with staples.
    - .4 Fittings - tightly wrapped flexible insulation to full thickness with PVC fitting cover
    - .5 Valves, Strainers - fitted pipe insulation with drains, blowoff plugs and caps uninsulated.
- .3 Scope: Cold Piping
  - .1 All domestic cold water piping - 25 mm [1"] thickness.
  - .2 All condensate drain piping - 25 mm [1"] thickness.
  - .3 Installation:
    - .1 The insulation shall include provision of a continuous vapour barrier.
    - .2 Mineral fibre insulation
    - .3 Spreading staples at 75 mm centres.
    - .4 Tape over all joints with vapour-barrier adhesive and staples.

- .5 Fittings - tightly wrapped flexible insulation to full thickness with PVC fitting cover
- .6 Valves, Strainers - fitted pipe insulation with drains, blowoff plugs and caps uninsulated
- .4 Scope: Refrigerant Piping
  - .1 25 mm [1"] thick flexible foamed elastomeric or flexible closed cell preformed piping insulation. Secure longitudinal and butt joints with adhesive. Insulate all fittings and components. Finish with flexible elastomeric or flexible closed cell insulation coating. Maintain continuous vapour-barrier for suction and mixed phase piping.
  - .2 Aluminum Jacket: Provide 22 ga. smooth aluminum jacketing with longitudinal slip joints on all pipe insulation outdoors.

### **2.3 DUCTWORK INSULATION**

- .1 Materials:
  - .1 Duct Liner - Flexible. Minimum noise reduction criteria (NRC): 0.70 as per ASTM C423 'Type A mounting'.
- .2 Scope: Ductwork, interior flexible or rigid acoustic insulation - 25 mm [1"] thickness where indicated by single hatching and as otherwise noted.

### **Part 3 Fire Protection**

#### **3.1 MULTI-PURPOSE DRY CHEMICAL EXTINGUISHERS (FE1)**

- .1 4.5 kg [10 lbs] Extinguisher: Multipurpose stored pressure rechargeable fire extinguisher, squeeze grip positive on/off operation, heavy duty glossy enamel finish steel cylinder, pull pin safety lock, forged valve, rating for 4-A, 60-B, C with universal wall mounting bracket.
- .2 Extinguisher Brackets
  - .1 Universal wall mounting bracket as recommended by extinguisher manufacturer.

### **Part 4 Plumbing Systems**

#### **4.1 GENERAL**

- .1 All work and equipment shall be in accordance with the Plumbing Code and the Authorities Having Jurisdiction.
- .2 Tests shall be as follows:
  - .1 Sanitary and storm drains - hydraulic, 3 m [10 feet] for 8 hours.
  - .2 Domestic water - hydraulic, 1034 kPa [150 psig] for 8 hours.



## 4.2 PIPING, VALVES AND FITTINGS

- .1 Drainage Piping
  - .1 Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Drain Waste and Vent Pipe Fittings.
    - .1 Conforming to CSA/CAN 3-B181.1 and ASTM F628.
    - .2 Joints: solvent weld to ASTM D2235.
  - .2 Water Piping
    - .1 Type 'K' copper pipe underground - 75 mm [3"] and smaller - brazed.
    - .2 Type 'L' copper pipe above ground with cast brass or wrought copper fittings 95/5 Sn/Sb solder.
  - .3 Hangers and Supports: Cadmium plated hanger rods. For copper pipe: Copper plated or epoxy coated
  - .4 Install dielectric couplings at copper piping connections to plumbing equipment of dissimilar material.
  - .5 Ball Valves
    - .1 Lever handle, brass two piece body, blow-out proof stem, PTFE seats, brass ball chrome plated.
    - .2 Sweat ends to ANSI/ASME B16.18, Class 150.
    - .3 Threaded ends to Class 150.
  - .6 Domestic Hot Water Tank - Electric (T-DHW)
    - .1 Commercial grade porcelainized glass-lined tank, electric hot water heater, CSA certified, maximum hydrostatic working pressure 1034 kPa [150 psi].
    - .2 Rigid R-16 polyurethane foam, mineral wool or fibreglass insulation.
    - .3 Enamelled steel jacket.
    - .4 Fully automatic controls, manually adjustable thermostat, 120 volt control circuit with fused transformer.
    - .5 3 year extended warranty certificate.

## 4.3 FIXTURES

- .1 S1 - Double Compartment, Ledge-Back, 300 mm [12"] Deep
  - .1 Double compartment, stainless steel sink complete with basket strainer, tail piece, clamps. Confirm punchings. Compartment size: 597 x 445 x 305 mm [17.5" x 12.5" x 12"], overall size: 1276 x 560 mm [50" x 22].
  - .2 Faucet: 225mm [9"] gooseneck to give approximate 200 mm [8"] clear to counter, lever handles.
  - .3 40 mm [1-1/2"] cast brass P-trap. Provide dishwasher trap.
  - .4 12 mm [1/2"] hot and cold supplies with stops.
- .2 Emergency Equipment
  - .1 EW1 - Emergency Eye Wash – Counter Mounted, Drop Down
    - .1 To ANSI Z358.1.
    - .2 Countertop mounted eye wash, head with inverted directional laminar flow with zero vertical velocity supplied by an integral flow control,

- polished chrome-plated brass single action pull-down valve body.  
Eyewash shall include yellow plastic pop-off dust cover for eyewash head, universal sign, 12mm [1/2"] supply, 13.6 l/min [3.0 gpm] flow.
- .3 Provide eye wash tempering valve (EW-MV). 12 mm [1/2"] hot and cold supplies with stops, 12 mm [1/2"] tempered water to eyewash.
  - .2 Eyewash Mixing Valve (EW-MV):
    - .1 Thermostatic mixing valve to supply tempered water to a single emergency eye/face wash fixture requiring a minimum flow of 13.6 l/min [3.0 gpm].
    - .2 The modular brass design with internal check stops, oversized valve seats. Lime and calcium resistant components are used throughout. 12 mm [1/2"] hot and cold inlets, 12 mm [1/2"] tempered outlet.
    - .3 Provide dial thermometer minimum 500 mm [20"] downstream of valve.
    - .4 The outlet temperature factory setting shall be 29°C [85°F]. Adjust to 22°C [72°F].
    - .5 Provided unions before and after the EW-MV to allow it to be removed for servicing.

## **Part 5 HVAC Systems**

### **5.1 DUCTWORK AND ACCESSORIES**

- .1 General
  - .1 Construction and installation of ductwork shall meet the standards of the latest editions of the SMACNA duct manuals and ASHRAE handbooks.
  - .2 The project drawings are diagrammatic. Effort has been made to indicate offsets and transitions, but not all are necessarily shown. Changes may be required to ductwork to avoid interference with structure and other services. Determine all required adjustments prior to fabrication and provided the adjustments without additional cost to the contract.
  - .3 Square throated - radius heel elbows shall not to be used.
  - .4 Duct sizes on drawings are the airway size clear of any specified internal lining. Size internally insulated ducts so that the free area of the duct is the dimension shown on the drawings.
  - .5 During construction, protect ductwork openings from the entry of dirt, dust and debris with suitable covers.
  - .6 Provide flashing and counter flashing on ducts through roofs and flashing and counter flashing on ducts through exterior walls.
  - .7 Install duct necks before grilles, registers and diffusers. Install cushion heads at diffusers.
  - .8 Provide suitably sized, factory manufactured access panels for dampers, fire dampers, at devices requiring maintenance, coils, at base of duct risers and elsewhere as indicated.
- .2 Ducts - Galvanized Steel - 500 Pa [2" W.G.] Static Pressure rating
  - .1 Ductwork Galvanized steel shall be lock forming quality with galvanizing coat both sides to ASTM A525 G90.

- .2 Provide 100 mm [4"] flexible connections where ducts connect to fans, equipment, terminal boxes and as shown.
- .3 Ducts - Flexible
  - .1 Flexible duct may not be used on this project.
- .4 Ductwork Sealing
  - .1 SMACNA Seal Classification A for all ductwork and plenums. Duct sealing to meet ASHRAE 90.1 2010 requirements.
- .5 Balance Dampers
  - .1 Provide balance dampers where indicated on the drawings and as required by the Balancing Agent to properly balance the system.
  - .2 Of same material as duct, 16 ga., V-groove stiffened.
  - .3 Multi-blade, factory manufactured where over 300 mm [12"] high.
  - .4 Locking quadrant with shaft extension to accommodate insulation thickness.
  - .5 End bearings both ends. Nylon on dampers up to 300 mm [12"] high, oilite bronze on dampers over 300 mm [12"] high or diameter.
  - .6 Channel frame of same material as adjacent duct, complete with angle stop.

## **Part 6 Controls**

### **6.1 GENERAL**

- .1 This Section is a performance specification clarified in certain sections to establish minimum standard of equipment, installation or level of control. The specification describes the basic functions required but not all of the installation details or components. The Controls Contractor is expected to have sufficient experience to be able to design and estimate the cost of an appropriate control system. Materials and work necessary to achieve a satisfactory result will not be considered extra to the contract.

### **6.2 ELECTRICAL COMPONENTS, WIRING AND CONDUIT**

- .1 By Controls Contractor:
  - .1 All control system components to make a complete and operable system, except those supplied as part of packaged equipment controls, but including all auto-sequencing devices and electrical interlocks required to accomplish the sequences specified hereafter. Refer to the electrical equipment schedule, the electrical drawings and the electrical specification Division serving mechanical systems. Materials, equipment, connections and power not provided by the Electrical Division 26 but required for the Control System shall be provided under this section.
  - .2 All control circuit transformers (120/1/60 or 24/1/60 and as designated).
  - .3 All control wiring and metallic conduit for mechanical system controls.
  - .4 Supply, installation and connection of all electric control items.
  - .5 All wiring and conduit from power distribution system to any control devices needing power.
  - .6 Coordinate with the Electrical Contractor.

- .7 Electrical work installed under this Section shall be to the standards specified under Division 26.
- .8 Obtain electrical permit.
- .2 Carrier System:
  - .1 All wiring in mechanical service spaces, where exposed to view and all 120 volt wiring shall be run in EMT conduit except the final 900mm [36"] of wiring to all operators and to all sensors subject to vibration shall be run in flexible metallic conduit.
  - .2 Run wiring not installed in conduit parallel to building lines and support every one meter independent of piping, ductwork, and equipment.
  - .3 Provide steel fittings with nylon throats for all conduit connections.
  - .4 Identify each wire and cable at every termination point. Identify conduit with colour bands at no more than 7.5m [25'] intervals and on both sides of walls and floor

### **6.3 EQUIPMENT SUPPLIED FOR INSTALLATION UNDER OTHER SECTIONS**

- .1 Hand over automatic control dampers to the appropriate trade sections for installation.
- .2 The Controls Contractor shall be responsible for arranging, coordinating and supervising the installation of the above devices in a suitable manner and readily accessible location.

### **6.4 CALIBRATION AND DEMONSTRATION**

- .1 Set up and calibrate all sensors during the initial start-up of the systems and check, recalibrate and readjust and debug operation as necessary.
- .2 Demonstrate the controls system to the satisfaction of the Consultant and the Owner.

### **6.5 PRODUCTS**

- .1 Control Dampers:
  - .1 Parallel type blade for all two position dampers unless otherwise indicated.
  - .2 Extruded aluminum or formed galvanized steel blades, frames, gussets and blade stops.
  - .3 Shafts - galvanized steel with keyways for securing blades to shafts.
  - .4 Hardware - keyed to prevent blade slippage and to provide smooth blade movement.
  - .5 Bearings - oil impregnated sintered bronze.
  - .6 Assemblies - rigid and adequately braced with corner gussets.
  - .7 Bearings and seals - suitable for exposure to a minimum of -30°C [-22°F] and a maximum of 100°C [212°F].
  - .8 Low leakage type with blade and frame seals.
  - .9 Maximum leakage in closed position shall be 50 L/s per square metre [10 CFM per square ft.] of face area at 1000 Pa [4" w.g.] pressure differential.
  - .10 Galvanized coating on all sheared edges of galvanized steel frames and blades exposed to outside atmosphere.
  - .11 Indicated size is outside frame dimension. Confirm with installer before fabrication.

- .12 Dampers shall be adequate for the maximum system pressure. Refer to the appropriate section of the specification.
- .13 Damper Actuator:
  - .1 Size actuators to control dampers against maximum pressure or dynamic closing pressure whichever is greater.
  - .2 Size damper actuators so that they will provide smooth and full travel of the dampers while stroking in both directions.

## **6.6 SEQUENCE OF OPERATION**

- .1 Domestic Hot Water System
  - .1 The internal controls of the Domestic Hot Water Tank shall control the operation of the system to maintain a water temperature of 60°C [140°F] within the tank.
- .2 Heat Recovery Ventilator:
  - .1 Mount the wall mounted unit controller.
  - .2 Program the controller to cycle the HRV ON/OFF on an OCCUPIED/UNOCCUPIED schedule and maintain both OCCUPIED/UNOCCUPIED room temperature set points.
  - .3 During the OCCUPIED it shall RUN and be OFF during the UNOCCUPIED periods.
  - .4 If the space is calling for cooling then the HRV shall go into bypass mode to provide free cooling.
  - .5 Modulate the electric heating coil to maintain room temperature.
  - .6 Hardwire the motorized control dampers CD-HRV1 and CD-HRV2 to open when the fan starts.
- .3 Baseboard Heater
  - .1 The baseboard's integral thermostat shall cycle the heater to maintain room temperature set point.
- .4 Cooler
  - .1 The cooler controller and temperature sensors provided with the cooler cooling system shall control the operation of the system to maintain a room temperature of 60°C [140°F] within the tank.

## **Part 7 Equipment Schedules**

### **7.1 HEAT TRACING FOR PIPING**

- .1 Provide complete, CSA approved system of heat tracing on the water piping in the crawlspace.
- .2 The entire design and installation of the system shall comply with the Canadian Electrical Code and the requirements of the local inspection authority.
- .3 Comply with all manufacturer's instructions/recommendations regarding the installations. Provide all necessary materials to provide a complete system.
- .4 System shall be thermostatically controlled with a thermostat with a non-adjustable set point of 5°C [40°F] complete with a 900 mm [36"] capillary.

- .5 Prior to installing heating cables, ensure the pipe systems are complete and have passed all necessary tests.
- .6 Cables to be secured to pipes using tape at 300 mm [12"] intervals on pipe.
- .7 After pipes are traced test all lengths prior to installation of pipe insulation.
- .8 Provide suitable identification for those pipe systems provided with heat tracing. At 6 m [20 ft] intervals provide an adhesive backed nameplate "Caution - Heat Tracing".

## **7.2 BASEBOARD HEATERS - ELECTRIC**

- .1 Steel enclosure 178 mm [7"] high.
- .2 Stainless steel element with aluminum fins.
- .3 Integral over-temperature protection.
- .4 Accessories: Integral thermostat.

## **7.3 FIXED LOUVRES - ALUMINUM**

- .1 Provide 100 mm [4"] deep, extruded aluminum alloy [6063-T5] with aluminum bird screen as indicated.
- .2 Finish: factory applied enamel. Colour: to Architect's approval.
- .3 Note the custom shape of the louvre.

## **7.4 HEATING COIL - ELECTRIC**

- .1 Coils:
  - .1 Flanged type for connecting to ductwork.
  - .2 CSA approved.
  - .3 Open coil resistance wire elements.
- .2 Control Panels:
  - .1 Factory attached panels.
  - .2 Power and control wiring terminals.
  - .3 Unfused disconnect.
  - .4 SCR controller complete with integral electronic air proving switch.
  - .5 Control transformer with secondary fuse.
  - .6 Overheat protection - manual reset with external button.
  - .7 Automatic reset linear thermal cut-out.
  - .8 Control wiring terminals for airflow proving switch and SCR controls.

## **7.5 HEAT RECOVERY VENTILATOR**

- .1 Provide a cross-flow sensible and latent heat recovery ventilator as indicated on the drawings and schedules.
- .2 Unit shall consist of:
  - .1 A fan in each airstream.
  - .2 Positively draining pan (no standing water).
  - .3 Automatic defrost function.

- .4 Heat recovery core by-pass.
- .5 Acoustically insulated cabinet.
- .6 Wall mounted programmable controller to maximize energy recovery, modulate electric heating coil operation to maintain room temperature set point.

## **7.6 COOLER EVAPORATOR COILS AND AIR COOLED CONDENSERS**

- .1 Walk-in cooler evaporator fan coil units and air cooled condensers including, coils, cabinet, electrical devices, fans, motors and control devices.
- .2 ULC listed.
- .3 Rated in accord with ARI Standards.
- .4 Materials new and without defect. Workmanship of highest quality. Fully factory tested.
- .5 Comply with applicable Codes, Standards, and regulatory requirements. Including, but not limited to:
  - .6 Safety Code Compliance: Comply with applicable portions of ANSI/ASHRAE 15-2001, "Safety Standard for Refrigeration Systems."
  - .7 ANSI Code Compliance: Comply with applicable provisions of ANSI B 31.5, "Refrigeration Piping."
  - .8 Equipment manufacturer is responsible for quality of brazing done by its organization and shall employ skilled craftsmen following qualified brazing procedures.
  - .9 Leak check each evaporator coil unit, pressure test to 250 psig, and evacuate prior to shipment. Ship evaporator coils leak free with holding charge of dry nitrogen.
- .10 Selection Criteria
  - .1 Cooler room temperature: 15°C [59°F], Low profile coil.
  - .2 Defrost: Cooler evaporator coils: Off time (air) defrost.
  - .3 Air Cooled Condenser Design requirements:
    - .1 Ambient temperature: 38°C [100°F].
    - .2 Design for proper elevation above sea level.
- .11 Warranty
  - .1 Refrigeration equipment warranties shall cover against defective materials and workmanship for a minimum period of one year from Substantial Performance.
  - .2 Manufacturer, at their own expense, must immediately correct defects due to faulty workmanship, materials or shipping.
- .12 Evaporator
  - .1 Provide factory assembled and tested, low profile type unit coolers suitable for use with non CFC and HCFC refrigerants.
  - .2 Unit Casings:
    - .1 Design units for flush mounting against a ceiling, independently baffled fan sections and low throw fan guards.
    - .2 Units shall have aluminum drain pan sloped to a single drain point, on back side.
    - .3 Provide electric pan heaters on units designed for electric defrost.

- .3 Coils:
  - .1 Provide staggered seamless copper tube, aluminum fin coil and distributor, circuited for the direct expansion refrigerant. Fin spacing shall be 6 fins per inch for units in spaces above 0°C [32°F] and 4 fins per inch for units in spaces at or below 0°C [32°F].
  - .2 Balanced port expansion valve and distributor to be manufacturer selected for the specific application and factory mounted.
  - .3 Provide a factory installed liquid line filter-drier per evaporator coil.
  - .4 Include a factory installed refrigeration service valve on suction outlet connection of each coil. Schrader taps are not acceptable. Provide forged brass body valve with seal caps. Service valve shall be brazed directly into piping, flare fittings are not to be used for the installation of service valves.
- .4 Fans and Drive Motors:
  - .1 Provide direct drive evaporator fan assemblies 208/230 volt 1 phase for evaporator coils with electric defrost elements, 115 volt 1 phase for off time and gas defrost evaporator coils, high efficiency ECM type with permanently lubricated ball bearings.
  - .2 Fan blades to be balanced, low noise type, constructed of heavy gage aluminum paddles mechanically attached to a plated steel hub.
- .5 Controls:
  - .1 Provide factory mounted adjustable thermostat for units equipped for defrost. Thermostat to control fans and defrost pan heaters during defrost.
  - .2 Provide factory mounted defrost sensor for all electric defrost unit coolers.
- .6 Evaporator Installation
  - .1 Hang or mount evaporator coils plumb and level in accord with manufacturer's published instructions and the drawings.
  - .2 Maintain manufacturer's recommended clearances so as to not restrict air flow.
  - .3 Support piping separately so that piping is not supported off evaporator coil units.
  - .4 Install electrical devices furnished by manufacturer.
  - .5 Install interconnecting refrigeration suction and liquid piping between cooler evaporator coils and associated condenser/compressor units.
  - .6 Install liquid line drier between the liquid connection and isolation valve.
  - .7 Provide condensate lines for cooler: 25mm [1"] copper with traps.
  - .8 Fit condensate lines with a union to facilitate cleaning of condensate line and removal of evaporator coil drain pan.
- .13 Air Cooled Condenser
  - .1 Provide factory assembled and tested, multi-circuit, air cooled condensers suitable for use with non CFC and HCFC refrigerants.
  - .2 Unit Casings:
    - .1 Design for outdoor installation with weatherproof control panels and hinged fan panels.



- .2 Construct of galvanized frame, legs, tube sheets, internal fan baffles and motor rails, painted aluminum or galvanized housings, and PVC coated steel fan guards.
- .3 Coils:
  - .1 Provide minimum of two independent refrigerant circuits per unit, staggered copper tubes with bonded corrugated aluminum fins, maximum 10 fins per inch.
  - .2 Provide a polyester protective coating on coil fins to protect against salt-water corrosion in accord with manufacturer's recommendation.
- .4 Fans and Drives Motors:
  - .1 Provide direct drive condenser fan assemblies pre-wired to condenser control panel.
  - .2 Fan motors to be drip-proof, 600 volt 3 phase, high efficiency with internal thermal overload protection, drip shield, and double sealed permanently lubricated ball bearings.
  - .3 Fan blades to be low noise type constructed of heavy gage aluminum paddles mechanically attached to a plated steel hub.
- .5 Control Panel, Electrical Components, and Controls:
  - .1 Include a weather tight control panel.
  - .2 Include a factory mounted, non-fused disconnect factory wired to condenser fan contactors and fuse blocks.
  - .3 Include individual fuse blocks, fuses and contactors for each condenser fan motor in the condenser control panel.
- .6 Condenser Installation
  - .1 Install air cooled condensers plumb and level in accord with manufacturer's published instructions and drawings.
  - .2 Maintain manufacturer's recommended clearances for service and maintenance.
  - .3 Support piping separately so that it is not supported off equipment piping connections.
  - .4 Install devices or parts furnished by manufacturer.
- .14 Controls
  - .1 Provide a room temperature sensor within the cooler. The cooling unit's controller shall control the operation of the evaporator and condenser units.
  - .2 Provide all required power and controls wiring between the evaporator and condenser units.
- .15 Refrigerant Tubing and Fittings
  - .1 Tubing:
    - .1 Processed tubing for refrigeration installation, deoxidized, dehydrated and sealed.
    - .2 Hard copper tube, type L, to ASTM B88M.
    - .3 Annealed copper tube to ASTM B280, with minimum wall thickness as per CSA B52.
  - .2 Fittings
    - .1 Service: design pressure 300 psig and temperature 250°F.

- .2 Brazed: wrought copper to ANSI B16.22 or cast bronze to MIL-F-1183E.
  - .3 Flanged: bronze or brass, Class 150 and Class 300 to ANSI B16.24.
  - .4 Flare: Bronze or brass, for refrigeration, to ANSI B16.26.
  - .5 Long radius type for elbows and return bends.
- .3 Joints
- .1 Brazing materials shall be SIL-FOS-15 phosphor-copper-silver alloy for copper piping jointed by copper fittings and silver solder for brass fittings.

**END OF SECTION**