

1. General

(a) Scope of work

- (i) The tender drawings and specifications provide a general description of the overall design intent and generally describes the related scope of work. Bidders shall ensure that they have the relevant past experience to successfully interpret the exact requirements and shall include all costs including materials, labour, tools, and other miscellaneous costs to be able to deliver a fully functional refrigeration system for this project.
- (ii) It is the Contractor's sole responsibility to verify the existing site conditions and to examine all of the tender Documents, Specifications and Drawings issued.
- (iii) Brief description of scope of work is as under:
 - (A) Safe removal and disposal of the existing compressors, dehumidifiers, piping, pumps, heat exchangers, motors, related refrigeration and hydronic components and associated piping, instruments, wiring and accessories. The equipment and accessories shall be disposed off in accordance with the provincial regulations. Bear all costs of disposal and submit certificates of disposal to the Owner.
 - (B) Provision of compressors, dehumidifiers, desuperheater and snow melting system complete with all associated piping, valves, wiring, controls, circulating pumps, supports and all other associated accessories as shown and indicated on drawings and as specified herein.
 - (C) Provision of all associated Ammonia, water and glycol piping and necessary additional charge of related fluids (Ammonia, water, glycol) as shown and indicated on drawings and as specified herein.
 - (D) Verification of existing sequences of operation and controls of the existing compressor and dehumidifiers and reinstatement of the same after installation of the proposed equipment.
 - (E) Contractor shall verify the existing refrigeration and ice making system's temperature controls and shall make necessary adjustments to the existing controls to accommodate the proposed equipment.
 - (F) Insulation, painting and labelling of all new piping to match existing conditions and to meet local regulations.
 - (G) Include all costs for arranging and completing inspections by the authorities having jurisdiction including TSSA. Submit application for and re-register the modified refrigeration plant including all pressure vessels and piping with TSSA.
 - (H) All associated electrical power and controls/automation work.
 - (I) Start-up, testing and commissioning of equipment c/w reports. commissioning shall be performed by a qualified refrigeration mechanic and controls technicians experienced with similar systems.
 - (J) Associated cutting, patching and painting.

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- (b) Boiler BAS Scope:
 - (i) The existing BAS/ Controls for the boiler system are setup as follows:
 - (A) One boiler is designated as 'lead' boiler and operates in that role unless it has failed or it is designated 'out of service' from the operator work station. Lead boiler will be rotated weekly. If operating boiler fails or it is designated 'out of service', start the other boiler immediately. BAS will modulate boiler low/high fire to maintain supply water temperature setpoint. BAS will accumulate boiler run time. If supply water temperature rises above setpoint plus deadband (10 degrees Celsius, adjustable).
 - (ii) Revise BAS programming to allow starting of the 'lag' boiler in addition to the 'lead' boiler when the prevailing load exceeds the output of the lead boiler (i.e. if the return water temperature setpoint is not met, start and control the lag boiler. Provide all necessary wiring, graphics, programming and accessories to provide a fully functional system as described herein.
- (c) Scheduling of the work
 - (i) Co-ordinate all mechanical work with the work of other trades and the Owner and schedule the work accordingly.
- (d) Codes, Regulations and Standards
 - (i) Comply with Municipal or Provincial Codes, Rules and Regulations and/or Authorities having jurisdiction, including TSSA.
 - (ii) Revisions issue: latest version as amended to date.
- (e) Permits, Certificates, Equipment Registration and Fees
 - (i) Make application and pay all required fees for permits, building permits, registration, inspections, etc. for all equipment and systems installed including those required by TSSA, local utility companies and municipalities.
 - (ii) Upon substantial completion of work, supply and turn over to the Consultant all required inspection certificates from governing authorities to certify that the work as installed conforms to the rules and regulations of the governing authorities.
 - (iii) Permits
 - (A) Obtain permits required for the installation of mechanical trades work including:
 - (I) Building Permit
 - (II) Pressure Vessel inspection
 - (III) Piping inspection
 - (IV) Electrical inspection
 - (V) TSSA inspection
 - (B) Arrange for inspections and tests and pay all fees and costs for the permits, inspections and tests. Obtain permits immediately after notification of award of Contract.

- (iv) Material approvals
 - (A) Obtain special inspection and approvals by CSA and/or local authorities, for materials and equipment where required or as specified.
 - (B) Obtain such approval for the particular installation with the co-operation of the material supplier.
- (f) Warranty
 - (i) The Contractor shall warrant the goods and installation specified hereunder against original defects in manufacture and workmanship for a period of one (1) year after Substantial Completion of the refrigeration contract.
 - (ii) Warranty shall include “Parts and Labour”.
 - (iii) If warranty work is required during the initial 1 year period, then the warranty period for the repair shall be an additional one (1) year from the time of repair.
- (g) Working Drawings and Documents
 - (i) Design Drawing Intent
 - (A) The design Drawings are schematic in arrangement, and describe the general design intent but do not show the exact details for the installation. They are not fabrication or installation Drawings.
 - (B) The overall scope of work is suitably outlined on the Drawings with regard to sizes, locations, general arrangements and installation details, and has been generally coordinated for routing of services. The routing of ductwork, piping and equipment arrangement are shown more or less in diagrammatic form except where in certain cases the Drawings may include details giving the exact locations and arrangements required.
 - (C) The location of equipment, and the associated arrangement of piping and other material describes the general requirements of the work. Final location is dependent on the actual equipment supplied. The Consultant reserves the right to make reasonable adjustment of up to 1 m to the location of equipment, floor drains, routing of major piping and ductwork, at no additional cost to the Owner.
 - (D) In order to provide clarity to the arrangement of the work, not all details including valves, thermometers, pressure gauges, etc. are shown on the plan Drawings. Refer to schematic Drawings, standard details and the specification for these requirements. In the absence of specific details, the Contractor is expected to follow generally accepted good installation practices. Alternatively, the Contractor shall submit a written request for Information (RFI) in accordance with Section 3.2.1 of the RFT document to the Owner/Consultant prior to submission of the bids and obtain a ruling prior to bidding or proceeding with the work.
 - (E) Where specific installation dimensions for location of equipment and access space requirements are indicated on the Drawings, install to these requirements.
 - (F) Where Standard Details are provided, these show the general installation

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requirements, and are applicable to each occurrence in the work, unless otherwise specified or shown.

- (G) Do not proceed with work where an obvious ambiguity is noted between tender documents. Notify the Consultant and obtain proper direction prior to proceeding with procurement or related construction work on site.
- (ii) Review before proceeding (HOLD)
 - (A) Where the word "HOLD" appears on Drawings and other Contract Documents, the work is included in the Contract.
 - (B) Execute such work only after verification of dimensions, verification of materials and obtaining Consultant's written permission to proceed.
- (iii) Coordination and Cooperation with Other Trades
 - (A) Review design drawings and coordinate scope of work between all trades and allow for adequate costs for all related work. Coordinate work with all trades to ensure a proper and complete installation of fully functioning system that can be properly maintained in future.
 - (B) Notify all trades concerned of the requirements for openings, sleeves, insets and other hardware necessary for the installation and , where work is to be integrated with the work of other trades or is to be installed in close proximity with the work of the trades, carefully coordinate the work prior to installation.
- (h) Coordination and Examination
 - (i) Examination
 - (A) Carefully examine work and Drawings of all related trades and thoroughly plan the work in advance so as to avoid interferences.
 - (B) Report the defects to the Consultant which would adversely affect the work. Do not commence installation until such defects have been corrected.
 - (ii) Coordination
 - (A) Coordinate work of Division 15 such that items will properly interface with work of other Divisions. Prepare installation and interference Drawings of all critical locations and submit to the Consultant for review.
 - (B) Architectural Drawings, or in their absence, Mechanical Drawings govern all locations.
- (i) Submittals
 - (i) Shop Drawings
 - (A) Submit detailed shop drawings to the Consultant within 15 working days of award of contract showing detailed piping layout c/w sizes, valves, sensors etc. for the complete refrigeration system ordering of materials or commencing any work on site

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- (B) Shop drawing shall be submitted electronically.
- (C) Conform to general conditions of contract and the following.
- (D) Shop Drawings showing more than one size or model will not be considered unless properly marked up.
- (E) For electrically driven, and fuel fired appliances, provide the following information:
 - (I) Electrical characteristics including voltage, phase, frequency and power rating.
 - (II) For motors, NEMA, Class and efficiency ratings
 - (III) Fuel input ratings, including flow rates and pressures
 - (IV) Equipment performance ratings, including flow rates, pressures, efficiencies, part load values and/or efficiencies (IPLV's), plotted flow characteristics (pump and fan curves) with operating points clearly plotted.
- (F) For other equipment include the following information:
 - (I) Equipment performance ratings, including flow rates, pressures drops.
 - (II) Electrical control power requirements
- (G) For all equipment, include the following:
 - (I) Equipment dimensions and weights.
 - (II) Itemized product description with optional items clearly marked as being included.
- (H) Provide wiring Shop Drawings:
 - (I) Wiring diagrams and schematics for all equipment which has electrical controls or devices furnished with the equipment.
 - (II) Wiring diagrams alone are not sufficient; schematic and interconnecting Detailed drawings and sequence of operation of all equipment are required for review.
 - (III) Clearly indicate the materials and/or equipment being supplied:
 - (1) Details of construction, finish, accurate dimensions, capacities and performance.
 - (2) Certify Drawings correct for construction by the manufacturer, before submission.
 - (3) Identify Equipment Shop Drawings with designations as shown on the Drawings or in the Specifications.
 - (4) If not complied with, Shop Drawings will not be reviewed and will be returned to the Contractor.
 - (IV) Coordinate equipment which attaches to and/or where external wiring provided connects to other equipment. Do such coordination whether such equipment is supplied under this or other contracts or subcontracts, for which relevant information will be provided by Owner/Consultant.
- (j) "As-Built" Record Drawings
 - (i) Reference
 - (A) Maintain an accurate dimensional record of all underground piping and all

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deviations and changes in aboveground piping and equipment.

- (B) On completion of the project, provide a CD containing as-built Drawings in Auto Cad format to the Consultant. Include the CDs and hard copies of the as-built Drawings in each O&M manual.
- (k) Installation and Start-up Instructions
 - (i) Reference
 - (A) Submit copies of installation instructions and copies of start-up instructions for any item of equipment when requested by the Consultant.
- (l) Operating and Maintenance Instruction Manuals
 - (i) Reference
 - (A) Include the following in the manuals:
 - (I) Non-dimensional layout showing location of all electrical devices on mechanical equipment.
 - (II) Operating instructions, including start-up and shut-down procedure.
 - (III) Lubricating instructions and recommended cycle of lubrication for each item of equipment, including various types of lubricants.
 - (IV) List of spare parts.
 - (V) All product warranties
 - (VI) All product technical manuals
 - (VII) All start-up, testing and commissioning reports
 - (VIII) All inspection reports
 - (IX) All TSSA certifications
 - (B) All the above applies to component parts of equipment whether they are manufactured by the supplier of the equipment or are supplied as a component part of an item of equipment.
- (m) Cleaning, Testing and Approval Records
 - (i) Records
 - (A) Maintain records of all pressure tests and flushing and sterilization tests, inspections and approvals by the Inspectors.
 - (B) Forward these tests to the Owner on completion of the work.
 - (C) Forward to the Consultant, copy of records on site on completion of each test, cleaning operation, etc.
- (n) Dimensions and Quantities
 - (i) Dimensions
 - (A) Dimensions shown on Drawings are approximate.
 - (B) Verify dimensions by reference to Shop Drawings and field measurement.

(ii) Quantities

- (A) Quantities or lengths indicated in any of the Contract Documents are approximate only and shall not be held to gauge or limit the work.

2. Products

(a) Materials and Equipment

(i) Materials

- (A) Use new materials and equipment, free from defects impairing strength and durability, as specified or specified equivalent.
- (B) Labelled or listed as required Code and/or inspection authorities.
- (C) Design of mechanical systems has been based on the first listed supplier and model number/size stated on the Equipment Schedules on the Drawings. Bear all costs due to physical or performance differences between stated equipment and proposed equipment. These differences include but are not limited to size, layout, arrangement, connection size, location and/or quantity of connections, or performance differences such as noise, power requirements, flow, throw, etc.

(b) Standard Specifications

(i) Product Quality

- (A) Ensure that the chemical and physical properties, design, performance characteristics and methods of construction of all Products provided comply with the latest issue of applicable Standard Specifications issued by Authorities having jurisdiction.
- (B) Do not apply such Standard Specifications to decrease the quality of workmanship, products and services required by the Contract Documents.

(c) Manufacturer's Nameplates

(i) Metal Nameplates

- (A) Provided with raised or recessed lettering, on each piece of equipment.
- (B) Mechanically fasten nameplate on a metal stand-off bracket arranged to clear insulation.
- (C) Mount on same stand-off Underwriters Laboratories and/or CSA registration plates.

(ii) Nameplate Data

- (A) Indicate:
- (I) Size
 - (II) Capacity
 - (III) Equipment model
 - (IV) Manufacturer's name

- (V) Serial number
- (VI) Voltage
- (VII) Frequency
- (VIII) Phases

3. Execution

(a) General

- (i) Execute work in accordance with requirements specified in the various Sections of Division 15.
- (ii) Coordinate all installation details and service requirements of equipment and accessories with other trades to eliminate conflicts prior to installation.
- (iii) Mechanical equipment and accessories shall be installed in a manner that provides adequate access to equipment and also assists in reducing the effort for maintenance. Equipment shall only be installed at heights or in spaces that can be easily reached by a standard height ladder (i.e. not exceeding 3 metres). In case space constraints on site require installation of equipment in other locations or heights, contractor shall bring this to the Engineer's attention and direction, prior to commencing work.
- (iv) Lay out work of each trade so that it does not interfere with work under other Divisions of Specifications.
- (v) Make good any damage to Owner's property or other trade's work caused by improperly locating or carrying out of work.
- (vi) Supply anchor bolts and templates for installation by other Divisions.
- (vii) Location of pipes, raceways and equipment may be altered without extra cost provided alteration is made before installation.

(b) Protection

- (i) Protect work and materials before, during and after erection from weather and other hazards and keep in a clean and orderly manner.
- (ii) Protect pipe ends, valves and parts of equipment left unconnected to prevent damage or intrusion of foreign matter. Provide pipe caps for threaded male connections and plugs for threaded female connections.
- (iii) Protect mechanical equipment having a baked enamel finish by covering with polyethylene sheet securely held in place.
- (iv) Protect finished floor slabs from scuffing, cracking, chipping, staining, cutting and other damage resulting from work of this Contract.
 - (A) Place 19 mm thick plywood under laid with 25 mm thick polystyrene insulation board adhered to same, over floor areas when working from, or over, such surfaces. Provide such protection below hoist rigs, ladders, pallets of material, and in other circumstances where the flooring is exposed to potential damage. Work damaged due to failure in providing such protection is to be removed and

replaced, or repaired, as directed by the Owner, at no increase in Contract Price.

(c) Painting

(i) Reference

(A) With the exception of prime painting of miscellaneous steel or any other specific requirements as specified under the respective Sections of Division 15, all equipment shall be factory painted.

(B) Factory applied finish painting:

(I) Factory prime and final coats applied to compressor.

(II) Protect factory finished equipment during construction, and clean at completion of work.

END OF SECTION

1. General

- (a) Related work
 - (i) Other Divisions
 - (A) Refer to other divisions of the Specifications and to the Drawings for work related to the mechanical work to avoid interferences with work of other trades (and other contractors) and to ensure proper completion of the work as a whole.
- (b) General Construction Requirements
 - (i) Applicable Codes and Standards
 - (A) CSA B52
 - (B) Ontario Building Code-2012
 - (C) Occupational Health and Safety Act and Regulations for Construction Projects, Ontario Regulation 691.
 - (D) Owners Health and Safety Requirements
 - (ii) Measurements and Deviations
 - (A) Where any parts of the mechanical work are specifically located by dimensions on the Drawings, check and verify these dimensions on site prior to installation.
 - (B) Before installing piping and equipment, review all tender documents.
 - (I) Where interference may occur and departures from arrangements as shown are required, consult with other trades involved, come to agreement as to changed locations or elevations and obtain approval of the Consultant for proposed changes before proceeding with the work.
 - (C) Examine work of other trades or contractors, prior to commencement of mechanical installations.
 - (I) Report in writing, to the Consultant, any discrepancies which will affect mechanical installations.
 - (II) Failure to do so shall be considered acceptance of the conditions.
 - (D) Where site conditions require minor deviations from indicated arrangements or locations, make such changes on approval of the Consultant without additional cost to the Owner.
 - (E) Should any discrepancies occur during installation of mechanical work which will necessitate major revisions to the mechanical trades work or the work of other trades or contractors, notify the Consultant immediately and obtain written authorization before proceeding with the work.
 - (iii) Building Attachments:

- (A) Obtain prior written Consultant's approval before drilling, cutting or welding of the building steel or building structure for erection of materials or equipment.
- (iv) Overloading
 - (A) During installation of mechanical work, do not load any part of the building structure with a load greater than it is capable of bearing.
 - (I) Should any accident occur or damage result through the violation of this requirement, the contractor shall be held solely responsible.
 - (B) Design temporary supports used during installation as being equivalent to permanent supports.
 - (C) Remove temporary supports at completion of work.
- (v) Cutting and Patching
 - (A) Do not cut, remove or burn structural parts or sections of the building, whether they are steel, concrete or masonry without the written authorization of the Consultant.
 - (B) Should cutting, repairing, and patching of previously finished work of other trades be required to allow installation of mechanical work, pay all costs for the trade concerned to perform the work.

2. Products

- (a) Building Attachments
 - (i) Welding Studs
 - (A) Maximum size: 10 mm (3/8") for attaching miscellaneous materials and equipment to building steel.
 - (B) If the weight of materials or equipment require bolts or studs larger than 10mm (3/8") diameter, use steel clips or brackets, secured to building steel by (welding or) bolting as approved by the Consultant.
 - (C) Acceptable Manufacturers:
 - (I) Graham
 - (II) Omark
 - (III) Nelson
 - (IV) Or approved equivalent
 - (ii) Self drilling expansion type concrete inserts:
 - (A) To secure miscellaneous equipment and materials to masonry or concrete construction already in place.
 - (B) Of sufficient number and size to prevent concrete from breaking away.
 - (C) The use of powder or power actuated fasteners will not be allowed unless prior written approval is obtained from the Consultant.

- (D) Acceptable Manufacturers:
 - (I) ITW "Redhead"
 - (II) Star "SSS"
 - (III) USM "Parabolt"
 - (IV) Or approved equivalent
- (iii) Supports for any suspended items:
 - (A) Do not fasten/attach to or extend through steel pan type roofs or through concrete slab roofs.
- (iv) Beam clamps:
 - (A) 2-bolt design and of such type that the rod load is transmitted only concentrically to the beam web centreline.
 - (B) The use of "C" and "I" beam side clamps, etc., will not be allowed without written consent of the Consultant.
 - (C) Acceptable Manufacturers:
 - (I) Grinnell
 - (II) Myatt
 - (III) Carpenter & Paterson
 - (IV) Or approved equivalent
- (v) Truss or steel joist roof or floor framing:
 - (A) Locate hangers at or within 150mm (6") of the joist top or bottom chord panel points
 - (B) Otherwise provide additional structural steel as required where hanger spacing does not coincide with joist spacing.
 - (C) Transmit hanger load only concentrically to the supporting truss or joist.
- (vi) Secondary structural steel members between trusses and/or joists:
 - (A) Locate at or within 150mm (6") of top or bottom chord panel points.
 - (B) Where the secondary structural steel member cannot be located at or near a truss or joist panel point, provide additional diagonal structural steel web member/members designed for the applicable load to the nearest panel point in the opposite chord member.
 - (I) The above condition may be waived if the load to be suspended between panel points is not in excess of 45kg (100 LB).
 - (C) Diagonal hangers which will induce lateral stresses in the chord members of the joist will not be permitted.
- (b) Drives and Accessories
 - (i) Drives
 - (A) V-belt drives selection: 150 percent of the motor size rating.
 - (B) Sheaves: cast iron construction with machined grooves.

- (I) Sheaves 75mm (3") size and larger diameter: taper lock bushings.
 - (II) Multi-belt drives: matched sets.
 - (III) Statically and dynamically balance all sheaves as an operating unit.
- (C) Adjustable sheaves:
- (I) Motors less than 1.1Kw (1.5 HP) rating: adjustable pitch motor sheave with diameter range selected to obtain specified RPM of the driven equipment at approximately the mid-point setting of the sheave.
- (D) Fixed Sheaves:
- (I) Motors of 1.1Kw (1.5 HP) and greater: solid type.
 - (II) Should such sheaves not provide design requirements under operating conditions, supply and install a new drive sheave of proper size at no increase in Contract Price.
- (ii) Drive Couplings
- (A) Acceptable Manufacturers:
- (I) Falk
 - (II) Fast
 - (III) Thomas
 - (IV) Or approved equivalent
- (iii) Lubricating Devices
- (A) Equipment to have oil reservoirs with level indicators, or pressure grease fittings.
- (B) Inaccessible fittings: provide extended tubes to an accessible location.
- (C) Grease fittings: Zerk, Alemite or approved equivalent.
- (I) All fittings shall be of one type.
- (iv) Drive Guards
- (A) To OSHA requirements.
- (B) Build guards of all welded construction on exposed rotating parts or elements and on all drives.
- (C) Construction:
- (I) Total enclosure type fabricated of minimum 1.3mm (18 ga.) black sheet steel.
 - (II) Hinged side to allow access for lubrication, inspection or removal of the drive parts.
 - (III) Maximum clearance of openings in guards to rotating parts: not to exceed 13mm (1/2").
 - (IV) Make provision for slide rail adjustment.
- (D) Rework any substandard guards supplied with mechanical equipment to conform to the above requirements.

REPLACEMENT OF REFRIGERATION SYSTEM

- (c) Sealants, Concrete and Grouts
 - (i) Pipe Sleeve Seals
 - (A) Acceptable Manufacturers:
 - (I) Thunderline "Link-Seal" Series LS
 - (II) Century-Line
 - (III) Metraflex
 - (IV) Or approved equivalent
 - (ii) Concrete
 - (A) Strength: Unless otherwise noted, 25 MPa concrete: to CSA-A23.1/A23.2
 - (iii) Concrete Grouts
 - (A) Acceptable Manufacturers:
 - (I) Sternson "M-Bed Standard"
 - (II) Sika "Sikagrout 212"
 - (III) Master Builders "Construction Grout"
 - (IV) Meadows "CG-86"
 - (V) Euclid "Euco NS Grout"
 - (VI) CPD "Non-Shrink Grout"
 - (VII) Or approved equivalent
 - (iv) Bonding Agents
 - (A) Acceptable Manufacturers:
 - (I) Sika "Sikadur 32" Hi-Mod
 - (II) Or approved equivalent
 - (v) Caulking Compounds
 - (A) Acceptable Manufacturers:
 - (I) Denso-Plast
 - (II) Or approved equivalent
 - (vi) Firestopping
 - (A) ULC listed fire stopping assembly
 - (B) Rating to suit wall and floor penetrations
 - (C) Acceptable Manufacturers:
 - (I) Hilti
 - (II) Fire Stop Systems
 - (III) Dow Corning
 - (IV) 3M
 - (V) Tremco
 - (VI) A/D Fire Protection System
 - (VII) Johns Manville
 - (VIII) Or approved equivalent
- (d) Miscellaneous
 - (i) Isolating Unions

- (A) Acceptable Manufacturers:
 - (I) Epco
 - (II) Marpac "Petro"
 - (III) Corrosion Service
 - (IV) Or approved equivalent
- (ii) Fabricated Equipment Supports (Floor Stands and Ceiling or Wall Mounted Supports)
 - (A) Structural steel members of welded construction or steel pipe and fittings, suitably braced and secured to the floor by mild steel floor pads or pipe flanges with bolts or anchors.

3. Execution

- (a) Equipment
 - (i) General
 - (A) Install equipment in a compact, neat and workmanlike manner.
 - (I) Align, level and adjust for satisfactory operation.
 - (II) Install in such a manner that connecting and disconnecting of piping and accessories can be made readily and that all parts are easily accessible for inspection, operation, maintenance and repair.
 - (B) Install and start up items of equipment in accordance with the manufacturer's printed installation and operating instructions.
 - (ii) Noise and Vibration
 - (A) Noise and vibration levels of equipment and systems shall be within design intent.
 - (B) If noise or vibration levels created by any mechanical equipment and systems and transmitted to occupied portions of building or other mechanical work are over the limits, make all necessary changes and additions as approved by the Consultant without additional cost.
 - (iii) Lubrication
 - (A) Lubricate all equipment prior to start up in accordance with the manufacturer's printed instructions.
 - (B) Supply all lubrication including sufficient quantity for drainage and refilling of oil sumps, etc., when required by manufacturer's instructions.
 - (iv) Setting and Alignment of Equipment
 - (A) Rotating equipment
 - (I) Use millwrights to set and align to lines established with an engineer's level.
 - (II) Shim equipment using standard brass or bronze shim stock of suitable thickness to provide proper level and alignment.
 - (III) Place 25mm (1") minimum thick grout between equipment base and concrete pad or foundation.

- (IV) Have the Consultant approve equipment settings for equipment mounted on concrete pads or foundations prior to grouting.
 - (V) Re-check alignment prior to start-up of equipment.
 - (b) Miscellaneous Steel
 - (i) General
 - (A) Hang or support equipment, piping, etc., with miscellaneous structural supports, platforms, braces as may be required unless Drawings or other Sections of the Specifications state otherwise.
 - (ii) Materials and Fabrication
 - (A) Conform to:
 - (I) CAN/CSA-S16.1-M Limit Status Design of Steel Structures.
 - (II) CSA-G40.20/G40.21 grade 300W for General requirement for rolled or welded Structural Quality Steel CSA W47.1 - for qualification of welders.
 - (III) CSA W48.1-M - for electrodes (only coated rods allowed).
 - (IV) CSA W59-M - Welded Steel Construction (Metal Arc Welding).
 - (V) CSA W117.2 - for safety in welding.
 - (B) Construction:
 - (I) Welded construction wherever practicable.
 - (II) Chip welds to remove slag, and grind smooth.
 - (III) Bolted joints allowed for field assembly using high strength steel bolts.
 - (iii) Painting and Cleaning
 - (A) Clean steel to Steel Structures Painting Council SSPC-SP6, Commercial Blast Cleaning.
 - (B) Apply one coat of oil alkyd primer conforming to CISC/CPMA 2.75 to all miscellaneous steel.
 - (C) In the field, touch up all bolt heads and nuts, previously unpainted connections and surfaces damaged during erection with primer as hereinbefore specified.
 - (D) Apply two coats of primer to all surfaces which will be inaccessible after erection.
 - (E) Thoroughly remove all foreign matter from steelwork on completion of installation.
 - (c) Concrete Inserts
 - (i) General
 - (A) Install inserts required for attachment of hangers, either for suspension of piping or equipment.

- (B) For masonry or poured concrete construction use expansion type units. Insert into the concrete after concrete has cured. Do not use anchors or inserts installed by explosive means.
- (d) Flashings
 - (i) Coordination
 - (A) Coordinate with general trades and roofing contractor.
 - (ii) Provide flashing and counter-flashing for all mechanical and related electrical penetrations through roof. Costs resulting from failure to comply with this requirement are the sole responsibility of the contractor.
 - (iii) Acceptable Manufacturer: Thaler Metal or approved equal.
 - (A) Flexible steel conduit: Thaler model MEF-2x
 - (B) Hot pipe: MEF-3A with stainless steel collar
 - (C) Rigid conduit: MEF-AE1
 - (D) Or approved equivalent.
- (e) Fire Stopping
 - (i) Submittals
 - (A) Submit shop Drawings, including the following information:
 - (I) ULC/CUL listing number
 - (II) Installation Drawings for each type of penetration
 - (III) Installation materials
 - (ii) General
 - (A) Seal piping, ductwork, conduits and miscellaneous support steel penetrating fire separations.
 - (B) Install fire stopping in accordance with manufacturer's instructions and ULC listing requirements.
 - (C) Provide a written report to the Consultant upon completion of fire stopping, by area or floor if necessary, indicating the work is completed and ready for inspection. Do not cover over fire stopping, including installation of walls and ceilings, until work is inspected by the Consultant.
- (f) Performance and Balancing
 - (i) Refer to section 15990 Start-up and Performance Testing.
- (g) Adjustment and Operation of Systems
 - (i) General
 - (A) When the work is complete:

- (I) Adjust equipment items of the various systems for proper operation within the framework of design intent, and the operating characteristics as published by the equipment manufacturer.
 - (II) Complete additional instructions are specified under the respective Sections of Division 15.
 - (B) The Consultant reserves the right to require the services of an authorized representative of the manufacturer in the event that any item of equipment is not adjusted properly.
 - (I) Arrange for such services and pay all costs thereof.
 - (II) After completion of adjustments, place systems in full operating condition and advise the Consultant that the work is ready for acceptance.
- (h) Acceptance
 - (i) General
 - (A) After all equipment has been installed and adjusted and all systems balanced:
 - (I) Conduct performance tests in the presence of the Consultant and the Owner.
 - (II) Arrange the time for these tests at the convenience of the Consultant and the Owner.
 - (III) Conduct tests under climatic circumstances to ensure complete and comprehensive tests and of such a manner and duration as the Consultant may deem necessary.
 - (B) During these tests:
 - (I) Demonstrate the correct performance of all equipment items and of the systems they comprise.
 - (II) Should any system or any equipment item fail to function as required, make such changes, adjustments or replacements necessary to meet performance requirements.
 - (III) Repeat tests until requirements have been fully satisfied and all systems accepted by the Consultant.
 - (ii) Mechanical Contractor Coordination
 - (A) Cooperate with the Testing and commissioning firm.
 - (B) Provide the following assistance and/or services:
 - (I) Provide immediate labour from pertinent mechanical trades and tools, equipment and materials to make equipment and system alterations and adjustments, as required including control adjustments.
 - (II) Make available all equipment data (Shop Drawing performance data and operating instructions) to the Testing and commissioning Firm.
 - (C) As part of the coordination effort, the Mechanical Contractor shall be fully responsible for systems constructed, installed and adjusted to Provide optimum performance as required by design intent. Any re-

adjusting required as the result of spot checks by the Consultant shall be done at no increase in Contract Price.

- (D) Nothing contained in this Section voids the responsibility of the Mechanical Contractor (Subcontractor) for systems constructed, installed and adjusted to achieve the design intent.

END OF SECTION

1. General

- (a) Submittals
 - (i) Shop Drawings
 - (A) Submit Shop Drawings in accordance with 15010 “Basic Mechanical Requirements”.
 - (B) Submit layout Drawings showing each type and placement of manufactured, pre-fabricated roof piping support system. Submit details of all piping penetrations through roof.

2. Products

- (a) Materials
 - (i) Acceptable Manufacturers
 - (A) Hangers:
 - (I) Anvil
 - (II) Myatt
 - (III) Carpenter & Paterson
 - (IV) Hunt
 - (V) B-Line
 - (VI) Or approved equivalent
 - (B) Insulation shields:
 - (I) Anvil
 - (II) Myatt
 - (III) Pipe Shields Inc.
 - (IV) Or approved equivalent
 - (ii) Lower Attachment
 - (A) Clevis hanger – steel pipe
 - (I) Standard weight black steel clevis hangers with level adjustment and locknut
 - (II) Anvil figures 260 and 300.
 - (III) For figure 260, provide clevis bolt spacer on insulated piping.
 - (IV) Or approved equivalent
 - (B) Clevis hanger – copper pipe
 - (I) Light weight black steel clevis hangers with copper coloured finish and plastic insert to suit local authority requirements, with level adjustment and locknut.
 - (II) Anvil figure CT-65.
 - (III) Or approved equivalent
 - (C) Roller hanger
 - (I) Adjustable roller type hangers with locknuts.
 - (II) Rollers of sufficient width to clear the outside diameter of the insulation on the piping.

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- (III) Support rollers at both ends, either by a yoke, swivel type hanger or by two adjustable rods with locknuts (double locknuts).
 - (IV) Anvil figure 177 or 171 as applicable.
 - (V) Or approved equivalent
- (iii) Insulation Protection
- (A) Insulation saddles, for welding to pipe:
 - (I) Anvil figure 160-165 as applicable.
 - (II) Or approved equivalent
 - (B) Insulation shields :
 - (I) Either shop fabricated, or manufactured plates of the size required to properly fit the outside diameter of the pipe insulation.
 - (II) Anvil figure 167, modified with holes at each end to suit 12 mm wide. stainless steel band clamps.
 - (III) Shop fabricate bearing plates conforming to the following table for various pipe sizes:

Pipe Size (NPS)	Length of Plate mm	Thickness of Plate mm
½ to 2	300	1.2
3 to 4	300	1.52
 - (IV) Form the bearing plates to the O.D. of the adjoining pipe insulation and extend the plate up to the horizontal centre line of the pipe.
- (iv) Middle Attachment
- (A) Machine threaded rods
 - (I) Black steel finish in concealed areas.
 - (II) Galvanized finish in mechanical rooms and exposed areas.
- (v) Upper Attachments
- (A) Beam clamps:
 - (I) Malleable iron C-Clamp with retaining clip, FM approved: Anvil figure 87, NPS ½ to NPS 2; maximum load: 180 kg, or approved equivalent.
 - (II) Malleable beam clamp FM approved: Anvil figure 218, NPS 2½ to NPS 8; maximum load: 540 kg, or approved equivalent.
 - (III) For pipes NPS 10 and larger, provide supplementary steel members supported from structural steel.
 - (IV) Do not use top beam clamps.
 - (B) Concrete inserts (new construction):
 - (I) Single hanger: Malleable iron body and nut, universal nut style: Anvil figure 282, to NPS 8, or approved equivalent.
 - (II) Continuous hanger: cold formed hot dipped galvanized strip steel with end caps: Power-Strut PS 449, or approved equivalent.
 - (C) Concrete clevis plates (existing concrete):
 - (I) Carbon steel plate, with clevis attachment.

REPLACEMENT OF REFRIGERATION SYSTEM

- (II) Anvil figure 49.
- (III) Do not use explosive driven anchors.
- (IV) Or approved equivalent

- (vi) Riser Clamps
 - (A) Black steel double clamp: Anvil figure 261, supported at floors; Anvil figure 240, supported by hanger rods.
 - (B) Or approved equivalent

- (vii) Pipe Guides
 - (A) Outer hinged housing with sliding spider clamp.
 - (I) Carbon steel, black steel finish.
 - (II) Anvil figure 256.
 - (III) Or approved equivalent

3. Execution

- (a) Installation
 - (i) General
 - (A) Support or suspend piping with necessary hangers, structural supports and/or brackets, to prevent sagging, warping and vibration and to allow for movement due to expansion and contraction. Provide adequate number of expansion compensators of suitable materials as required to allow movement of pipe work.
 - (B) Place hangers and supports close to fittings, elbows, valves and/or other heavy parts.
 - (C) Do not allow loads of any nature to be transmitted through the piping connections to equipment not specifically designed for such loads.
 - (I) Where flexible connections are not called for at connections to equipment, support the pipe by stands attached to both pipe and supporting structure so that force in any direction is not transmitted to the equipment.
 - (D) Place suitably dampened spring hangers at the first three supports from the equipment connection on piping subject to excessive movement or shock from any source, thermal expansion and contraction.
 - (I) Where it is evident that no undue loads will be transmitted to the equipment by the system concerned, i.e. small bore connections to comparatively large equipment, cold service piping not subject to shock, etc., then spring hangers may be omitted and standard hangers used.
 - (E) Do not hang pipe from another pipe unless specifically shown on the Drawings.
 - (ii) Hanger Selection
 - (A) Select lower attachment and insulation protection based on the following, unless otherwise shown on Drawings:

PIPE HANGERS AND SUPPORTS

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Pipe Size NPS	Operating Temperature		
	Less than 21°C	Between 21°C and 43°C	Greater than 43°C
	Insulated	Non-insulated	Insulated
2 and less, steel	Clevis and Shield	Clevis only	Clevis
2½ to 8, steel	Clevis and Shield	Clevis only	Roller and Saddle

(B) Install temporary spacers between the insulation Shield and the pipe equal to the thickness of insulation specified. Refer to Section 15080 "Mechanical Thermal Insulation".

(iii) Saddles and Roller Supports

(A) Place saddles at roller supports for piping carrying liquids at 43°C (110°F) or higher.

(B) Weld saddles to black or galvanized steel piping.

(C) Refinish galvanized surfaces destroyed by the welding with a zinc rich paint such as W.R. Meadows "Galvafroid", Kerry Industries "ZRC" or Niagara Paint Inc. "PL052898" or Approved Equivalent.

(iv) Insulation Shields

(A) Place insulation shields at pipe supports for pipes carrying liquids at 21°C (70°F) or less.

(B) Field or factory punch a hole at each end of the shield to allow a 12 mm stainless steel band clamp to pass through opening.

(C) Secure shields with 2@ 12 mm stainless steel band clamps per shield.

(v) Hanger Spacing - General

(A) Horizontal runs of plumbing and drainage piping: to hanger spacing requirements of the Ontario Building Code.

(B) Place additional hangers in locations where there are concentrated loads such as valves, specialties, etc.

(vi) Hanger Spacing - Black Steel and Galvanized Pipe

(A) For horizontal runs of black or galvanized steel pipe, other than for plumbing service:

(B) Maximum distances between supports and with minimum diameter rods as follows:

Pipe Size NPS	Rod Size mm	Spacing	
		Water Service m	Gas, Steam or Air m
½ Thru 1	10	2.0	2.7
1¼	10	2.0	2.7
1½	10	2.7	3.6
2	10	3.0	3.9

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Pipe Size NPS	Rod Size mm	Spacing	
		Water Service m	Gas, Steam or Air m
2½	12	3.3	4.2
3	12	3.6	4.5
4	16	4.2	5.0

(vii) Hanger Spacing - Copper Tubing

(A) For horizontal runs of copper tubing for services other than plumbing:

(B) Maximum distances between supports and with minimum diameter rods as follows:

Pipe Size NPS	Rod Size mm	Spacing	
		Water Service m	Gas, Steam or Air m
Thru ¾	10	1.5	1.8
1	10	1.8	2.4
1¼	10	2.0	2.7
1½	10	2.4	3.0
2	10	2.4	3.3
2½	12	2.7	3.9
3	12	3.0	4.2
4	16	3.6	4.8

(viii) Hanger Spacing - PVC or CPVC

(A) For horizontal runs of PVC or CPVC for services other than plumbing.

(B) Maximum distances between supports and with minimum rods sizes for un-insulated pipe as follows.

Pipe Size nps	Rod Size mm	Spacing			
		PVC 40	CPVC 40	PVC 80	CPVC 80
½	6	1.2	1.2	1.2	1.2
¾	6	1.2	1.2	1.2	1.5
1	6	1.2	1.5	1.5	1.8
1¼	6	1.2	1.5	1.5	1.8
1½	6	1.5	1.8	1.8	1.8
2	6	1.5	1.8	1.8	2.0

(C) For insulated pipe, reduce spacing by 30%.

(D) Do not restrain axial movement

(E) Spacing based on fluids with specific gravity of 1.0 and 26°C 80°F. For other conditions, use other published data approved by the Consultant.

END OF SECTION

REPLACEMENT OF REFRIGERATION SYSTEM

1. **General**

- (a) Submittals
 - (i) Shop Drawings
 - (A) Submit Shop Drawings in accordance with Section 15010 “Basic Mechanical Requirements”.
 - (B) Submit schedule of Equipment Identification Nameplates for review.
 - (ii) Samples
 - (A) Submit samples of piping, valve and ductwork identification markers.

2. **Products**

- (a) Materials
 - (i) Equipment Identification
 - (A) Laminated phenolic plastic with white finish and minimum 10 mm high black letters.
 - (B) Three rows of text, based as shown in equipment Schedules.
 - (I) Line 1: Equipment ID (e.g. SP-1)
 - (II) Line 2: Equipment Name (e.g. Snow Melting Pump)
 - (III) Line 3: Optional, up to 15 characters (e.g. Standby Pump)
 - (C) This identification is in addition to manufacturer’s nameplate data.
 - (ii) Pipe Identification
 - (A) Paint fluid names and directional arrows on the piping to match existing.
 - (B) Piping shall be marked and labelled according to Section 5.11 of CSA B52 code and TSSA Standards.
 - (iii) Colour Coding of Piping: Pipe colours shall be according to the standard colour code set by the department.
 - (A) Ammonia :YELLOW
 - (B) Brine Lines Light: GREEN
 - (C) Water Lines (potable): BLUE
 - (D) Glycol: DARK GREEN
 - (E) Compressor Blow off Valves Fire: RED
 - (iv) Valve Identification
 - (A) Laminated phenolic plastic with minimum 10 mm high lettering, with brass keychain.
 - (B) Minimum two lines of text:

REPLACEMENT OF REFRIGERATION SYSTEM

- (I) Line 1: valve designation
- (II) Line 2: valve position instruction
- (v) Manufacturers
 - (A) Acceptable manufacturers
 - (I) S.M.S.
 - (II) Brady
 - (III) Safety Supply Co.
 - (IV) Revere-Seton
 - (V) Or approved equivalent

3. Execution

- (a) Installation
 - (i) Equipment Nameplates
 - (A) Identify mechanical and electrical equipment installed under this Division with nameplates describing the function or use of the particular equipment involved.
 - (B) Do not commence fabrication of nameplates until after receipt of the Consultant's review.
 - (C) Equipment includes, but not limited to:
 - (I) Equipment as shown on schedules and specified
 - (II) Motor starters
 - (III) Motor Control Centres
 - (IV) Pushbutton stations
 - (V) Control panels
 - (VI) Time switches
 - (VII) Disconnect switches
 - (VIII) Contactors or relays in separate enclosures
 - (IX) Main ducts (i.e. main supply, main return main outdoor air and main exhaust air ducts) for all HVAC systems.
 - (D) Securely fasten nameplates to the equipment with round-head cadmium plated steel self-tapping screws.
 - (ii) Piping Identification
 - (A) Label all piping installed under this Division to indicate the content and direction of flow.
 - (B) For piping carrying ammonia, show on label the pressure and working units as applicable.
 - (C) Locate labels as follows:
 - (I) At every end of pipe run, adjacent to the valve or item of equipment serviced.
 - (II) At valves, tees and changes of direction.
 - (III) On each exposed pipe passing through a wall, partition or floor (one on each side of such wall, partition or floor).

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- (IV) At intervals not to exceed 15 m along every exposed pipe run exceeding 15 m in length.
- (V) At every access point on concealed piping.
- (D) Labels to be visible from 1.5 m above the adjacent floor or platform.
- (iii) Valve Tags
 - (A) Provide valve tags on all valves
 - (B) Provide a valve identification directory for each system.
 - (I) Quantity: two (2) copies of valve identification directories for each system
 - (II) Documented as follows (example given):

Valve No.	Service	Valve Location	Nearest Column
HGV-1	Ammonia Hot Gas Bypass	Refrigeration Room	C-8

END OF SECTION

REPLACEMENT OF REFRIGERATION SYSTEM

1. General

- (a) General
 - (i) Provide thermal insulation on glycol piping, hot water piping, heating water piping and Ammonia suction piping including fittings and valves. Refer to Refrigeration systems section for details of insulation for Ammonia piping.
- (b) Reference Standards
 - (i) General
 - (A) Provide insulation materials and adhesives of fire retardant type with flame spread and smoke developed ratings not exceeding ULC, Government, or Municipal standards.
 - (B) Fire retardant materials with flame spread/smoke developed ratings not exceeding 25/50 when tested in accordance with CAN/ULC-S102, and complying with the requirements stated in the building code having jurisdiction.
 - (C) Identify insulation, coverings and adhesives where required by Federal and/or Provincial health and safety WHMIS legislation.
 - (D) Asbestos-free materials.
 - (ii) Reference Standards
 - (A) Comply with the latest edition of:
 - (I) NFPA 90-A
 - (II) NFPA 255, determination of flame spread rating and smoke development
 - (III) CAN/ULC-S102, determination of flame spread rating and smoke development
 - (IV) ASTM C-411, materials testing
 - (V) ASHRAE 90.1
- (c) Submittals
 - (i) Shop Drawings
 - (A) Submit Shop Drawings in accordance with Section 15010 “Basic Mechanical Requirements”.
- (d) Product Delivery, Storage and Handling
 - (i) General
 - (A) Retain insulation materials in original cartons or containers until immediately prior to application and store in dry location.
 - (B) Keep adhesives in their original containers with manufacturer's name and catalogue number clearly stated. Protect contents against freezing.

REPLACEMENT OF REFRIGERATION SYSTEM

2. Products

(a) Materials

(i) Pipe Insulation: Thermal resistance of all pipe insulation materials shall meet or exceed the requirements specified in ASHRAE 90.1.

(A) Insulation

(I) Insulation materials shall be Glass-Cell Isofab, Dow Trymer 2000 or approved equal, having R value of 5 per inch, density of 2 lbs / cu. ft. and suitable for temperature range of -300°F to 300°F c/w vapour barrier and Venture clad jacketing.

(ii) Insulation Finish

(A) PVC (Polyvinyl Chloride) jacket

(I) Minimum thickness: 20 mil
(II) Maximum permeability: 0.09 perms
(III) Premoulded one-piece fitting covers
(IV) Tape: vinyl, pressure sensitive, colour matched.
(V) PVC Jacketing materials shall be colour coded to clearly distinguish between various services (e.g. hot gas, liquid lines, suction lines, chilled brine supply, chilled brine return, compressor oil cooler, and the warm brine.). Submit colours for Engineer's approval prior to ordering of jacketing materials.

(VI) Acceptable manufacturers:

(1) Johns Manville - Manville Zeston 2000
(2) ACWIL Insulations
(3) Sure Fit Systems
(4) Or approved equivalent

(iii) Adhesives

(A) Contact bond cement

(I) Quick setting for metal surfaces
(II) Acceptable manufacturers:
(1) Monsey Bakor - 200-37
(2) Foster - 85-75
(3) Or approved equivalent

(B) Lap seal adhesive

(I) For joints and lap sealing of vapour barriers
(II) Acceptable manufacturers:
(1) Monsey Bakor - 230-39
(2) Foster - 85-75
(3) Or approved equivalent

(C) Contact adhesive

(I) Acceptable manufacturers:
(1) Foster - 85-20
(2) Or approved equivalent

(D) Lagging adhesive

(I) Acceptable manufacturers:

REPLACEMENT OF REFRIGERATION SYSTEM

- (1) Monsey Bakor - 120-18
 - (2) Foster - 30-36
 - (3) Or approved equivalent
 - (iv) Miscellaneous Products
 - (A) Sealants:
 - (I) Acceptable manufacturers:
 - (1) Monsey Bakor - 230-39
 - (2) Foster - 30-80
 - (3) Or approved equivalent
 - (B) Vapour barrier tape
 - (I) Colour matched, foil faced vapour barrier tape
 - (II) 75 mm wide
 - (III) Vinyl backed or foil backed to suit insulation
 - (IV) Acceptable manufacturers:
 - (1) Johns Manville - Zeston Z-tape
 - (2) MacTac Canada Ltd - Vinyl Scrim or Foil Scrim Kraft
 - (3) Compac Corp
 - (4) Fattal Canvas Inc
 - (5) Or approved equivalent

3. Execution

- (a) Application
 - (i) General
 - (A) Perform insulation Work using qualified insulating applicators, in accordance with latest trade application methods and to the Consultant's approval.
 - (B) Clean all surfaces to be insulated to remove grime, grease, oil, moisture or other matter to ensure that insulation is applied to clean and dry surfaces.
 - (C) Apply insulation under ambient temperature conditions in accordance with insulation or adhesive manufacturer's recommendations.
 - (D) Do not apply insulation until such time as installation and testing of piping, ductwork and equipment has been inspected, verified, and accepted by the Consultant.
 - (E) Apply insulation neatly and tightly in unbroken lengths and with ends of sections firmly and squarely butted together. Lap canvas (or other specified wrapping) well over joints and cement down well with adhesive.
 - (F) At wall sleeves: extend insulation through to make insulation continuous.
 - (G) At fire walls: terminate insulation at wall, and pack space between wall sleeve and duct or pipe as specified in Section 15050 "Basic Mechanical Material and Methods".

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- (H) Neatly finish insulation at pipe hangers, supports, sensors and interruptions.
- (I) Apply two layers of 1.5” thick insulation, staggered joints sealed with approved adhesives, on all new Ammonia suction piping including valves and fittings.
- (J) Provide distinctly coloured PVC jacketing c/w directional arrows for all insulated piping.

END OF SECTION

REPLACEMENT OF REFRIGERATION SYSTEM

1. General

- (a) Reference Standards
 - (i) Contractor Certification
 - (A) Contractors providing the Work regulated under O.Reg. 220/01 Boilers and Pressure Vessels are to be holders of a Technical Standards and Safety Authority (TSSA) Certificate of Authorization to conduct this Work, including:
 - (ii) Pressure piping fabrication and installation
 - (A) CSA B52
 - (B) Boiler and Pressure Vessel repairs and alterations.
 - (C) Ontario Plumbing Code.
 - (D) Submit documentation of this certification with bid documents.
 - (iii) Registration
 - (A) Register with the TSSA, and pay associated registration and inspection costs, for pressure piping systems regulated under O.Reg. 220/01 Boilers and Pressure Vessels.
- (b) Submittals
 - (i) Shop Drawings
 - (A) Submit Shop Drawings in accordance with section 15010 “Basic Mechanical requirements”.
 - (B) Submit shop Drawings for the following items and indicate where they are used and with which system
 - (I) Pipe materials
 - (II) Fittings
 - (III) Valves
 - (ii) Operation and Maintenance Data:
 - (A) Submit printed operation instructions and maintenance data in accordance with Section 15010 “Basic Mechanical requirements”.

2. Products

- (a) Equipment connections: Provide V-line insulating couplings as supplied by H&G Specialties Limited, or approved equal, for prevention of galvanic corrosion at all points where connections are required between copper, brass or bronze and black iron or galvanized steel piping.
- (b) Ammonia (R717) Piping and Fittings – Primary Refrigerant
 - (i) Ammonia piping shall conform to CSA B-52 safety code, ANSI/ASME B31.5

Code for Pressure Piping, and ANSI/HRA 2, Equipment Design and Installation of Ammonia Mechanical Refrigeration Systems.

- (ii) 2" and smaller shall be not less than schedule 80 carbon steel pipe, seamless to ASTM A106 B or ERW ASTM A53B with socket weld or threaded fitting.
- (iii) 2-1/2" shall be not less than schedule 40 carbon steel pipe, seamless to ASTM A106B or ERW ASTM A53B with butt welded fittings.
- (iv) 3" and larger shall be not less than schedule 40 carbon steel pipe, ERW, ASTM A53B with butt welded fittings.
- (v) Pipe and fitting materials shall be suitable for Ammonia and shall be rated for:
 - (A) Highside, 95 deg F: 250 psi design and 400 psi test pressure.
 - (B) Lowside, 10 deg F: 150 psi design and 200 psi test pressure.
- (vi) All refrigerant fittings shall bear the manufacturer's identification, and shall have a current CRN registration, conforming to applicable standards.

(c) Glycol System Valves

- (i) All valves shall be, to the extent possible, the product of a single manufacturer and shall have the manufacturer's name, pressure rating and size clearly marked on the outside of the body.
- (ii) Valves shall be suitable for fluid media in which they are installed.
- (iii) Valves installed in glycol and water lines shall be rated for working pressure of 150 PSI.
- (iv) Glycol valves 2" and smaller, shall be full port ball or gate valve type, with screwed ends, and fully suitable for the intended service.
- (v) Glycol valves 2 1/2" and larger, shall be butterfly, full lug type having iron body, SS stem, replaceable EPDM seat, nylon coated ductile iron disc and suitable mounting between 150 lb ANSI flanges. Valves shall be Challenger or approved equivalent.
- (vi) Insulated valves shall have extended stems and shafts, where the thickness of insulation interferes with the operation of the handle.
- (vii) Refrigerant control valves shall be as manufactured by Refrigeration Specialities, Phillips, Armstrong, Hansen, Danfoss or approved equivalent.
- (viii) All Ammonia valves and fittings, including shutoff and relief valves shall have current CRN numbers.

(d) Refrigerant Process Valves

- (i) All valves shall be, to the extent possible, the product of a single manufacturer and shall have the manufacturer's name, pressure rating and size clearly marked on the outside of the body.

- (ii) Valves shall be suitable for fluid media in which they are installed.
 - (iii) Valves installed in Ammonia lines shall be rated for working pressure of 400 PSI.
 - (iv) Shut-off / Stop valves in Ammonia lines shall be hand operated, as manufactured by Refrigeration Specialities, Hansen, or approved equivalent.
 - (v) Safety relief valves shall be Parker, or approved equivalent. Prior to ordering of valves, confirm pressure setting and volume of liquid/gas to be relieved.
 - (vi) Insulated valves shall have extended stems and shafts, where the thickness of insulation interferes with the operation of the handle.
 - (vii) Refrigerant control valves shall be as manufactured by Refrigeration Specialities, Phillips, Armstrong, Hansen, Danfoss or approved equivalent.
 - (viii) All Ammonia valves and fittings, including shutoff and relief valves shall have current CRN numbers.
- (e) Pressure And Temperature Gauges
- (i) Gauges shall be, to the extent possible, the product of single manufacturer name clearly marked on the outside of the body. The gauges shall be suitable for fluid media in which they are installed.
 - (ii) The gauges scale ranges shall be such that the working temperature or pressure of the system for which the instrument is provided is at approximately the mid-point of the instrument scale.
 - (iii) Pressure gauges in ammonia line shall be Parker's or approved equal, combination pressure / temperature refrigerant gauges, 6" (150mm) diameter adjustable pointer, having pressure rangers of 760mm to 25 bar on high side and 760 mm to 10.5 bar on low pressure sides.
- (f) Heating pipes and fittings
- (i) Use pipes, fittings and valves as shown below unless specifically shown or specified otherwise.
 - (ii) Heating water less than 121 degrees C (250 F) at 1035kPa (150 psi), or heating water less than 93.2 degrees C (200 F) at 1139kPa (165 psi).
 - (A) Pipes 65mm (2 ½ ") to 250mm (10") ASTM A53, Schedule 40, plain ends, ANSI B36.10.
 - (B) Pipes 50mm (2") and smaller, black steel ASTM A53, Schedule 40, threaded, ANSI B36.10.
 - (C) Fittings 65mm (2 ½ ") to 250mm (10") black steel ASTM A234, Schedule 40, butt-welding ends, ANSI B16.9.
 - (D) Fittings 50mm (2") and smaller, cast iron ASTM A126.
 - (E) Flanges 65mm (2 ½ ") and larger, ANSI B16.1. Use only weld neck

PIPES, FITTINGS AND VALVES

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flanges with butterfly valves.

- (F) Flange accessories for heating water gasket, 1.5mm graphite impregnated asbestos, bolts, square head machine with hexagonal nut, steel ASTM A307, ANSI B18.2.
- (iii) Gate valves 65mm 2 ½ “) and larger, cast iron 860kPa (120 psi) Working Steam Pressure (WSP), bronze mounted, O.S. and Y A.N.S.I B16.1 Flanges, shall be Crane #465 1/2, Jenkins #454J, Toyo 421 or Kitz 72.
- (iv) Gate valves 50mm (2”) and smaller, bronze 1035kPa (150 psi) Working Steam Pressure (WSP) rising stem, threaded shall be Crane #431, Jenkins #2810J, Toyo 298 or Kitz 42.
- (v) Globe valves 65mm (2 ½”) and larger, cast iron 860kPa (120 psi) WSP, bronze mounted, renewable composition disc, A.N.S.I B16.1 Flanges shall be Crane #351, Jenkins #2342, Toyo 400A or Kitz 76.
- (vi) Globe valves 50mm (2”) and smaller, bronze 1035kPa (150 psi) WSP, renewable composition disc, threaded shall be Crane #7TF, Jenkins #106-B, Toyo 221 or Kitz 9.
- (vii) Check valves 50mm (2”) and smaller bronze 860kPa (125 psi) WSP, swing check, screwed cover, screwed shall be Crane #37, Jenkins #4092, Toyo 236 or Kitz 22.
- (viii) Check valves 65mm (2½”) and larger ANSI Class 150, 1030kPa (150 psi) WSP, dual flapper retainer-less design with carbon steel body and stainless steel check, renewable disc and seat for flanged installation, shall be Velan-Proquip model BDD10-1B or DUO CHEK II H15SMF-201, Mueller 72-DHH-3-H.
- (ix) Drain valves for blow-off of sediment from strainers and tank drainage shall be 19mm (3/4”) size 4140kPa (600 psi) WOG ball valve with bronze or forged brass body, virgin Teflon seat and packing, male threaded garden hose end, brass cap and chain shall be Watts B6000, Crane 9202, Jenkins 201J, Toyo 5046, Kitz 58CC or Apollo 78-100.
- (x) Suction elbow on vertical in-line pumps shall be combination elbow and strainer (suction diffuser). Strainer perforations shall be as specified for Y strainers. Blow-off valves shall be provided in all sizes. Sizes of suction diffuser shall match the pump inlet and interconnecting piping. Suction diffuser shall be cast iron and shall be provided by the pump manufacturer.
- (xi) Ball valves for heating water 50mm (2”) and smaller shall be bronze body 4140kPa (600 psi) WOG, virgin Teflon seat, TFE stem packing and thrust washer, 1/4 turn open-closed operation. All components to be replaceable in-line. Solder end valves are not acceptable. All ball valves shall be complete with stem extensions. Ball valves shall be Watts No. B-6800, Toyo 5050, Kitz 62, or Apollo 82-100-04.
- (xii) Ball valves for heating water 63mm (2½”) and larger shall be bronze or forged brass 4140kPa (600 psi) Water, Oil & Gas (WOG), virgin Teflon seat,

TetraFluorEthylene (TFE) system packing and thrust washer, 1/4 turn open-close operation. All ball valves shall be complete with stem extensions. Ball valves shall be Watts B6000, Crane 9202, Jenkins 201J/202J, Toyo 5044A, Kitz 58/59, or Apollo 70-100/200-04.

- (g) Domestic water pipes and fittings
 - (i) Pipes: copper tube, hard drawn, type L: to ASTM B88M.
 - (ii) Fittings: Bronze pipe flanges and flanged fittings, Class 150 and 300: to ANSI/ASME B16.24.
 - (iii) Joints: Solder: 95/5 tin copper alloy. Provide Teflon tape: for threaded joints.
 - (iv) Provide dielectric connections between dissimilar metals: dielectric fitting, complete with thermoplastic liner.
- (h) Hangers and Riser Supports
 - (i) Provide adequately sized hangers and supports for all new piping.
 - (ii) Remove all existing hangers and supports.
 - (iii) Prime and apply two coats of paint all ferrous materials prior to their installation. The prime and materials shall be suitable for humid and low temperature applications.
 - (iv) Provide adequately sized heavy duty chairs for new embedded tubing as recommended by the pipe manufacturer.

3. Execution

- (a) General Piping Construction Methods
 - (i) General
 - (A) Standards:
 - (I) To ANSI Sections B31.1 to B31.9 as applicable to service, unless specified otherwise herein.
 - (B) Inserts, sleeves and anchors:
 - (I) Avoid unnecessary cutting of masonry.
 - (II) Supply inserts, sleeves, and anchors to other trades for building in as the Work proceeds.
 - (III) Arrange with other trades to leave openings, slots and chases to accommodate later installation of mechanical Work.
 - (C) Inspect pipe and fittings for soundness and clean off all dirt and other foreign matter immediately prior to installation.
 - (I) Reject all damaged items.
 - (D) Pipe layout:
 - (I) Install piping in the most direct, straight and functional manner possible.
 - (II) Except where otherwise shown, install all vertical lines plumb, and run

- horizontal lines parallel to building walls.
 - (III) Install piping close to walls, partitions and ceilings.
 - (IV) On multiple runs of piping, space piping to allow for installation of insulation and for proper servicing of valves.
- (ii) Lines, Grades and Slopes
- (A) Install piping in conformity with elevations and grades indicated on the Drawings using axis lines and bench marks provided under General Construction.
 - (I) Verify such axis lines and bench marks.
 - (II) Lay out the Work and be responsible for lines, elevations, measurements, etc., required for installation of the Work.
- (b) Sleeves
- (i) Installation Requirements
- (A) Provide where piping passes through above grade floors and walls.
 - (B) Materials
 - (I) Schedule 40 black steel pipe or type "K" copper tubing for installation in floors
 - (II) 1 mm (20 ga.) galvanized sheet steel where installed in above grade walls.
 - (C) Terminate sleeves flush with finished ceilings, walls and floors on grade.
 - (I) For piping passing through floors above grade extend sleeve a minimum of 75 mm above the floor.
 - (D) Sleeve sizes
 - (I) Large enough to pass full thickness of pipe covering where same is used.
 - (II) With sufficient clearance between pipe/insulation and sleeve to allow for any lateral movement of piping due to expansion and contraction.
 - (E) Assume responsibility for the setting of all sleeves necessary for this Work in masonry walls during construction or in concrete forms before concrete is poured.
 - (F) Coat exterior surface of all sleeves of ferrous material with a heavy asphalt emulsion.
- (ii) Firestopping
- (A) Provide approved firestopping on pipes passing through firewalls, fire separation walls or through walls, partitions or floors which are considered as serving as firestops.
 - (I) Provide at partitions around washrooms.
 - (II) Seal the space around the pipe, in the sleeve, in accordance with Section 15050 "Basic Mechanical Materials and Methods".
- (iii) Escutcheon Plates
- (A) Place escutcheon plates on bare piping passing through finished walls or floors.

- (c) Flashing
 - (i) Refer to Section 15050 “Basic Mechanical Materials and Methods” for details
- (d) Joints, Unions, Flanges and Fittings
 - (i) Pipe Joints
 - (A) Preparation
 - (I) Ream pipe ends and thoroughly clean all dirt, cuttings and foreign matter from pipe after cutting and threading.
 - (II) Thoroughly clean all fittings, valves and equipment before connections are made.
 - (III) Cut copper tubing with a tube cutter and clean the joining surfaces of the tubing and fitting with fine emery cloth. Wipe clean with a dry cloth.
 - (B) Threaded joints:
 - (I) Use Teflon tape or Masters metallic compound, or approved equivalent, with the compound applied to the male threads only and particular care taken to prevent the compound from reaching the interior of the pipe or fittings.
 - (C) Carbon steel welded joints:
 - (I) To ANSI B31.1 Section IX for welding.
 - (II) Fusion welded joints made by electric arc welding, gas metal arc welding, or oxy-acetylene gas welding.
 - (III) Ensure that supervisory staff, fitters and welders are fully conversant with the requirements laid down by that Standard prior to the commencement of welding.
 - (IV) Employ qualified welders holding a current up-to-date Provincial Certificate for the process and rating involved as required by the Provincial Regulations.
 - (V) Unless more stringent methods of inspections are specified the Consultant will visually inspect welded joints for fusion of metal, icicles, alignment, etc.
 - (VI) Remove any defects and remake the joint to his satisfaction.
 - (VII) For welding of materials other than carbon steel, conform to the requirements specified in the relevant section of the Specification.
 - (ii) Unions and Flanges
 - (A) Provide unions or flanges in the following locations:
 - (I) For by-passes around equipment or control valves or devices in piping systems.
 - (II) At connections to equipment. Locate between shut-off valve and equipment.
 - (B) If unions are concealed in walls, partitions or ceilings, build access thereto.
 - (C) Provide dielectric unions or isolating type companion flanges at all connections between copper tubing and ferrous piping.

- (D) Flange joints
 - (I) Assemble joints with appropriate flanges, gaskets and bolting.
 - (II) Allow clearance between flange faces such that the connections can be gasketed and bolted tight without undue strain on the piping system, with flange faces parallel and bores concentric.
 - (III) Centre gaskets on the flange faces so as not to project into the bore.
 - (IV) Lubricate bolts before assembly and Provide 2 hardened steel washers under the head of each unit to assure uniform bolt stressing.
 - (V) Machine off raised face flanges when joining to a flat companion flange and use a full face gasket.
 - (VI) Follow gasket manufacturer's instructions for correct bolting procedure.
 - (VII) Use calibrated torque wrench and tighten bolts in recommended sequence in four equal steps to required final torque value.
- (e) Valves
 - (i) Installation
 - (A) General
 - (I) Wherever possible, source valves from one manufacturer.
 - (B) Where required
 - (I) At locations shown on the Drawings.
 - (II) At all piping connections to equipment.
 - (III) At all connections to control valves or control devices.
 - (IV) Where required for sectionalizing a system or floor.
 - (V) Check valves wherever required to ensure flow of liquid in one direction.
- (f) Inspection and Testing
 - (i) Pressure Leak Testing
 - (A) Make specified pressure tests on all piping included in this Contract.
 - (B) Furnish all pumps, compressors, gauges and connectors necessary for the tests.
 - (C) Test sections as authorized by the Consultant to accommodate construction schedule. However, test complete systems on completion of the Work.
 - (D) Coordinate and conduct all tests and inspections required by TSSA.
 - (E) Conduct tests in the presence of:
 - (I) Consultant
 - (II) Personnel of governing authorities having jurisdiction
 - (F) Notify above personnel in ample time to permit them to be present.
 - (G) Conduct tests before piping is painted, covered or concealed.
 - (H) Disconnect pumps or compressors used for applying the test pressure, during the test period.
 - (I) Disconnect and/or remove equipment or specialties not designed to withstand the

test pressure during the test and reconnect same after completion of test.

- (J) Promptly correct any defects that develop through tests and re-test to the complete satisfaction of the Consultant and other parties involved.
 - (K) Forward copies of all final tests on all pressure and drainage piping and a copy of governing authority approvals to the Consultant immediately on acceptance of tests and/or approvals.
 - (L) Final payment for the Work will not be made until the above has been received.
 - (M) Pressure test shall comply with CSA B52, section 5.10.
- (ii) Pneumatic Tests
- (A) Initially pressurize the system with air to approximately one-half the specified operating pressure.
 - (I) Examine joints for leaks with a soapsuds solution.
 - (II) Repair leaks as detected.
 - (III) Repeat test and repairs until soap test passes.
 - (B) Provide a final pressure test on the system with air to the test pressure specified under the respective Section of the Specifications.
- (g) Pre-Operational Cleaning
- (i) Temporary Connections
 - (A) Make temporary cross-overs, blank-off equipment connections, install drain and fill lines for circulating cleaning fluid through piping.
 - (ii) Flushing and cleaning of Piping Systems
 - (A) Flush and clean all piping as per manufacturer's recommendations. Remove all dirt, scale, and cuttings from the entire length of the piping.
 - (B) Thoroughly clean, prior to fabrication, sections of new piping which cannot be isolated for flushing purposes.
 - (C) Thoroughly clean, insofar as possible, welded joints by swabbing interior of pipe with swabs soaked with a caustic solution.

END OF SECTION

1. General

- (a) Scope of work
 - (i) This is a performance specification for a glycol based, snow melting system. The design intent is to melt a single load (approximately 60 to 75 cubic feet) of packed snow/ice mixture delivered by the ice re-surfacing machine (Olympia/Zamboni) once every 2 hours. Note that the pit will be used to accommodate delivery of approximately 12 loads of 60 to 75 cubic feet per day.
 - (ii) Provide all required services, engineering, materials and labour to complete a detailed design, supply, installation, start-up and commissioning of a fully functional glycol based snow melting system.
 - (iii) The system shall be complete with heat exchanger, circulating pumps, expansion tank, glycol fill station, 40% propylene glycol solution, pre-insulated Ecoflex (or equal approved) buried piping, S.S. manifolds, HEPEX (or equal approved) tubing, S.S. supporting frames, isolation valves, control valves, strainers, thermal insulation, controls and all other accessories required for a snow melting system as generally described on the drawings, as specified herein and as required.
 - (iv) Allow all costs for engineering, testing and start-up of the system.
 - (v) Brief description of work in the snow pit:
 - (A) The snow melting plastic tubing circuits shall be connected to S.S. manifolds, each circuit shall be equipped with independent supply and return isolation valves. Provide suitable Dielectric couplings at all interfaces of dissimilar materials.
 - (B) Adequate maintenance clearances shall be provided around the manifolds and valves.
- (b) Reference Standards
 - (i) Standards and codes to be latest editions adopted by and enforced by local governing authorities.
 - (ii) ANSI B31.3 Process piping Systems.

2. Products

- (a) Piping
 - (i) All hot fluid supply piping inside the snow melting pit shall be stainless steel Schedule 40, welded construction, 316L materials. Piping may be bent (to eliminate elbow fittings) to suit the exact site requirements.
 - (ii) Piping system shall be suitable for a maximum operating pressure of 125 Psi.

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- (iii) All joints shall be flanged type (Van Stone or equal approved).
- (iv) Insulation
 - (A) Provide a minimum of 40 mm thick rigid fibreglass insulation. white PVC jacketing for all piping inside the snow melting pit.
 - (B) Provide Multilayered, closed-cell, PEX-foam insulation with a thermal conductivity of 0.26 BTU in./sq. ft./hour/°F; vapor permeability of 0.1g/100 sq. in./day for all manifolds.
- (v) Hydronic snow and ice melting system shall use multiple hot fluid tubes inside the pit in a configuration as required. The temperature differential between the hot fluid entering and leaving the area to be protected should not exceed 14°C (25°F) to avoid thermal shock.
 - (A) Material: Cross-linked polyethylene (PEX) manufactured by the Engle method.
 - (B) Material Standard: Manufactured in accordance with ASTM F876 and ASTM F877 and tested for compliance by an independent third-party agency.
 - (C) Pressure Ratings: Standard Grade hydrostatic design and pressure ratings as issued by the Plastics Pipe Institute (PPI), a division of the Society of the Plastics Industry (SPI).
 - (D) Show compliance with ASTM E119 and ANSI/UL 263 through certification listings through UL.
 - (E) Minimum Bend Radius (Cold Bending): No less than six times the outside diameter. Use the PEX tubing manufacturer's bend supports if radius is less than stated.
 - (F) Oxygen Diffusion Barrier: The oxygen diffusion barrier shall not exceed an oxygen diffusion rate of 0.10 grams per cubic meter per day at 40 °C (104 °F) water temperature in accordance with German DIN 4726.
 - (G) Nominal Inside Diameter: Provide tubing with nominal inside diameter in accordance with ASTM F876, as indicated:
 - (I) 12.7 mm (½");
 - (II) 19.05 mm (¾");
 - (III) 25.4 mm (1").
- (vi) System Description
 - (A) Insulated pipe system for commercial hydronic heating applications.
- (vii) Service Pipe
 - (A) Cross linked polyethylene (PEX-a) Engel-method tubing or equal approved with an EVOH oxygen barrier that conforms to German

DIN 4726; smoothness value of 0.02 mil; NSF certified SDR-9.

- (viii) Insulation
 - (A) Multilayered, closed-cell, PEX-foam insulation with a thermal conductivity of 0.26 BTU in./sq. ft./hour/°F; vapor permeability of 0.1g/100 sq. in./day.
 - (ix) Jacket
 - (A) Corrugated seamless high-density polyethylene (HDPE), UV-protected.
 - (x) Operating Limits
 - (A) -50°C to 95°C (-58°F to 203°F) at 87 psig.
 - (xi) Pipe Sizes: 25.4 mm (1") to 38.1 mm (1 ½") diameter.
 - (xii) Standard of quality assurance manufacturer is Ecoflex or approved equivalent.
 - (xiii) All hot fluid main supply piping inside the snow melting pit shall be stainless steel Schedule 40, welded construction, 316L materials. Piping may be bent (to eliminate elbow fittings) to suit the exact site requirements.
 - (xiv) Piping system shall be suitable for a maximum operating pressure of 125 Psi.
 - (xv) All joints shall be flanged type (Van Stone or equal approved)
 - (xvi) Provide a minimum of 40 mm thick rigid fibreglass insulation covered with white PVC jacketing for all supply piping inside the snow melting pit.
 - (xvii) Adequately insulate all manifolds with flexible fibreglass insulation materials.
 - (xviii) Provide one circuit balancing valve for each manifold.
 - (xix) Provide identification for all major piping components such as supply and return headers.
 - (xx) Provide shut-off valves in accessible locations for isolation of supply and return glycol to and from the snow melting pit.
 - (xxi) Piping drainage ports, equipped with isolation valves and manual air vents shall be provided.
- (b) Manifolds
- (i) For system compatibility, use 2-inch valved Stainless Steel manifolds. Valving shall include ball isolation valves and balancing valves.
 - (ii) Ensure manifold end cap offers tapping for 3.175 mm (1/8") FNPT and

12.7 mm (½ ") FNPT for vent and drain.

- (c) Glycol
 - (i) Propylene glycol blended with Nitrite based corrosion inhibitors.
 - (ii) Standard of quality assurance manufacturers are:
 - (A) DOW;
 - (B) or approved equivalent.
- (d) Glycol Fill Tank- Hydronic System Feeder
 - (i) Hydronic system feeder shall be AXIOM INDUSTRIES LTD. Model DMF150 or approved equivalent. System shall include 17 litre (4.5 U.S. gallon) storage/mixing tank with molded-in level gauge, 125 mm (5") fill/access opening and cover; pump suction hose with inlet strainer; pressure pump with fuse protection; check valve; low fluid level pump cut-out float switch; manual diverter valve for purging air and agitating contents of storage tank; digital pressure switch adjustable from 0 kPa (0 psig) to 310 kPa (45 psig) cut-out pressure; factory cut-out pressure set to 115 kPa (18psig); digital pressure display, visual alarm on low level, low level alarm comes with remote dry contacts; wall mounting bracket. Unit to be c/w UL listed and fused power supply adapter with LED power indicator light, 100-240VAC/50-60Hz/1 to 24 VDC, supplied loose for field installation.
 - (ii) Feeder shall be compatible with glycol solutions of up to 50% concentration. Pump shall be capable of running dry without damage. Unit shall be completely assembled.
- (e) Pump (SP-1)
 - (i) The pump shall be close-coupled, inline for vertical or horizontal installation, in cast iron bronze fitted (or all bronze) construction specifically designed for quiet operation and shall be suitable for 40% propylene glycol application. Suitable standard operations at 180°F and 175 PSIG working pressure. The pump internals shall be capable of being serviced without disturbing piping connections.
 - (ii) As an option, an EPR/Graphite loaded Silicon-Carbide/Graphite loaded Silicon-Carbide or FKM/Carbon/Silicon-Carbide seal (225°F maximum operating temperature) should be used in lieu of the standard EPR/Carbon/Silicon-Carbide seal (250°F maximum operating temperature).
 - (iii) The pumps shall have a solid stainless steel shaft that is integral to the motor.
 - (iv) The motor bearings shall support the shaft via heavy-duty permanently lubricated ball bearings.
 - (v) Pump shall be equipped with an internally-flushed mechanical seal assembly installed in an enlarged tapered seal chamber. Seal assembly shall be the unitized type with stainless steel drive tabs, EPR bellows and seat gasket, stainless steel spring, and be of a carbon silicon-carbide design with the carbon face rotating against a stationary silicon-carbide face.

- (vi) Pump shaft shall connect to a brass impeller. Impeller shall be hydraulically and dynamically balanced, threaded onto the motor shaft.
- (vii) Pump should be designed to allow for true back pull-out access to the pump's working components for ease of maintenance.
- (viii) Pump volute shall be of a cast iron design for heating systems or cast brass for domestic water systems. The connection style on the cast iron and bronze pumps shall be flanged. Volute shall include gauge ports at nozzles.
- (ix) Motors shall meet scheduled horsepower, speed, voltage, and enclosure design. Motors shall have permanently lubricated ball bearings sized to offset the additional bearing loads associated with the closed-coupled pump design. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications.
- (x) When specifying the e-90E Smart Pump models with integrated VFD, the motors shall be Xylem's ultra-premium efficient IE5 permanent magnet Smart Motor, capable of multiple speeds ranging from 800RPM to 3600RPM.
- (xi) Pumps shall conform to ANSI/HI 9.6.3.1 standard for Preferred Operating Region (POR) unless otherwise approved by the engineer.
- (xii) Pump shall be of a maintainable design and for ease of maintenance should use machine fit parts and not press fit components
- (xiii) Pump manufacturer shall be ISO-9001 certified.
- (xiv) Each pump shall be factory tested and name-plated before shipment.
- (xv) Acceptable Manufacturers: Bell and Gossett, Armstrong or approved equivalent
- (f) Heat Exchanger
 - (i) Heat exchanger shall be plate frame type heat exchanger constructed of material suitable for glycol application. Duty shall be as per mechanical schedule. Heat exchanger shall be countercurrent type.
 - (ii) Acceptable Manufacturer: AIC or approved equivalent

3. Execution

- (a) Pre-Installation
 - (i) Verify existing site conditions including project requirements, substrate conditions, floor coverings, manufacturer's installation instructions and warranty requirements.
 - (ii) Review project construction timeline to ensure compliance or discuss modifications as required.
 - (iii) Interface with other trade representatives to verify areas of responsibility.

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- (b) Testing Adjusting and Balancing
 - (i) Employ services of an independent testing, adjusting, and balancing agency meeting qualifications specified below, to be single source of responsibility to test, adjust, and balance building mechanical systems to produce design objectives. Agency is to have successfully completed testing, adjusting and balancing of mechanical systems for a minimum of five projects similar to this Project within past three years, and is to be certified as an independent agency in required categories by the following:
 - (A) NEBB - National Environmental Balancing Bureau.
 - (ii) TAB technicians performing work are to be fully qualified and experienced in TAB of respective products and work.
 - (iii) Testing, adjusting and balancing of complete mechanical systems is to be performed in accordance with one of following publications:
 - (A) National Standards for a Total System Balance published by Associated Air Balance Council;
 - (B) Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems published by National Environmental Balancing Bureau;
 - (iv) Mechanical systems to be tested, adjusted and balanced are to be maintained in full, normal operation during each day of testing, adjusting and balancing;
 - (v) Agency is to check valves for correct and locked position, and temperature control systems for completeness of installation before starting equipment;
 - (vi) Wherever possible, Agency is to lock balancing devices in place at proper setting, and permanently mark settings on devices;
 - (vii) Agency is to perform testing, adjusting and balancing to within $\pm 5\%$ of design values, and make and record measurements which are within $\pm 2\%$ of actual values;
 - (viii) Agency is to perform auditing on the existing system prior to demolition and submit a TAB report confirming flows, pressures and temperatures for each system. Report shall be submitted to consultants for analyzation and confirmation of all required design values before commencing demolition. Once approved by the consultant, and after completion of manifold/piping installation, all the design values shall be adjusted and the system shall be balanced to the design parameters that were noted before demolition.
 - (ix) Agency is to include for each system to be tested, adjusted and balanced, a neatly drawn, identified (system designation, plant equipment location, and area served) schematic "as-built" diagram indicating and identifying equipment, terminals, and accessories.
 - (x) After final testing and balancing report has been submitted, Agency is to visit site with Contractor and Consultant to spot check results indicated on balancing report. Agency is to supply labour, ladders, and instruments to complete spot

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checks. If results of spot checks do not, on a consistent basis, agree with final report, spot check procedures will stop and Agency is to then rebalance systems involved, resubmit final report, and again perform spot checks with Contractor and Consultant.

- (xi) When final report has been accepted, Contractor is to submit to the owner, in name of the owner, a certificate equal to AABC National Guaranty Certification or a NEBB Quality Assurance Program Bond, and in addition, Contractor is to submit a written extended warranty from Agency covering one full heating season and one full cooling season, during which time any balancing problems which occur, with exception of minor revision work done during scheduled site visits, will, at no cost, be investigated by Agency and reported on to the owner, and if it is determined that problems are a result of improper testing, adjusting and balancing, they are to be immediately corrected without additional cost to the owner.
- (c) Stainless Steel piping inside the pit
 - (i) Comply with manufacturer's product data, including product technical bulletins, installation instructions and design drawings.
 - (ii) Insulation
 - (A) Provide a minimum of 40 mm thick rigid fibreglass insulation covered with white PVC jacketing for all rigid piping
 - (iii) Installer's Experience
 - (A) The installing contractor shall have a min. of 10 years of demonstrated experience on projects of similar size and complexity in Ontario.
 - (iv) Examination
 - (A) Verify that site conditions are acceptable for installation of the snow and ice melt system.
 - (B) Do not proceed with installation of the snow and ice melt system until unacceptable conditions are corrected.
 - (C) Glycol/Water Solution
 - (I) The heating fluid shall be premixed glycol/water solutions. Piping manufacturer allows site-mixed solutions if mixed to the proper concentration before entering the system.
 - (II) Mix the glycol/water solution to proper concentration levels to protect the system freezing during operation shutdown.
 - (III) System circulators must operate continuously for a minimum of 30 days after the system is filled to ensure the glycol and water does not separate in a static system.
 - (IV) Do not use ethylene glycol due to toxicity issues. Instead, use of inhibited propylene glycol. Also, refer to the boiler manufacturer's recommendations.

- (D) Adjusting
 - (I) Balancing Across the Manifold:
 - (II) Balance all loops across each manifold for equal flow resistance based on actual loop lengths and total manifold flow.
 - (III) Balancing is unnecessary when all loop lengths across the manifold are within 3 percent of each other in length. Install the supply and return piping to the manifold in a reverse-return configuration to ensure self-balancing.
 - (IV) Balancing between manifolds is accomplished with a flow control device installed on the return piping leg from each manifold when direct return piping is used for the supply and return mains.
 - (V) Adjust all boiler and system controls after the system has stabilized to ensure proper operation in accordance with the system design.
- (E) Cleaning
 - (I) Remove temporary coverings and protection of adjacent work areas.
 - (II) Repair or replace damaged installed products.
 - (III) Clean installed products in accordance with manufacturer's instructions prior to owner's acceptance.
 - (IV) Remove construction debris from project site and legally dispose of debris.
- (F) Demonstration
 - (I) Demonstrate operation of hydronic snow and ice melting system to owner's personnel.
 - (II) Advise the owner's representative about the type and concentration of glycol/water solution used in the hydronic snow and ice melting system.
 - (III) The owner monitors the solution effectiveness through an established maintenance program as outlined by the glycol manufacturer.
- (G) Protection
 - (I) Protect installed work from damage caused by subsequent construction activity.
- (d) Substantial completion inspection
 - (i) At the completion of the site hardware inspection, the Contractor shall test and verify that the system programming, graphics and alarm software is operating correctly and is in compliance all requirements of the specifications.
 - (ii) The Contractor shall provide written notification to the owner, that the site

- is ready for the Substantial Completion Inspection by the Consultant
- (iii) issue a comprehensive site deficiency report to the Contractor for his immediate action.
 - (iv) The Contractor shall correct all items noted in the site deficiency report within ten (10) business days of receipt.
 - (v) The Contractor shall provide written notification to the owner, that all items on the Consultant's site deficiency report have been corrected.
- (e) Flushing and Filling of Piping Systems
- (i) Applicable Systems
 - (A) Flush glycol water piping as follows.
 - (I) Flush water piping with water flowing at a velocity of not less than 1.8 m/sec, for a period of 15 minutes or longer as required to remove all dirt, scale and cuttings from the entire length of the piping.
 - (B) Thoroughly clean, prior to fabrication, sections of new piping that cannot be isolated for flushing purposes.
 - (C) Thoroughly clean, insofar as possible, welded joints by swabbing interior of pipe with swabs soaked with a caustic solution.
 - (ii) Filling of Glycol Systems
 - (A) After system has been cleaned out and tested for leaks, fill with water through temporary water meter to obtain total system volume.
 - (B) Drain water from system and fill with pre-mixed glycol solution first with calculated volume of concentrated glycol then make up to system volume with water.
 - (iii) Testing
 - (A) Circulate solution for one week and then take samples for testing for percentage concentration by specific gravity method, in glycol supplier's laboratory.
 - (B) Submit results of analysis.
 - (iv) Corrective Action
 - (A) If correction of concentration is required, amount of mixture to be drawn from system to be calculated and drained into original containers. To this volume add water or glycol in calculated amounts to correct concentration in system, and recharge into system.
 - (B) Provide 24 hours notice before draining and refilling to correct concentration.
 - (C) Circulate after correcting concentration for a further 24 hours and retest

concentration. Submit final report with historical data showing dates and times, results of each analysis, calculations and corrections made, and final concentration.

- (f) Chemical Supplies
 - (i) Supply two 170 litre drums of premixed propylene glycol to the Owner at Substantial Completion.

END OF SECTION

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1. General

- (a) References
 - (i) ANSI-ASME-B31.5, Refrigeration Piping.
 - (ii) ANSI/ASME-B16.31, Valves-Flanged, Threaded and Welded End.
 - (iii) CSA B52, Mechanical Refrigeration Code.
 - (iv) TSSA requirements.
- (b) Permits, Equipment Registration and Fees
 - (i) General
 - (A) Make application and pay all required fees for permits, registration, inspections, etc. for all equipment and systems installed including those required by TSSA.
- (c) Submittals
 - (i) Shop Drawings
 - (A) Submit Shop Drawings in accordance with Section 15010 “Basic Mechanical Requirements”.
 - (ii) Operation and Maintenance Data:
 - (A) Submit printed operation instructions and maintenance data in accordance with Section 15010 “Basic Mechanical Requirements”.
- (d) Quality Assurance
 - (i) Qualification: execute work of this section only by skilled tradesmen regularly employed in the installation of refrigeration systems.
 - (ii) Units shall be produced by a recognized manufacture who maintains a local service agency and parts stock. All units shall be factory tested.

2. Products

- (a) REFRIGERATION COMPRESSORS
 - (i) General: Compressor shall be high efficiency, reciprocating type (M Series) water cooled, and shall incorporate automatic unloader starting feature, and shall be fully complete with motors and drives.
 - (ii) Gaskets: Pollution free non- asbestos gaskets suitable for ammonia refrigerants.
 - (iii) Crankcase: The crankcase shall be Meehanite casting (semi-steel alloy), and shall be normalized, shot blasted, machined, pressure tested and immaculately cleaned.
 - (iv) Crankshaft: The crankshafts shall be dynamically and statically balanced for smooth operation, made of ductile iron for extreme resistant to wear.
 - (v) Piston & Cycle sleeves: All pistons and cylinder sleeves shall be removable type.

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The pistons shall be designed for high volumetric efficiency. The cylinder sleeves shall be made of a specially heat-treated alloy of iron.

- (vi) Compression and oil rings between the piston and cylinder wall shall ensure a perfect sealing, yet allow efficient lubrication with a minimum of oil consumption.
- (vii) Plate Valve Mechanism: Optimized plate valve lift, valve spring tension as well as the introduction of gas cushioning provide long-term durability.
- (viii) Unloader Mechanism: The unloader mechanism shall permit quick disassembly and re-assembly for time-saving servicing and shall be controlled hydraulically by a solenoid valve.
- (ix) Oil Filtration: The Cuno filters shall provide efficient filtration. Additional external oil filters shall also be provided.
- (x) Oil Cooling: Glycol cooled oil coolers shall be provided.
- (xi) Head Cover Cooling: Compressor shall be glycol cooled.
- (xii) Spring Loaded Safety Heads: The safety heads shall be spring loaded to prevent liquid hammer in the refrigeration system.
- (xiii) The Compressor shall provide all operating and safety, including the following accessories:
 - (A) Unloader solenoid valves for all stages
 - (B) Discharge & Suction shut-off valves with companion flanges
 - (C) Discharge check valves
 - (D) Oil Coolers (glycol cooled for Ammonia applications)
 - (E) Oil separators
 - (F) External Pressure relief valves
 - (G) Discharge & Suction Thermometers
 - (H) Oil drain & charge valves 3/8"
 - (I) Purge valves
 - (J) Crank case heaters
 - (K) Relief Valves
 - (L) Tool Kit
 - (M) Glycol Cooled Head Covers for Ammonia applications
 - (N) Flywheels
 - (O) 313 PSIG working pressure
- (xiv) The compressor shall be Mycom Model N2MII reciprocating type, or approved

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equal complete with matching premium (86% efficiency) efficiency, WEG or Baldor motor, drive assembly (for 870 rpm) with OHSA belt guard, painted structural steel base frame and accessories.

- (b) DESUPERHEATER
- (i) Desuperheater shall be installed in the compressor discharge line between the compressors and the condenser. The unit shall recover waste heat from the discharge gas to preheat potable water.
 - (ii) Heat Recovery unit shall have adequately sized refrigerant circuits to match the number and capacity of that of the refrigeration system. Refrigerant circuits must be independent of each other to prevent migration of refrigerant and oil between circuits.
 - (iii) The heat recovery heat exchanger shall have a minimum heat transfer effect of 1000 Btuh per ton of total system capacity at 60F entering water temperature and R-717 refrigerant vapor entering at 95F saturated condensing temperature and 220F actual discharge temperature. See schedule for specific project performance requirements. Full load refrigerant pressure drop shall not exceed 4.0 psi to have minimal effect on the refrigeration system.
 - (iv) Unit shall be vented double-wall, straight tube-in-tube design.
 - (v) Unit shall be gravity drain design.
 - (vi) Unit shall be mechanically cleanable from one end. Non-cleanable construction is not acceptable.
 - (vii) Unit shall consist of an external refrigerant containing carbon steel tubes and internal, double-wall, 304L/316L, stainless steel tubes with integral vent path suitable for potable water service.
 - (viii) Unit shall be enclosed in an insulated cabinet consisting of painted aluminum with 1 inch of fiberboard insulation to minimize heat loss.
 - (ix) Unit shall be UL and USDA listed with CRN and rated for 300 psig shell and 150 psig tube side.
 - (x) Potable water pump shall be interlocked with the refrigerant compressor(s).
 - (xi) A thermostat set at 180F shall be installed in the return water line to the heat recovery unit. Thermostat shall be wired to hot gas bypass solenoid around the heat recovery unit to limit water temperature rise and sound an alarm. Thermostat shall be suitable for the proposed application as mentioned herein. Acceptable manufacturer is United Electric or approved equivalent. Thermostat shall open the hot gas bypass valve when tripped.
 - (xii) Flow switch shall open the hot gas bypass valve when tripped and shall sound an alarm to indicate pump failure. Flow switch shall be McDonnell and Miller or approved equivalent.
 - (xiii) Acceptable Manufacturers for Desuperheater: CADS Series Heat Recovery unit by Doucette Industries or Approved equivalent

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3. Execution

- (a) Equipment Tagging and Identification
 - (i) Attach a tag to each equipment and device using approved lamacoid materials, in accordance with City standards.
 - (ii) Identify and label all piping systems in accordance with the City standards.
- (b) Installation
 - (i) Comply with manufacturer's requirements for the installation of the equipment. Install all necessary safety and operating components and accessories.
 - (ii) Locate the equipment as shown on the drawings to provide best possible connection arrangement and accessibility for servicing. Provide clearances on all sides of equipment as required by the Authorities having jurisdiction or manufacturer, whichever is greater.
 - (iii) Prior to removal of the equipment, devices, piping and wiring thoroughly review and ensure that removal of these do not affect operation and performance of the equipment/ system that remains
 - (iv) Install items of equipment, with due regard to Architectural treatment, and ensure all items are level and finished in keeping with good workmanship.
 - (v) Install and connect remote components such as thermostats, control panels, safeties etc. that are supplied with the equipment or are existing. Install in locations as shown on the drawings.
 - (vi) Charge refrigeration system with refrigerant. Charge compressors with initial charge of oil. Include for all TSSA safety features.
 - (vii) Provide start-up, testing and commissioning report. Start-up, testing and commissioning shall be performed by factory trained technician of the equipment manufacturer.

End of Section

DEHUMIDIFIER

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1. General

(a) Scope

- (i) Unit shall be a heavy duty, self contained packaged ice rink dehumidifier for commercial application. Unit shall be ETL or CSA listed and shall comply with Boca code M-401 and M-402.1.
- (ii) Unit shall be completely factory assembled, wired, piped and tested. All controls shall be factory adjusted and preset to the design conditions. Test report shall be available on request.
- (iii) Each unit shall include compressor, evaporator coil, air reheat coil (condenser coil), high efficiency motor, belt drive forward curve blower and adjustable sheave.
- (iv) Unit shall have a hot gas defrost feature and be activated periodically to defrost the ice formed on the evaporator when required.
- (v) Unit manufacturer shall be THERMOPLUS, KOOLAIR OR APPROVED EQUIVALENT

(b) Quality and Safety Assurance

- (i) The system shall be ETL listed.
- (ii) The system shall be completely assembled, wired, piped, and test-run at the factory prior to shipping. All controls shall be factory adjusted to satisfy the design conditions.
- (iii) Manufacturer shall have a minimum of ten-plus years experience making similar equipment as described in this specification.

2. Part 2 - Product

(a) General

- (i) Unit enclosure shall be designed for indoor installation. All cabinet 16, 18 and 20-gauges sheet metal shall be G90 galvanized steel, mill applied zinc phosphate primer followed by an exterior grade light gray silicon modified polyester top coat. The frame panels, removable access panels, and top panel shall be constructed of medium gauge steel. The base shall be constructed of medium gauge steel supported with bolted steel channels for maximum rigidity. Removable panels shall allow easy access to internal parts within each section. The electrical control panel shall be in its own separate compartment out of air stream.

(b) Evaporator Coil

- (i) Coil shall be UL or ETL listed. Shall be designed specifically for low ambient moisture removal (minimum six rows deep). 3/8-inch OD seamless copper tubing

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mechanically expanded into plate type aluminum corrugated fins to assure high heat transfer with accurate fins spacing of 6 FPI (fins per inch).

- (ii) Coils shall have galvanized casing and shall be factory tested at air pressure not less than 400 PSIG in water bath.
- (c) Condenser (Reheat Coil)
 - (i) Condenser shall be UL or ETL listed. Shall not be less than 2 rows deep with maximum 12 fins per inch and sized to transfer entire captured of compressor heat rejection to air. Shall have 3/8-inch OD seamless copper tubing mechanically expanded into plate type aluminum corrugated fins to assure high heat transfer. Coil shall have galvanized casing and shall be factory tested at air pressure not less than 400 PSIG in a water bath.
- (d) Refrigeration Circuit
 - (i) Dehumidifier units shall be completely factory piped, tested, dehydrated and charged with R448A, green refrigerant. The refrigerant circuit includes refrigerant high-pressure switch, low pressure switch, compressor, evaporator, expansion valve, condenser coil, suction accumulator, receiver and 3 ways diverting valve (for defrost mode), and access service valves on the low and high-pressure sides. The refrigerant circuit shall support 20 psig (low side) and 400 psig (high side). All units are equipped with low and high pressure cut off switches.
- (e) Compressor
 - (i) Compressor shall be UL or ETL listed. Shall be high efficiency, suction cooled scroll type with Rotolock valves and crankcase heater. It should be located out of air stream and mounted on rubber isolator to provide vibration free operation. It should be suitable for refrigerant R-448A and equipped with internal check valve. Compressor manufacturer must have a wholesale outlet for replacement parts in nearest major city.
- (f) Electrical Control Panel
 - (i) Panel shall be built-in with a separate compartment in order not to disturb the air flow during servicing.
 - (ii) All wiring shall be installed in accordance with UL or CSA safety electrical code regulation and shall be in accordance with NFPA. All components used shall be UL or CSA listed.
 - (iii) Power block terminal shall be provided for proper wire size.
 - (iv) Color coding and wire numbering shall be provided for easy troubleshooting. All wires shall be in a wire duct.

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- (g) Piping
 - (i) Piping shall be in accordance with BOCA code P-308-2 for corrosion resistance coating of copper tubing and M-702.0 for joints and connections. All refrigerant pipes shall be copper type “L” and vinyl-coated for corrosion prevention.
- (h) Drain Pan
 - (i) Each unit shall be equipped with a slopped non-tapping stainless-steel drain pan under entire evaporator coil to prevent condensate carryover. It shall be equipped with an electric heater trace to prevent drain pan from freezing. Drain connection shall be 1-1/2” MPT connection for easy installation, disassembling and cleaning.
- (i) Fan
 - (i) The blower shall be a double inlet type with centrifugal forward curved wheel, statically and dynamically balanced. Blower sheave is fix type and no pitch adjustment.
- (j) Blower Motor
 - (i) Open drip proof, ball bearing type, permanently lubricated. Protected by an overload. Motor sheave is adjustable pitch type.
- (k) Air Filters
 - (i) The air filters shall be standard sized, disposable type pleated filter, 2-inch, MERV 8 suitable for commercial application.
- (l) Control
 - (i) The electrical control panel shall be accessed easily from one side of the unit so that all service can be performed adequately. The electrical components shall include compressor and blower contactor, a transformer for the control circuit, a high-pressure manual reset pressure switch, a low-pressure switch, a low ambient thermostat and a defrost timer.

3. **Part 3 - Execution**

- (a) Product Delivery, Acceptance, Storage and Handling
 - (i) Perform a thorough physical inspection of the system upon delivery from the shipment carrier.
 - (ii) Identify and immediately report any physical damage to manufacturer.
 - (iii) If the system is to be stored prior to installation, store in a clean, dry place protected from weather, dirt, fumes, water, construction and physical damage.
 - (iv) Handle the system carefully during installation to prevent damage.
 - (v) Comply with the manufacturer's rigging and installation instructions for

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unloading the system and moving it into position.

- (b) Connections
 - (i) Where installing piping adjacent to the system, allow space for service and maintenance.
 - (ii) Electrical connections: comply with code requirements for power wiring, switches and motor controls in electrical sections.
- (c) Installation
 - (i) The agency responsible for start-up should work in accordance with the specifications and in accordance with the manufacturer's instructions and only by workers experienced in this type of work.
- (d) Start Up
 - (i) Detailed instructions for start up as provided by the manufacturer must be followed.
 - (ii) Installing contractor must contact the manufacturer prior to start up to confirm start up procedures.

END OF SECTION