SECTION 15650 - REFRIGERATION

PART 1 - GENERAL

1.1 SCOPE

A. Work required under this Specification shall include furnishing all labor and materials for the complete installation of the refrigeration work as described herein and shown on the Drawings.

B. The intent of the Plans and Specifications is not to show every item required for proper operation and service. No extras will be allowed for any item such as offsets, supports, valves, or thermometers which are required for operation and maintenance, but which may not be shown.

C. The scope of the work shall include, but not be limited, to the furnishing and installing of the following:

1. All transportation, storage, unloading, moving and rigging of the Contractor's equipment.
2. Air cooling units.
3. All valves, gauges, thermometers, oil reclaimation devices, accessories, and all other equipment required for the complete installation of the refrigeration system.
4. All piping listed below:
   a) Refrigeration piping including tie-ins to existing refrigeration piping.
   b) Air unit drain piping.
5. Steel supports for all equipment and piping, including all hangers, brackets, stands, and guards.
6. Motors and drives.
7. Shop painting, touch-up painting of equipment and piping and labeling.
8. Refrigeration controls including float valves, level controllers, automatic valves, thermal operated valves, pressure switches, safety controls, thermostats and all other controls required for a complete operating system.
9. Pipe insulation.
10. Warranty.

D. The following items are **NOT** included under this Specification.

1. General construction of the building.
2. All power wiring, motor starters, switches and lighting, except as required for the Contractor's own use during construction.

1.2 INSTRUCTION MANUALS

A. The Contractor shall furnish to the Owner four copies of an Instruction Manual. This manual shall include maintenance and operating instructions for the major equipment, lubrication instructions, wiring diagrams for all controls, and power wiring, etc., recommended spare parts and replacement parts list.

B. The Contractor shall provide training for all equipment installed. Training must include emergency shut down of equipment and systems, start up of equipment and systems after emergency and normal shutdowns. Training shall be conducted for each shift personnel.

1.3 REVIEW OF MATERIALS AND SUBMITTALS

A. The Contractor shall submit copies of Shop Drawings to the Engineer for review before installation for items listed in the Plans and Specifications. Each Shop Drawing shall be certified as being checked and approved by the Contractor before being submitted to the Engineer.

B. The Contractor shall submit to the Owner one copy of Record Drawings showing all changes made during construction.

1.4 GENERAL INFORMATION

A. The Contractor is to familiarize himself with the full scope of the Project, review all Drawings, field verify all new piping, routing, etc. prior to bidding and furnish a complete installation for work outlined and as required to provide a complete and operational system.

B. All work shall be done in a good workmanship like manner with as little inconvenience as possible for the Owner.

C. The Contractor shall follow all practices as set forth by “good manufacturing practices” by IIAR and ASHRAE, and shall fully comply with all rules and regulations as set forth by the Owner. A certificate of insurance shall be forwarded within one week after notification of receiving a contract.

D. The Contractor shall visit the site and become fully aware of all details, tie-ins, removals, etc. It is imperative that all work performed shall be done by personnel trained and skilled in the installation of industrial refrigeration systems. All welders are to be certified and the Contractor shall retain copies of welder certifications that are to be available upon request.

E. The Owner requires that the Contractor comply with all parts of the RMP regulations. The Contractor will be responsible for providing all necessary documentation to satisfy these regulations.

F. All exceptions to the specifications or referenced documents shall be identified in the bid documentation and approved by the Owner, or his agent, in writing. All work that is not performed in accordance with these specifications and not approved by the Owner or his agent, will be corrected at the Contractor’s expense.

PART 2 - MATERIALS

2.1 AIR UNITS (CORRIDOR)

A. Units shall be furnished complete with direct drive axial fans, motor and drive, finned coil, and unit casing.

B. Fans shall be steel sheet metal, draw thru type and shall be mounted on the fan screen. Motors shall be factory wired to a common NEMA 4X, non-fused disconnect located on the fan casing.

C. Coils shall be tested at 300 psig under water.

D. Drain pan shall be heavy gauge stainless steel interior & exterior, non-heated, double-pan construction with 2” thick closed cell polyurethane insulation between pans. Drain pans shall be factory mounted.

E. Casing shall be heavy gauge galvanized steel. Removable access doors shall be provided to facilitate inspection and service.

F. All bearings and moving parts shall be factory lubricated for operation in the indicated ambient, and lubrication instructions shall be furnished with the units. Lubrication points shall be easily accessible.

G. Each unit shall comply with the following requirements:

1. Duty: +35° F. Corridor
2. Quantity: One (AU-5)
3. Refrigerant: Ammonia
4. Capacity: 1,720 BTUH/° F. temperature difference (1.7TR @ 12° F. TD)
5. Air Flow: 3,375 CFM
6. Face Velocity: 582 FPM @ 0" WG Total Static Pressure
7. Fin Spacing: 4 Fins Per Inch
8. Coil Depth: 6 Rows
9. Coil Construction: Hot Dipped Galvanized Steel
10. Coil Circuiting: Direct Expansion
11. Motors: One, 1/3 HP, 1140 RPM, 460/3/60 VAC, TEAO with Internal Thermal Overload Protection
12. Fan Size: (1) 22" Diameter
13. Defrost Method: Air (off cycle)
14. Arrangement: Left Hand
15. Model: Krack Model DT1S-200-DXA-A-LH, Evapco, Imeco, or Approved Equal.

2.2 CONTROL WIRING

A. The refrigeration control wiring shall be done in accordance with the NEC.

B. All wiring throughout the facility shall be run in rigid (RGC) or intermediate (IMC) conduit.

C. All field wire shall be stranded copper No. 14 AWG, Type "THHN".

D. Refer to the drawings for control wiring schematics.

E. Wire numbers shall be installed on both ends of each wire labeled.

2.3 MOTORS

A. All motors shall be of the electrical characteristics specified. All motors shall be high efficiency.

B. Motors shall have adequate torque characteristics for the duty required and shall be of the type and frame construction suitable for the application.

C. Motors shall conform to the standards of the AIEE and NEMA for their respective classes in accordance with manufacturer's nameplates, and shall conform to the requirements of the local Power Company and all applicable codes.

2.4 CONTROLS

A. General

1. Type of control valve and port size of each are called out on the Refrigeration Drawings. Companion flanges shall be the same size as the adjacent pipe size unless noted otherwise.

B. Solenoid Valves

1. Solenoid valves shall be of the packless, normally closed type with 120 volt, single phase, 60 cycle, molded watertight solenoid coil, manual jacking stem with NEMA 4 watertight pilot light assembly with long life L.E.D. light. Each solenoid valve shall be preceded by a close coupled 60 mesh strainer complete with socket weld companion flanges.
2. Valves shall be HS6 type as manufactured by Hansen Technologies, or Approved Equal, and shall be as indicated on the Drawings:

C. Pressure Regulators

1. Pressure regulators shall be furnished complete with 3-1/2" pressure gauge and valve, companion flanges, bolts, nuts and gaskets, and shall be as indicated on the Drawings.
2. Companion flanges shall be socket weld type.
3. Valves shall be HA4A style and shall be as manufactured by Hansen Technologies, or Approved Equal.

D. Thermostatic Expansion Valves

1. Contractor shall furnish and install thermostatic expansion valves as shown on the Drawings.
2. Contractor shall carefully install thermal valves, taking into account actual pressure drop across coil and distributor, static head, line drop, variable discharge pressure and amount of subcooling.
3. The Contractor shall mount thermal bulb and equalizer line as shown on the Drawings.
4. Valves shall be Sporlan, or Approved Equal, with 1/4" FPT external equalizer and capillary of sufficient length.

E. Thermometers

1. Thermometers shall be provided where shown and/or where required for proper operation of the system. Ranges shall be suitable for the service intended.
2. Thermometers shall be provided with separable stainless steel well sockets. On insulated piping, sockets shall have necessary extension neck.
3. Thermometers shall be located with due regard for ease of reading and non-interference with working space and measured fluid flows.
4. Dial thermometers shall be Trerice 5" dial, bi-metal type, stainless steel case and stem, or Approved Equal.

F. Gauges

1. Gauges shall be provided where shown and/or where required for proper operation of the system. Ranges shall be suitable for the service intended. All gauges in refrigerant lines shall have appropriate refrigerant temperature- pressure scales. All gauges shall be designed for refrigeration, water, or as required. All gauges shall be no less than 3-1/2" in size and may be mounted locally. All gauges shall be installed with a Hansen long neck shutoff valve upstream of the gauge. Gauges shall be Ashcroft, or Approved Equal.

G. Strainers

1. All refrigerant strainers shall be Type ST with 60 mesh stainless steel screens as manufactured by Hansen Technologies, or Approved Equal.

2.5 THERMOSTATS (ROOM)

A. Single stage (SPDT) 120/1/60 VAC integral bulb thermostats shall be furnished, mounted, and wired as shown on the Drawings. Differential of each shall be a minimum of 3°F. Capillary shall be 6 feet long.

B. Thermostat quantity, range, and model are as follows:

1. Quantity: One
2. Range: -20 to +80 F.
3. Model: Penn-Johnson A19BBA-2, or Approved Equal.
4. Set Point: make @ +36 F., break @ +33 F.

2.6 EQUIPMENT SUPPORTS

A. The Contractor shall furnish and install all necessary steel supports for air units as required. Supports shall be complete so as to provide a firm, rigid support for all equipment mounted thereon.

B. The Contractor shall be responsible for accurately sizing, locating and cutting and patching all openings for refrigerant piping.

C. If the Contractor installs approved equipment by manufacturers other than specified, he shall be responsible for any extras required to modify the supporting steel.

2.7 PIPING SYSTEMS

A. Refrigerant Piping

1. General
   a) The Contractor shall furnish and install all necessary refrigerant piping as shown on the Drawings, complete with all valves, fittings and hangers.
   b) It is extremely important that any foreign matter shall not enter the system, and that **NO STRAINS ARE IMPOSED ON THE SYSTEM MACHINERY BY PIPING CONNECTIONS**. When connections are made, piping strains shall be checked by removing flange bolts at equipment which shall be loose and readily removed. **ANY PIPING MIS-ALIGNMENT EVIDENCED BY BOUND BOLTS SHALL BE CORRECTED AT NO COST TO THE OWNER.**
   c) The Owner's representative will witness the final leveling of equipment and the proper alignment of all piping and flanges.
2. Steel Piping

a) All refrigerant and oil piping shall be ASTM A53, Grade B (Seamless) with the code markings clearly visible.

b) All lines used for threaded connections shall be schedule 80.

c) Liquid lines 1-1/2" and smaller, whether threaded or welded, shall be schedule 80.

d) All other lines shall be schedule 40, up to and including 10" and standard weight (.375" wall thickness) above 10" size.

3. Joints

a) Joints in lines 1-1/2" and smaller shall be welded, using 3000 psi forged steel socket weld couplings. 1" and smaller forged steel screw valves shall be made up on pipe and joints seal welded. Where screwed joints on gauges, screwed automatic controls, or where equipment materials do not permit seal welding, joints shall be made using Teflon tape and silver Never-Seez.

b) Screwed joints shall be avoided wherever possible.

4. Flanges and Fittings

a) Standard refrigerant flanges shall be used for interconnection to refrigerant valves, refrigerant control valves, refrigerant check valves, and refrigerant strainers. Standard ANSI FLAT FACE FLANGES are to be used where required to match valves or equipment.

b) Steel flanges are to be ASTM A181, fittings other than socket weld are to be ASTM A234, and socket weld fittings are to be A105.

c) Non-ferrous flanges should be used only when flowing fluid and valve specifications require. Flanges of this type must be supplied as companion flanges or flange kits for the specific valve. Copper bearing alloy flanges must not be used on ammonia systems.

d) All refrigerant lines are designed for 250 PSIG.

e) Bolts for cast iron flanges shall be ASTM A307, Grade B. All bolts for steel ANSI flanges shall be ASTM A320, Grade L7. Bolt threads and nut to flange matching surfaces shall be coated with an anti-seizing compound. Fel-Pro C-5A, manufactured by Felt Products, or Approved Equal.

f) All refrigerant gaskets shall be graphite composite, non-asbestos. Refrigerant flanges are tongue and groove type. ANSI flanges are to have gaskets applied as ring type gaskets - not as full face gaskets - to permit seating the gaskets without overstressing bolts.

g) All gasketed flange joints shall be assembled so as not to overstress bolts and/or flanges and be evenly torqued to prevent cocking and flange fracture.

5. Valves

a) Refrigeration Shut-Off Valves

1) All valves shall be of the globe or angle, hand wheel type as shown on the Drawings, designed for the refrigerant in the system and as specified. Screwed valves with seal weld or socket weld end valves may be used in sizes through 1", and shall be cast or forged steel. Valves 1 ¼" and larger shall be weldable steel suitable for direct insertion in steel lines. Valves 1 ¼" and smaller that are to be installed in insulated lines shall be extended neck, bolted bonnet type. Gauge and Purge valves shall be long- neck style to clear insulation where applicable. Valves shall be as manufactured by Hansen Technologies, Refrigerating Specialties, or Approved Equal.

2) All valves shall be of the back seating type to permit repacking under pressure, except small forged steel angle valves, 1/4" to 1/2", used in gauge lines.

3) Valves shall be installed with stems horizontal, unless otherwise shown on Drawings. All valves shall have flow through the seat toward the stem, unless otherwise noted on the Drawings. Valves shall not be installed with stems vertically down.

B. Condensate Drain Piping

1. The Contractor shall furnish and install all condensate drain piping from air units as shown on the Drawings, and as required to complete the system. Drain piping shall be schedule 40 galvanized pipe with screwed joints. Fittings shall be 150 psi galvanized malleable iron.

2. Condensate drains must be pitched 1/4" per foot, and must be provided with plugged tees for cleanout at **EVERY** change of direction.

3. Provide wet traps as indicated on the Drawings.

4. All threads cut on galvanized steel pipe shall be spray painted with ZRC zinc paint.

2.8 PIPE INSULATION

A. General

1. **Staples <u>Not Permitted</u> On Any Insulation**

2. All refrigeration piping requiring pipe insulation shall be insulated with the type and thickness of insulation outlined in Section 3.2, Applications.

3. Where insulation is indicated on non-insulated lines from a tie-in or branch from insulated lines, this insulation shall be the same type and thickness as the insulation on the main line, and shall extend a minimum of 4 feet onto the branch. The termination of such insulation on the non-insulated branch shall be neatly and positively vapor sealed to the pipe with vapor barrier mastic. Valves and fittings falling into the 4 foot distance shall be insulated in accordance with the Specifications.

B. Materials

1. Pipe Insulation

a) Straight Runs

1) Rigid Foam

(a) Fabricated rigid foam pipe insulation shall be manufactured in the shop by a fabricator approved by the Engineer. Bun stock for use in fabrication shall be closed cell modified polyisocyanurate cellular plastic having a nominal density of 2.05 lbs. per cu. ft., and an aged (180 days) thermal conductivity (design value) of .19 at 75^{o}F mean temperature.

(b) Fabricated pipe insulation shall have Saran 560 (6-mil) industrial film vapor barrier jacket furnished for each section of pipe insulation.

(c) Bun stock material shall be Trymer 2000 rigid foam modified polyisocyanurate as manufactured by Dow Chemical Company, or Approved Equal.

b) Fittings and Valves

1) Pre-Molded Rigid Foam

(a) Pipe fittings shall be neatly and tightly covered with two piece premolded fitting covers. Any gaps in the joints or voids under the insulation shall be filled with loose insulation. Fitting covers shall be taped securely together. Fittings are to be installed before the straight runs of insulation except for pipe caps and flanged fittings. Flanged fittings are to be fitted over the adjacent pipe insulation with a minimum lap of 2". Field fabricated elbows or tees are not permitted.

(b) Valves shall be insulated with factory prefabricated fitting covers, oversized to fit snugly over the valve and of equal wall thickness to adjacent pipe insulation. Valve covers are to be taped securely together. All joints are to overlap adjacent pipe insulation by a minimum of 2". Any gaps in the joints or voids under the insulation shall be fitted with loose insulation. Valves installed in vertical piping shall be insulated so that coverings will not trap water. For stop valves, the packing nuts must be exposed for tightening and the vapor barrier sealed to the valve bonnet just below the packing nuts. For strainers, the insulation shall be installed so that the bottom ends can be removed for cleaning strainers. The insulation shall be replaced and butt strips of foil laminate used to seal the vapor barrier.

2) Foamed-In-Place Polyurethane

(a) Where polyurethane pipe insulation is specified, refrigerant fitting, valve and flange insulation may be foamed-in- place polyurethane. Foamed-in-place polyurethane shall be dispensed from an aerosol unit which contains the chemical components for making polyurethane foam.

(b) Kits shall be Insta-Foam Froth Pak as manufactured by Insta-Foam Products, Inc., Joliet, Illinois.

2. Pipe Insulation Finish

a) Straight Runs

1) All interior piping insulated with rigid foam insulation shall be finished with a high impact plastic covering. Covers shall be vapor and moisture resistant, shall be USDA approved, and shall be Zeston 2000 PVC, 20 mil thick as manufactured by Manville, or Approved Equal.

b) Fittings and Valves

1) Fittings and valves in interior piping shall be covered with the same high impact plastic covering as the adjacent piping. Fitting and valve covers shall be factory molded, vapor and moisture resistant, USDA approved, and shall be Zeston 2000 PVC, 20 mil thick, as manufactured by Manville, or Approved Equal.

3. Insulation Accessories

a) Adhesives and Coatings

1) Adhesive For Sealing Laps of Vapor Barrier Jackets.

(a) PVC glue.

2) Insulation Joint Sealer/Bedding Compound

(a) Joint sealer for use in sealing joints of rigid foam pipe insulation and insulation board shall be a non-hardening, water and weather resistant, vapor barrier sealant, Benjamin Foster #30-45 FoamSeal, or Approved Equal.

2.9 INSULATION PROTECTION SADDLES

A. Insulation protection saddles shall be provided and installed by the Contractor at all pipe hangers and supports for insulated lines. All insulation protection saddles shall be rolled with a true radius to suit the insulation OD Prime galvanized sheet metal shall be used for all saddles. The saddles shall be sized to wrap the insulation in an arc between 120 degrees and 180 degrees. The saddles shall be anchored to the pipe insulation with no less than two bands per saddle. Bands shall be stainless steel or galvanized steel.

B. The schedule for the saddles shall be as follows:

PIPE SIZE	SADDLE GAUGE	SADDLE LENGTH
2" and smaller	16	8”

2.10 PIPE HANGERS AND SUPPORTS

A. Contractor shall furnish and install all pipe hangers and supports for all piping installed by the Contractor.

B. Pipe hangers shall be of the trapeze type or clevis type equal to Grinnell Fig. 260. Chain, perforated and flat steel strip hangers will not be acceptable. Sway bracing shall be provided to minimize vibration, particularly on discharge and liquid lines.

C. Care shall be taken to insure that bracing and supports will not restrain expansion and contraction or set up excessive stresses at the joints and equipment.

D. Pipe hangers for pipe shall be spaced not greater than shown in schedule below:

PIPE SIZE IN INCHES	STEEL PIPE
1/2" to 1"	6 ft.
1-1/4"	8 ft.
1-1/2"	10 ft.

E. Additional supports shall be provided for tubing, valves, fittings, and accessories. In all cases, a hanger shall be placed not over two feet from a change in direction of any piping.

F. All hangers supplied for insulated lines shall be sized for the outside diameter of the applied insulation. Contractor shall provide temporary wooden blocks, properly sized for insulation thickness, which will accurately center the pipe in the hanger. If hanger adjustment allows, hangers may be raised to support piping in final position, so that insulating contractor may lower each hanger to install insulation for required density and thickness as indicated on the Drawings.

G. All hangers, rods, angles, roof stands, clevis, etc., shall be **galvanized** steel.

PART 3 - INSTALLATION

3.1 GENERAL

A. All work shall conform to the requirements of the American National Standard B31.5, Code for Pressure Piping: Refrigeration Piping, latest edition.

B. Pipe shall be cut accurately to measurement established at the site and shall be worked into place without springing or forcing.

C. All piping shall be installed with sufficient flexibility to adequately provide for expansion and contraction due to temperature fluctuation inherent in its operation.

D. No piping shall be run concealed in walls or partitions nor underground or under the floor, except as shown. Where pipe passes through building structure, pipe joints shall not be concealed, but located where they may be readily inspected.

E. All pipes to be insulated shall be run as shown and as required with sufficient clearance to permit application of insulation. Any burrs on the pipe due to cutting or other causes shall be completely removed by reaming prior to installation.

F. Screw joints shall be made with uniform tapered threads properly cut with sharp clean dies. Screw joints shall be made perfectly tight with a thread compound suitable for the fluid involved. Threads of fittings shall not be coated with compound.

G. Flanged joints shall be used only where necessary for normal maintenance and where required to match valves and equipment. Flanges shall be faced true and made up perfectly square and tight.

H. Welded joints shall be made only be certified welders thoroughly experienced in welding on pressure piping systems. All welded joints shall be made in such a manner that the inside of the pipe is relatively free of welding slag, scale and drippings.

I. Surfaces for welding shall be cleaned and free from paint, oil, rust, and other foreign matter. Surfaces to be welded shall be aligned as accurately as is practical within existing commercial tolerances. All gaskets, packing and thread compounds shall be suitable for the fluid for which they are used.

J. Long radius elbows shall be used wherever possible to reduce pressure drops. Pipe bends in lieu of welding fittings may be used where space permits. Pipe bends shall have a uniform radius of at least five times the pipe diameter and must be free from any appreciable flattening, wrinkling, or thinning of the pipe.

K. Mitering of pipe to form elbows, notching straight runs to form full fixed tees, or any similar construction shall not be used. Branch connections must meet the requirements of ANSI B31.5, Section 504.3. Right angle branch connections may be made by attaching the branch pipe directly to the pipe run by socket welding providing:

1. The nominal size of the branch does not exceed 2" NPS, or ¼ the nominal size of the run, whichever is lesser.
2. The depth of the socket in the run is at least 3/8” deep with a minimum shoulder of 1/16” between the bottom socket and the inside diameter of the run.
3. The branch connection is made by welding a socket or butt weld outlet integrally reinforced to branch connection fitting to the main pipe, provided the fitting meets the requirements of ANSI B31.5, Section 504.3.

L. All piping shall be fabricated, installed, supported and tested in accordance with the latest edition of the American National Standard Code for Pressure Piping ANSI B31.5.

M. All piping shall be run essentially as shown and detailed on the Drawings, care being taken to avoid interference with other piping, conduit or equipment. Except where specifically shown otherwise on the Drawings, piping shall run straight and parallel to walls and ceilings. Refrigerant piping shall slope toward the compressor room where shown. Trapping of lines shall not be permitted without the approval of the Engineer except where shown on the Plans.

N. To avoid loss of time, damage to equipment, and start-up difficulties, each section of pipe, fittings and valves shall be thoroughly cleaned and positively free of all foreign matter before installation. Prior to erection, each piece of pipe shall be thoroughly cleaned of loose scale and foreign matter and then swabbed. Open ends of mains shall be PLUGGED OR CAPPED during all non-working periods. Lines shall not be left open at any place where any foreign matter might accidentally enter pipe.

O. Use of curtains, plywood, etc. is required to protect walls, roof, floors, equipment, etc. Any damage from weld splatter or sparks from cutting tools will be corrected at no cost to the Owner.

3.2 INSULATION

A. General

1. Surfaces to receive insulation shall in all cases be free of rust, scale or dust, clean and dry. **All weld joints shall be painted with one coat of red oxide primer prior to installation of the insulation**. All insulation must be installed prior to refrigeration system pulldown.
2. Insulation shall be applied with tightly butted joints, free of voids and gaps. All fasteners and bands shall be neatly aligned and overall appearance of work shall be subject to Engineer's approval. All insulation must be sealed to the pipe lines a minimum of six (6") inches from any termination of such insulation. The pipe insulation vapor barrier jacket must also be positively sealed to the pipe at the points of termination.

B. Pipe Insulation

1. Rigid Foam Pipe Insulation

   a) Pipe insulation shall be placed on the pipe with all joints tightly butted. At all insulation joints (longitudinal and butt), surfaces of insulation shall be sealed with a continuous bead of specified joint sealant. The vapor barrier jacket shall be sealed using the specified adhesive to provide a perfect vapor seal. End butt joints shall be similarly sealed using factory finished butt strips and the specified adhesive. **NO STAPLES WILL BE PERMITTED.**

C. Fitting, Valve and Flange Insulation

1. Premolded PVC (Rigid Foam Only)

   a) Fitting and valve insulation may be two piece premolded fitting covers with vapor barrier mastic and PVC or aluminum fitting and valve covers of appropriate size to give equal insulation thickness as the adjacent pipe covering. PVC or aluminum fitting and valve covers will serve as the exterior finish in all areas. Zeston tape shall be used to seal PVC cover seam at abutting pipe insulation.

2. Foamed-in-Place (Rigid Foam Only)

   a) Fitting and valve insulation may be field foamed-in-place using PVC fitting and valve covers of appropriate size to give equal insulation thickness as adjacent pipe covering. Fitting and valve covers shall be left in place after foaming operations as the insulated fitting or valve finish. PVC covers shall be initially placed using fibrous glass reinforced tape to keep the cover in its proper shape during the expansion of the foamed-in-place insulation. Distorted shapes will not be acceptable. Excess foam shall be neatly trimmed off and exposed foam shall be coated with mastic matching color of fitting cover. Reinforced tape shall be removed from fitting cover after foam is cured, and specified Zeston tape shall be used to seal PVC cover seam at abutting pipe insulation. Urethane tanks or kits must be kept at 80^{o}F to 100^{o}F during froth foaming operations to attain proper form density and structure.

   b) Flanged fittings and valves shall be covered with 4 mil polyethylene film before application of fitting covers and foaming operations to provide for mold release should insulating covers be required to be removed for maintenance.

   c) Engineer reserves the right to strip any insulated fitting or valve suspected of improper installation or off-ratio foam quality. If found unsatisfactory, the valve or fitting shall be re-insulated properly at no cost to the Owner.

D. Special Finishes

1. High Impact Plastic Covering

a) All interior insulated piping shall be covered with high impact plastic covering. Covering shall be installed using special adhesives (solvent weld) as supplied by the manufacturer. All laps shall be continuously sealed.

E. Insulation Application

1. Insulation shall be installed on all cold refrigerant lines including suction and return lines, pumped liquid lines and chilled liquid lines. Insulation shall be rigid foam in all areas with thicknesses as follows:

PIPE SIZE	**Thickness**
1/2" thru 1 1/2"	1 1/2" thick

F. Inspection

1. Upon completion of the piping insulation, at the Engineer or Owner's request, the insulation subcontractor will remove random sections of protective jacketing for inspection of the vapor barrier.

G. Workmanship

1. Contractors are reminded that the service life of the insulation depends primarily on the in-place permeance of the vapor barrier. Therefore, the Contractor will exercise diligence to provide a vapor barrier free of discontinuities and penetrations.

2. **Metal fasteners** or **staples** are **not permitted** under any circumstances and if used will be cause for rejection of the vapor barrier and require replacement. Where breaks occur in the vapor barrier jacket during installation, they shall be covered in the same manner as butt joints.

3. **Pressure sensitive adhesive tapes** under any brand name, for sealing butt joints as the finished vapor barrier are **not permitted** under any circumstances.

3.3 PIPING TESTS

A. Refrigerant

1. All refrigerant piping shall be tested before pipe insulation is applied.

2. Leaks shall be repaired by removing and remaking the defective joint. No caulking will be permitted. After repair of leaks, system shall be retested and proved tight.

3. Refrigerant piping shall be tested at a minimum of 250 PSIG. Suggested procedure is as follows:

a) Charge system with dry nitrogen or dried compressed air to pressure of 100 PSIG. Make a soap bubble test of all joints and all welds. Mark all leaks, blow down and repair all leaks.

b) After above test and repair, charge with refrigerant to a pressure of 45 PSIG. Make a rapid leak check at this pressure using an electronic leak detector. If no leaks are found, raise pressure to 250 PSIG using dry nitrogen or dried compressed air.

c) Let mixture set overnight to permit mixing by diffusion. Check diffusion and leak tester operation by venting a flange or valve stem. Make a thorough leak test. If leaks are found, blow down, repair, and retest. Continue this procedure until entire system is proved to be absolutely tight.

4. After the refrigerant piping has been pressure tested and proven tight and before pipe insulation is applied, the entire system shall be evacuated with a vacuum pump to remove air and moisture. Evacuation shall be performed with all spaces containing refrigerant piping or equipment at no less than 50°F.

5. All manual valves except those open to atmosphere shall be opened and all controls such as solenoids and back pressure regulators shall be jacked open. Any gauges or pressure controls which could be damaged by a deep vacuum shall be valved off. All seal caps on valves shall be in place and tight. Any valves open to atmosphere shall be closed and plugged.

6. The entire system shall be double evacuated to 1500 microns.

a) When vacuum pump is started, vacuum should pull down fairly rapidly to 25,000 microns. If vacuum does not pull down below 25,000 microns, obviously there are leaks in the system and leak test procedure must be repeated.

b) At approximately 10,000 microns, evaporation of free water in the system will be rapidly accelerated and vacuum will tend to remain constant as evaporation rate begins to equal vacuum pump capacity. Depending on amount of water, ambient temperature and vacuum pump capacity, it may take several hours to make any noticeable decrease in vacuum below 10,000 microns. During this period, apply heat to any low points or suspected points of moisture. Feel pipes for cold spots and apply heat.

c) Continue evacuation until a pressure of 1,500 microns minimum is reached, then break the vacuum and pressurize to 10 PSIG with dry nitrogen as holding charge until ready for charging.

d) When ready for charging, vent nitrogen holding charge to atmosphere and re-evacuate down to a minimum of 1,500 microns. Break vacuum with refrigerant gas. Do not use liquid refrigerant.

3.4 START UP OF SYSTEMS

A. After testing and evacuating, and after pipe insulation is complete, the systems shall be charged and started. The Contractor shall operate the refrigeration system until the process is down to design conditions and held at design conditions for a minimum of seven days. The defrost systems shall be operated during this period. During this period the Contractor shall calibrate and adjust all operating and safety controls.

B. During start up, all strainers shall be cleaned. **EXTREME** care shall be taken to keep air out of the system during the cleaning operation.

C. Prior to acceptance, the Contractor shall clean all strainers, purge all air, and **RECHECK THE ENTIRE SYSTEM FOR LEAKS**.

D. Proper operation of all equipment, safety controls, and automatic controls shall be demonstrated to the Owner prior to acceptance.

3.5 PAINTING

A. After all systems are ready for operation, the Contractor shall touch-up factory finish on all equipment, installed under this Specification, which has become marred during shipment or installation.

B. The Contractor shall also paint all uninsulated black steel pipe, steel hangers, and steel supports supplied by the Contractor for the refrigeration equipment.

C. Painting shall be one primer coat plus one finish coat of best quality Koppers, Sherwin-Williams, or Approved Equal, oil based paint. Color of finish coat to be determined by the Owner.

3.6 FINAL INSPECTION

A. Proper operation of all equipment, safety controls, and automatic controls in accordance with the Specifications shall be demonstrated to the Owner prior to acceptance.

B. The Engineer's final inspection will not be made until the Contractor has complied with the start-up procedure and not until his clean-up work has progressed to the point where the plant is in condition to turn over to the Owner's operators. The time shall be mutually agreed upon with the Owner.

3.7 WARRANTY

A. All refrigeration equipment must be warranted in writing (both parts and labor) for a period of one year from date of acceptance by Owner.

END OF SECTION
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