This document intends to help with the design of piping layout to ensure proper operation of the connected Advance Industrial Refrigeration equipment.

Contents

1. Materials

A. Copper Tube and Fittings

For installations with R134a, utilize commercial copper tubing Type K (heavy wall) or Type L (medium wall). For brazed or soldered joints, the material shall be forged brass or wrought copper.

Drawn-Temper Copper Tube:	follow ASTM B 280, Type ACR (Air-Conditioning and Refrigeration), clean, dry, and capped
Annealed-Temper Copper Tube:	follow ASTM B 280, Type ACR, clean, dry, and capped. Annealed copper tubing must not be used for piping with an outside diameter (O.D.) larger than 0.625".
Wrought-Copper Fittings:	follow ASME B16.22 (elbows, couplings, etc.)
Bronze Filler Metals:	follow AWS A5.8, Classification BAg-7 (50% silver), BCuP-5 (15% silver)

B. Pressure Relief Valves

If pressure relief valves are field installed, use straight-through or angled pattern, brass body and disc, neoprene seat, and factory sealed and ASME labeled for standard pressure setting. Valves must be factory set to maintain an operating or standby pressure per ASHRAE 15 and not to exceed the receiver design pressure or pressure of the lowest-rated piping component in the system.

For AIR split systems with R134a, use 350 psig pressure setting.

C. Pipe Insulation

Insulate pipes where the normal operating temperature is 60°F or lower. This applies to the suction line.

If piping must be run through boiler rooms or other areas where they will be exposed to abnormally high temperatures, it may be necessary to insulate both the suction and liquid lines to prevent excessive heat transfer into the lines.

Closed-cell elastomeric insulation in tubular or sheet form is a good solution.

Consider the use of materials with the following properties:

1. Flame spread index of less than 25 and a smoke-developed index of less than 50 when tested in accordance with ASTM E84. In addition, it shall not melt or drip flaming particles, the flame shall not be progressive and all material shall pass simulated end-use fire tests.
2. Materials with a maximum thermal conductivity of 0.27 Btu-in/h-ft^2-°F at a 75°F mean temperature when tested in accordance with ASTM C177 or ASTM C518.

3. Materials shall have a maximum water vapor transmission of 0.08 perm-inches when tested in accordance with ASTM E 96.
4. UV resistant material when directly exposed to sunlight.

2. Refrigeration Piping

Refrigeration piping is a relationship between flow of refrigerant and oil. It is desirable to have maximum capacity, minimum cost, proper oil return, minimum power consumption, minimum refrigerant charge, low noise level, proper liquid refrigerant control, and perfect flexibility of system operation from 0 to 100% of system capacity without lubrication problems. All of these goals cannot be satisfied simultaneously and sound engineering decisions must be made under the basic effects on system performance of the piping design in the different parts of the system.

Pressure drop in refrigeration lines shall be minimized to avoid decreased capacity and increased power requirements. However, refrigerant velocities shall be the determining factor in the piping design. Because oil and refrigerant vapor do not mix readily and the oil must circulate through the system, the mass velocity of the refrigerant vapor must be adequate to sweep the oil along. The refrigerant velocity inside a pipe depends on the mass flow rate and density of the refrigerant, and on the inside diameter of the pipe.

General guide:

Discharge line	- Up to 5 psi of pressure drop - Keep velocities below 3,000 FPM to avoid high noise level - Horizontal lines with a pitch in the direction of flow of at least ½" in 10 feet.
Liquid line	- Ensure a solid liquid head of refrigerant at the expansion valve - 3 to 5 psi of pressure drop (or the equivalent to 2°F) - A head of 2 feet of liquid refrigerant is approximately 1 psi - Keep velocities below 300 FPM to avoid pressure surges or liquid hammer
Suction line	- Up to pressure drop equivalent to 2°F (pressure depend upon evaporating temperature) - Maintain minimum velocities of 700 FPM in horizontal lines and 1500 FPM in vertical lines - Consider the use of double risers

Recommendations:

Horizontal suction and discharge lines should be pitched downward in the direction of flow to aid in oil drainage, with a downward pitch of at least ½ inch in 10 feet.

Refrigerant lines should always be as short as possible and should run as directly as possible.

Traps at the foot of hot gas risers (discharge line) are normally not required because of the easier movement of oil at higher temperatures.

The discharge line from the compressor should be looped to the floor prior to being run vertically upwards to prevent the drainage of oil back to the compressor head during shut down periods.

Do not install trapped sections of the suction line as oil or liquid refrigerant accumulated during the off cycle can return to the compressor at high velocity and cause permanent failure of the equipment.

Install a small trap at the base of the evaporator. The trap should be of minimum depth and the horizontal section should be as short as possible to avoid the accumulation of large quantities of oil (Figure 1).

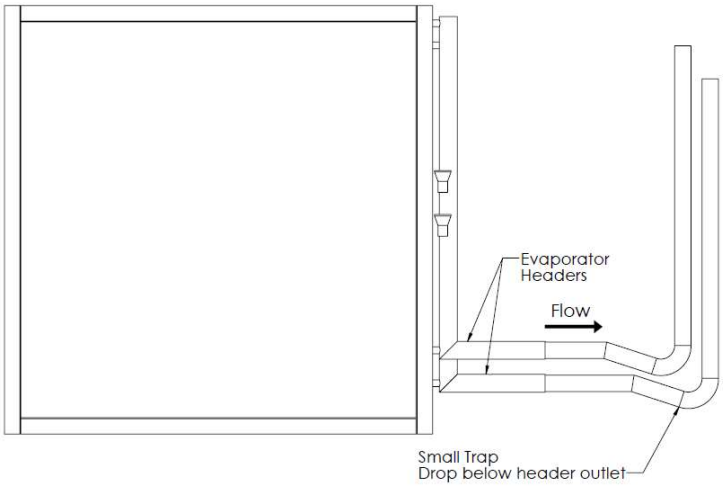

Figure 1 - Small trap on evaporator.

If the evaporator is above the condenser, which causes the suction line to leave the evaporator and then drop vertically, install an inverted trap (going up above the highest tube in the evaporator) to prevent liquid refrigerant from draining back to the suction line towards the compressor by gravity during the off cycle.

3. Coordinating Installations

Coordinate layout and installation of refrigerant piping and suspension system components with other construction, including light fixtures, HVAC (heating, ventilating, and air-conditioning) equipment, fire-suppression-system components, and partition assemblies.

Coordinate pipe sleeve installations for foundation wall penetrations.

Coordinate installation of roof curbs, equipment supports, and roof penetrations when applicable.

Coordinate pipe sleeve installations for penetrations in exterior walls and floor assemblies. Coordinate with requirements for local fire stopping specifications (materials and methods for sealing pipe penetrations through fire and smoke barriers).

Coordinate pipe fitting pressure classes with products specified in related sections.

4. Installing Piping

Install piping to be as short and direct as possible, with a minimum number of joints, elbows, and fittings. It is recommended that piping be installed parallel to the building lines with appropriate pitch free from traps.

Pipe must be worked into place without springing or forcing. Pipes must be installed as to permit free expansion and contraction without damage to joints or hangers.

Arrange piping to allow inspection and service of compressor and other equipment. When necessary, install valves and specialties in accessible locations to allow for service and inspection. Installed piping must not interfere with the operation or accessibility of doors or windows and must not encroach on aisles, passageways, and equipment.

Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

To prevent contaminating the system, pipe must be maintained with capped or plugged ends when shipped and as erected. Pipe contamination can permanently damage the equipment.

5. Installing Hangers and Anchors

The information listed in this section is for reference only. Local documents shall replace the information listed here.

All piping should be rigidly supported from the building structure by means of adjustable ring-type hangers. Welding to building structures is not recommended). Unistrut® trapeze-type hangers are a good solution where pipes run side by side. Hanger spacing recommendation is as follows:

Copper Piping	Maximum Spacing
3/8" and smaller	**4'-0"**
1/2" through 3/4"	**6'-0"**
1" through 1-1/2"	**8'-0"**
2" and larger	**10'-0"**

Copper piping must be supported at 10' intervals maximum. Round rods supporting the pipe hangers recommendation:

Pipe Size	Rod Size
2" pipe and smaller	**3/8" rod**
2-1/2" to 3" pipe	**1/2" rod**

Insulated pipes should be protected with a galvanized-steel shield.

Place a hanger within 1'-0" of each side for each horizontal elbow.

Use hangers that are vertically adjustable (1-1/2" recommended) after piping is erected.

Use plastic coated straps on copper pipe. Unistrut-type clamps and Unicushion® inserts are a good solution. Clamps must not be spaced greater than 4'-0" apart.

6. Brazing Joints

Tubing must be cut square, reamed, and have burrs removed.

The inside of fittings and outside of tubing must be well cleaned with an abrasive cloth or stainless-steel wire brush before brazing. Steel wool is not recommended.

During brazing, an inert gas (such as dry nitrogen or argon) must be passed through the system continuously at a flow rate sufficient for maintaining an oxygen-free environment to prevent the formation of copper oxide scale.

Take care to prevent damage to fittings and tubing caused by overheating when making connections.

Copper-to-copper joints must be brazed with a copper-phosphorous brazing alloy containing a minimum of 15% silver and conforming to AWS A5.8, BCuP-5.

Copper-to-brass joints must be brazed with a silver brazing alloy containing a minimum of 50% silver and conforming to AWS 5.8, BAg-7.

Copper-to-stainless-steel joints must be brazed with a silver brazing alloy containing a minimum of 50% silver and conforming to AWS 5.8, BAg-7.

All brazed joints must be cleaned to remove residual flux.

If applicable, when brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion valve bulb. Joints must be cool before reassembling valve.

7. Testing Piping Systems for Leaks

The high side and low side of each completed refrigeration piping system must be pressure tested at a pressure not less than the lower of the system test pressure (R134a – 115 psig for low side and 225 psig for high side). Do not exceed the setting of the pressure-relief device protecting the high side or low side of the system (typically 350 psig for R134a). It is recommended that field-installed systems with copper tubing not exceeding 0.625" O.D. must be tested by means of refrigerant charged into the system at the saturated vapor pressure of the refrigerant at 68°F minimum.

The testing media must be dry nitrogen. Execute the leak test before insulating, evacuating, and charging.

Isolate the compressor from the leak test by firmly closing the suction and discharge valves.

Do not attempt to repair any leak while the system is pressurized. If any leaks are found, relieve the test pressure and perform repairs.

Allow the system to remain under pressure for 24 hours. Maximum pressure drop is 5 psig in 24 hours at constant ambient temperature. For every 10°F drop in ambient temperature from start of test, the maximum pressure drop may increase by 3 psig.

8. Evacuating and Charging

After the piping pressure test is complete, the refrigeration system must be evacuated and dehydrated with a vacuum pump. The following procedure is recommended:

1. Connect an accurate, high-vacuum gauge with a range of 0−1,000 microns Hg to the system.
2. Connect the vacuum pump to both the high and low side of the system. Leave the compressor suction and discharge service valves closed. Start the vacuum pump.
3. Ambient air temperatures must be above 60°F during the evacuation process. (During cold times of the year, it may be necessary to construct a temporary enclosure with heat added to maintain the 60°F or higher temperature for the duration of the evacuation and charging period.)
4. Operate the vacuum pump until the system is evacuated to 500 microns Hg.
5. Break the system vacuum with dry nitrogen. Open the compressor suction and discharge service valves, and re-evacuate the system to 500 microns Hg.
6. After the system has been twice evacuated to 500 microns Hg, close the vacuum pump suction valve, and stop the pump. Allow the system to stand under a vacuum a minimum of four hours. If no rise in pressure has occurred after four hours, the system may be charged.

Charge the system by introducing liquid refrigerant in the receivers located in the condenser.

After initial refrigerant charge, it may be necessary to add lubricating oil to the refrigeration circuit (compressor).

After the refrigeration system has been charged and has been in continuous operation for one week, replace the liquid line filter/drier.

9. Before Operating the System

Perform the following operations before operating the refrigeration system:

1. Open shutoff valves in condenser water circuit (when water cooled)
2. Check fans rotation (when air cooled)
3. Check compressor oil level for proper charge.
4. Open compressor suction and discharge valves.
5. Open refrigerant valves, except bypass valves that are used for other purposes (when present).

10. Documents for Reference

1. American Society of Mechanical Engineers Standards and American National Standards Institute (ASME/ANSI)

ANSI B16.22	Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
ANSI B31.5	Refrigeration Piping and Heat Transfer Components
ASME Section VIII	Boiler and Pressure Vessel Code - Unfired Pressure Vessels

2. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

ANSI/ASHRAE 15	Safety Standard for Refrigeration Systems
ASHRAE 34	Refrigerants

3. American Society for Testing and Materials (ASTM)

ASTM B280	Seamless Copper Tube for Air-Conditioning and Refrigeration Field Service

4. American Welding Society (AWS)

AWS A5.8	Specification for Filler Metals for Brazing and Braze Welding - Classification BAg-7 (50% silver), BCuP-5 (15% silver)