UNITED TECHNOLOGIES CARRIER

COMMERCIAL SYSTEMS and SERVICES

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APP-99-001

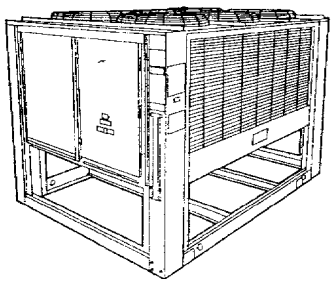
APPLICATION TIPS

30HXA-076 to 271 Ecologic™ Condenserless Chiller Refrigerant Line Design Guide

TIP107
1/20/99

Note: For 30HXA076 to 186 chillers, refer to the latest product catalog and installation instructions for information on refrigerant piping design. The data contained in this Application TIP will be added to the next 30HX product catalog.

Supersedes Tip095 & Tip098



Carrier 09DK Air-Cooled Condensers

The primary areas of concern when selecting and installing 30HXA split-chiller systems are:

- **Proper condenser selection**
- **Chiller and condenser placement**
- **Proper layout and sizing of discharge, liquid, and relief vent lines**
- **Prevention of refrigerant migration from the cooler when chiller is off**

Each of these items are important to the successful installation and operation of the 30HXA chillers and are discussed in detail on the following pages. Please note that some of the information in this bulletin has been updated from similar data in the 30HXA product literature. The literature is currently being updated to reflect this information.

Proper Condenser Selection:

Only condensers approved for use with R-134a which have published ratings for R-134a can be used.

If a condenser is manufactured for a refrigerant other than R-134a, but has R-134a ratings, the condenser should be modified for the R-134a usage per the manufacturer's recommendations. This may involve replacing pressure switches, relief valves, modifying circuiting, etc., to provide proper operation with R-134a.

Condensers must be selected to maintain system operation within the following limits:

- **Minimum system subcooling 15 deg. F (8.3 C)**
- **Minimum saturated discharge temperature (SCT) 90 deg. F (32.2 C)**
- **Maximum saturated discharge temperature (SCT) 135 deg. F (57.2 C)**
- **Minimum temperature difference (SCT-Ambient) 20 deg. F (11.1 C)**
- **Maximum temperature difference (SCT-Ambient) 40 deg. F (22.2 C)**

If a single condenser per refrigeration circuit is used , make sure that it has the control flexibility to allow for proper head pressure control and it has a refrigerant subcooling circuit to provide 15 degrees of subcooling. In addition, the 30HXA chillers have uneven capacity splits. An attempt should be made to match the condenser capacity splits as closely as possible to that of the chiller.

Motormaster headpressure control is required if the chiller is operating when the outside air temperature is 60F (15.5C) or lower.

Condenser head pressure control is required to maintain the saturated discharge temperature above 90F (32C) SCT . When condensers other than 09DK with Motormaster headpressure control are used, controls must be used to maintain the SCT above 90 degrees f (32C).

09DK Condenser Modifications for use with R-134a

The 30HXA chillers are shipped with fan-cycling pressure switches (packed inside the control box) for use with the 09DK condensers. They should be used instead of the switches provided with the 09DK piping package which were intended for use with R-22.

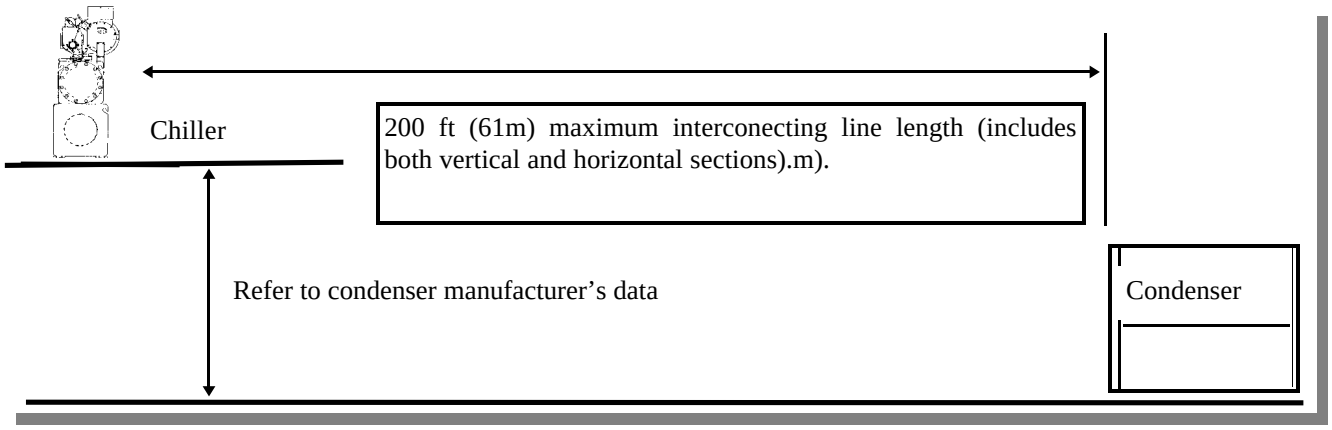
Equipment Placement Considerations

Like any other split refrigeration system, it is always best to place the chiller and condenser(s) as close together as possible. This minimizes the length of interconnecting refrigerant piping which keeps installation costs to a minimum while maximizing the reliability of the system.

Specific 30HXA Placement Considerations:

- **Minimum surrounding ambient temperature: 50 degF (10 degC)**
- **Maximum line length (actual length) : 200 ft (61m) l**
- **Maximum Vertical Separation:**
- **Chiller above condenser: Refer to condenser manufacturer's data**
- **Condenser above chiller: Limited by max line length constraints**

Chiller Above Condenser



Condenser Above Chiller

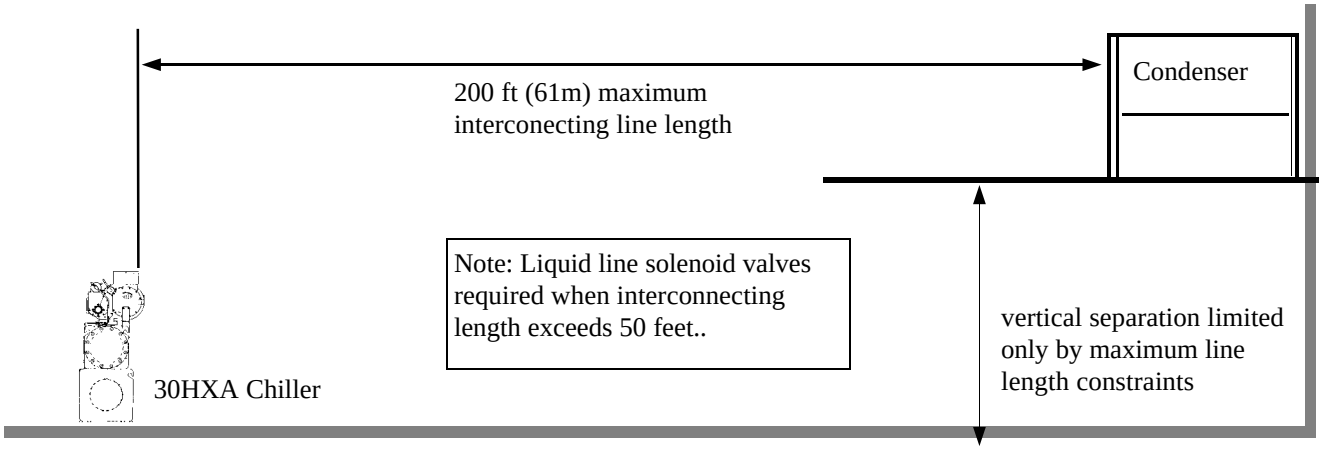


Figure 2. Maximum Chiller- Condenser Separation Limits

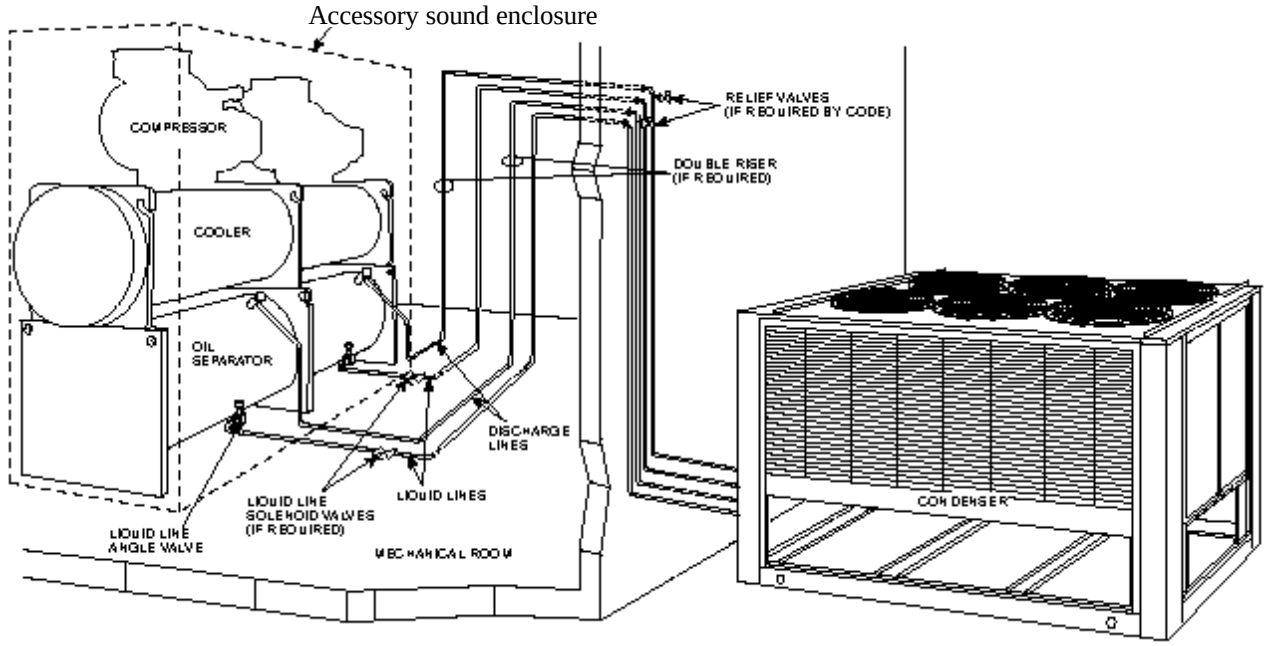


Figure 3. Typical 30HXA Refrigerant Piping to Remote Condenser

Refrigerant Line Layout and Sizing

General Considerations:

A good system piping design will ensure reliable system operation at all chiller loading conditions. The design process not only encompasses line sizing, but includes line layout, support, vibration considerations, sound enclosures, refrigerant vent lines and insulation, to mention a few. Full coverage of all these aspects are beyond the scope of this application tip which is only intended to highlight specific areas of concern to the 30HXA chillers but always PLAN AHEAD to avoid suprises.

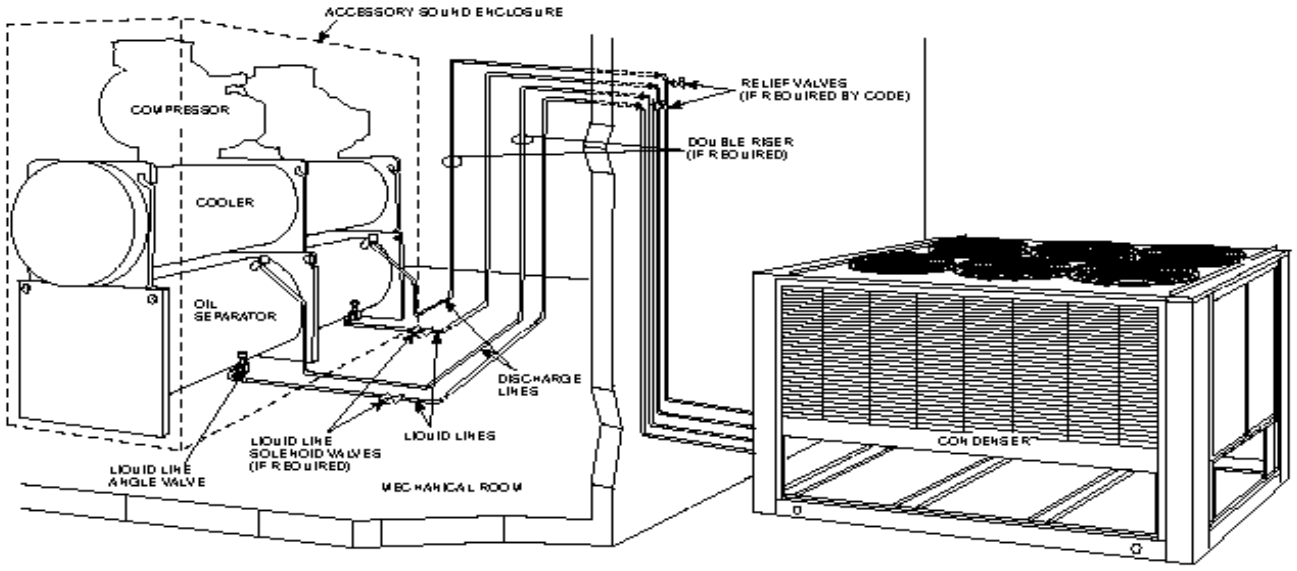
The design considerations are the same for R-134a as other refrigerants such as R-22. An excellent design reference is the 1994 ASHRAE Refrigeration Handbook. It contains R-134a line sizing tables as well as detailed information on proper system piping design. The Carrier System Design Manual, chapter 3, also contains proper design practices, but does not have R-134a sizing tables at this time.

Discharge Lines

The discharge lines are connected to the backpressure regulating valve on the oil separator. When a riser will be required leaving the chiller, the lines should first be routed down to the floor before construction of the riser. This forms a trap to prevent refrigerant from draining back into the oil separator when the circuit is shut down. Also, when using the accessory sound reduction enclosure, it facilitates the enclosure installation by requiring only a simple notch to allow the enclosure to fit over the piping. See figure 3 above.

The discharge lines are generally sized for a pressure drop equivalent to 2 degrees F saturated temperature drop at the design chiller capacity. This results in a good balance between pressure drop and cost.

Discharge Line Layout and Sizing, con't



NOTES:

The piping shown at the right is for general point-of-connection and is NOT intended to show details for a specific installation.

See 30HXA chiller certified drawings for specific connection locations and dimensions.

Piping and discharge line pressure relief devices(if required) are not supplied by Carrier Corp. but can be ordered from RCD.

Vent refrigerant relief devices per local code requirements.

In layouts where discharge risers are required, it is important to ensure that the line sizes selected will allow proper oil return at the *minimum load* condition for each circuit. A riser is a vertical line section in which the refrigerant is travelling upward against the force of gravity.

Each compressor can unload to 40% of it's full load capacity. Each circuit on units equipped with minimum load control can unload to 20% of the full load capacity. Refer to the 30HXA product catalog for the minimum unloading capacities per circuit as well as a sample calculation of the minimum circuit tonnage.

In many 30HXA sizes, the individual refrigerant circuits have unequal capacities. Refer to the 30HXA product catalog for the percentage capacity of each circuit for line sizing purposes. Be sure to use the correct capacity when calculating line sizes.

If it is determined that the minimum tonnage is too low to provide proper oil return, then double discharge risers will have to be used.

Liquid Line Layout

The liquid lines connect to a liquid service valve located near the bottom of the oil separator. The line layout should be as direct as possible to minimize pressure drop. If the accessory sound reduction enclosure is used, route the liquid line along the floor to facilitate the enclosure installation. No consideration for double risers is required in the liquid line.

Line sizing tables are provided product catalog for 30HXA chiller combinations with Carrier 09DK condensers operating at leaving water temperatures above 40 degrees F (4.4 C). For chillers using brine or those matched with other condensers, the lines must be sized manually using design guides such as ASHRAE, or the curves in the 30HXA installation instructions.

In terms of refrigeration specialties, liquid line pressure relief devices may be required by local codes. The use of filter driers is acceptable; replaceable core driers are recommended. In applications where the condenser is elevated above the chiller AND the liquid line length exceeds 50' (15.3 m), liquid line solenoid valves are required to prevent excessive amounts of refrigerant draining into the cooler when the chiller is not operating. The liquid line solenoid valves (normally closed type) may be wired to the 30HXA condenser fan output terminals as shown in the diagram below:

Liquid Line Solenoid Valve Wiring

If the condensers are above the chiller or if the liquid line length exceeds 50 feet (15.3 m), liquid line solenoid valves must be installed and wired as described below and in the illustrations on the page 7.

- **For Across-the-Line machines, the load on the 1CR relay contacts as shipped from the factory is 60 VA for 50 Hz, 73 VA for 60 Hz. This leaves 150 VA available for a 50 Hz relay coil sizing, or 177 VA available for a 60 Hz relay coil sizing.**
- **For Wye-Delta machines, the load on the 1CR relay contacts as shipped from the factory is 120 VA for 50 Hz, 146 VA for 60 Hz. This leaves 90 VA available for a 50 Hz relay coil sizing, or 104 VA available for a 60 Hz relay coil sizing.**

For single compressor circuits, wire the liquid line solenoid valve relay (LLSVR-A1) in parallel with either the CA1 (Across-the-Line) or CA1-1M (Wye-Delta) contactor for the circuit A liquid line solenoid valve. For circuit B, wire the liquid line solenoid valve relay (LLSVR-B1) in parallel with either the CB1 (Across-the-Line) or CB1-1M (Wye-Delta) contactor for the circuit B liquid line solenoid valve.. See Figure 1 on page 7.

Multiple compressor circuits MUST be wired as shown, due to automatic lead-lag. In this case, an additional relay is required. Wire the relays for A1 and B1 as stated above. The additional liquid line solenoid valve relay (LLSVR-A2) should be wired in parallel with the CA2 (Across-the-Line) or CA2-1M (Wye-Delta) contactor. See Figure 1 on page 7.

The relay outputs will control the liquid line solenoid as shown in Figure 2 on page 7.

Liquid Line Solenoid Valve Wiring (con't)

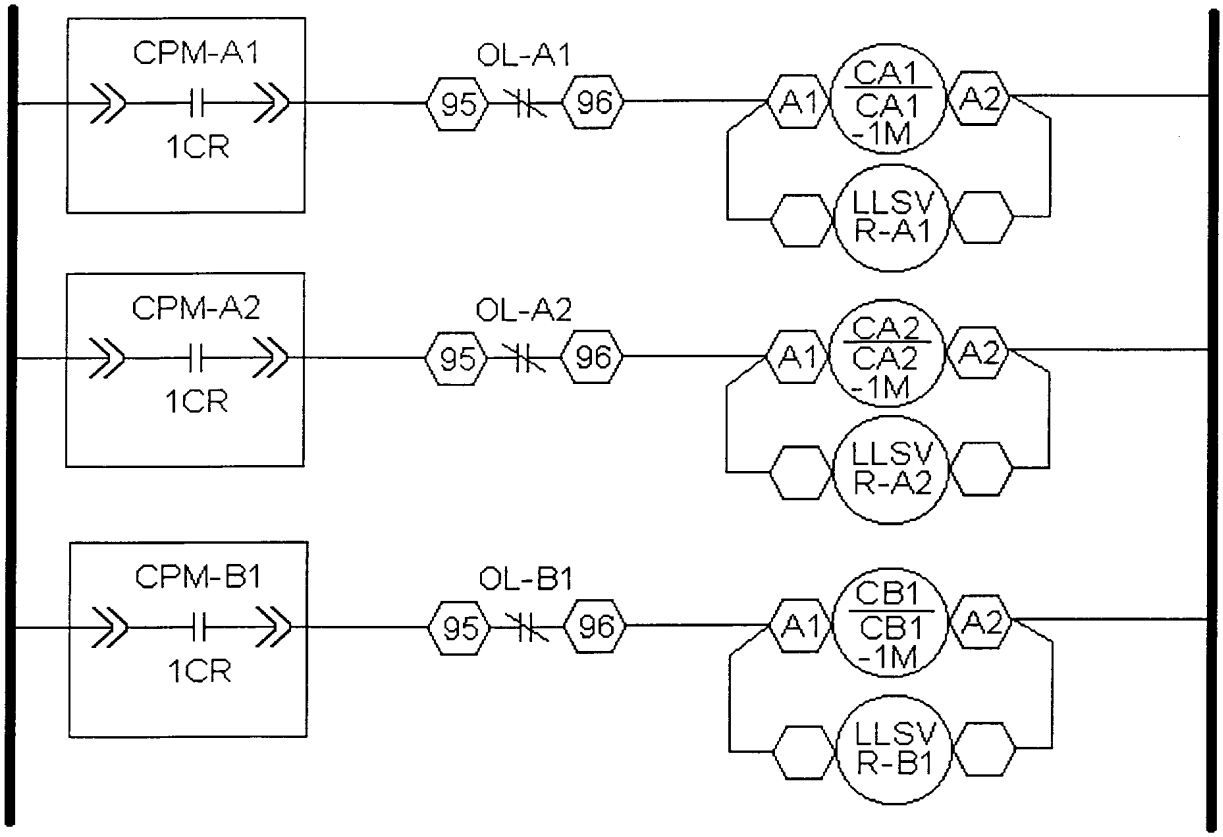


Figure 1 - Liquid Line Solenoid Valve Relay Control Wiring

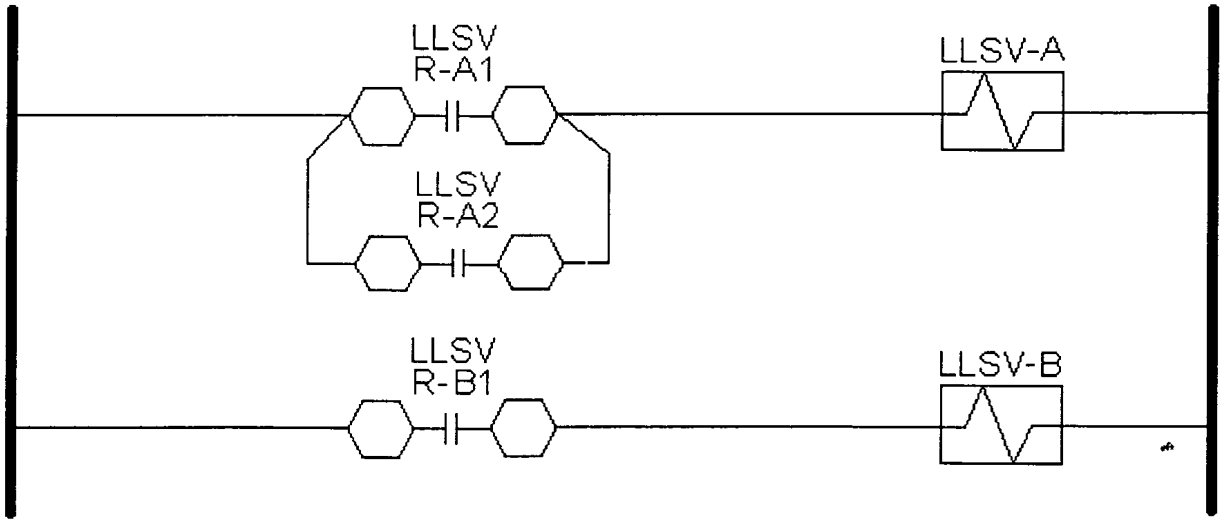


Figure 2 - Liquid Line Solenoid Valve Wiring

Liquid Line Layout

The liquid lines connect to a liquid service valve located near the bottom of the oil separator. The line layout should be as direct as possible to minimize pressure drop. If the accessory sound reduction enclosure is used, route the liquid line along the floor to facilitate the enclosure installation. No consideration for double risers is required in the liquid line.

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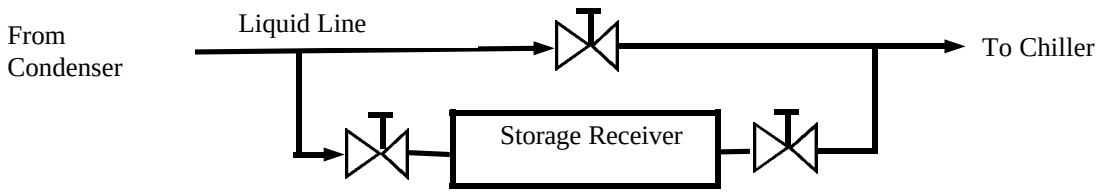
When designing the refrigerant line layout, the impact of refrigerant relief valve vent lines and the use of the 30HX Sound Enclosure must be factored into the layout. Detail information on the 30HX sound enclosure can be found int he published 30HX literature on the sound enclosure. Details on the refrigerant relief valves is in the 30HX product catalog.

Receivers

The use of receivers is not recommended as they can cause a loss of liquid subcooling and subsequent refrigerant flow control problems. Where the use of a receiver is desired for service purposes, the receiver should be piped in parallel with the main liquid line and equipped with shut-off valves to isolate it during unit operation. See sketch below:



Relief Valve Vent Lines

The standard 30HXA chiller has four refrigerant relief valves: two on the cooler and two on the oil separator. They are located at the top of each vessel, one for each refrigerant circuit.

On chillers equipped with the optional suction service valves, there will be an additional relief valve located in the discharge line leaving each compressor. Refer to the 30HXA certified drawing in the product literature for specific location of all relief valves.

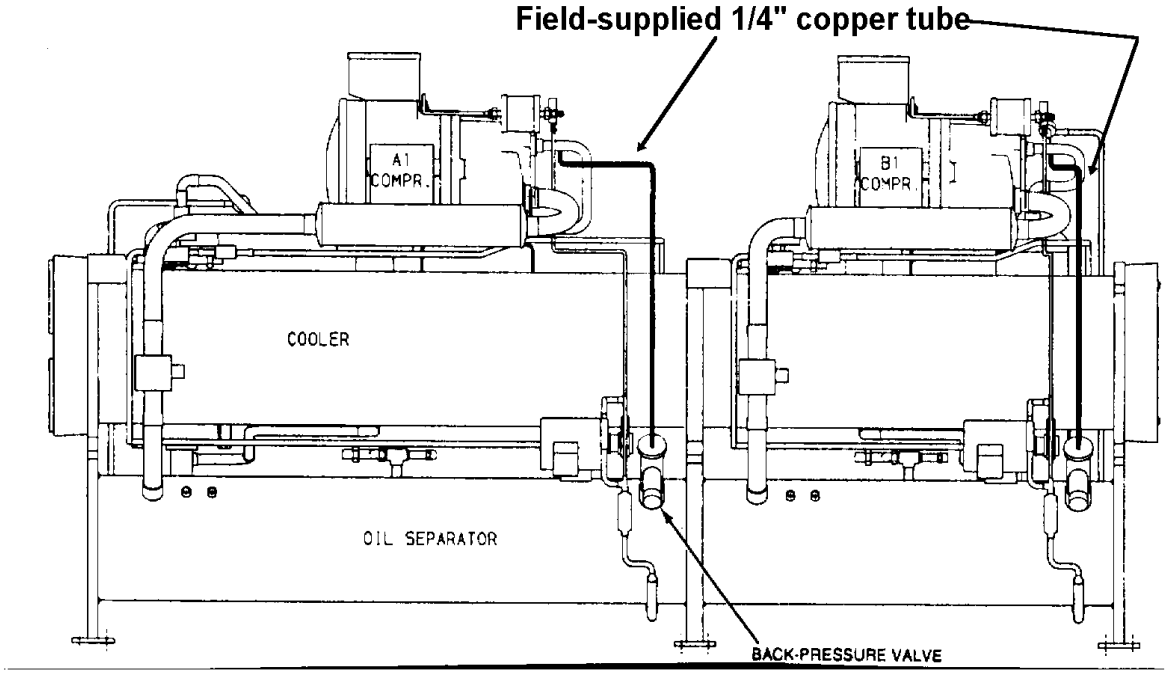
Most codes require that all refrigerant relief valves must be vented outdoors. The vent lines must be sized and installed as prescribed in ASHRAE 15," Safety Code for Mechanical Refrigeration". ASHRAE 15 generally outlines the relief valve vent piping termination requirements as follows:

Vent line termination must :

a. **not be less than 15 ft (4.6 m) above adjoining floor level.**
b. **not be less than 20 ft (6.1 m) from any window, ventilation opening, or exit in any building.**
c. **be made in such a manner that will prevent the discharged refrigerant from being sprayed directly on any personnel in the vicinity.**
d. **prevent foreign material or debris from entering the discharge piping.**
e. **prevent the buildup of condensation in the vent line piping.**
f. **not be routed into the chiller refrigerant discharge lines.**

Consult ASHRAE 15 for more specific details as well as the vent line sizing tables.

Oil Pressure Sensing Line



In order for the unit to properly measure the compressor oil pressure differential, a field-supplied 1/4 in. (6.4 mm) copper tube must be fabricated and installed between the back-pressure valve on the oil separator and the fitting on the refrigerant line entering the compressor economizer port. Both connections are 1/4 inch SAE flare fittings. See figure above.

Note : Both fittings have schrader valves as shipped from the factory. The schrader valves must be removed before the 1/4 in. lines are attached.

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