HEATCRAFT™ Refrigeration Products

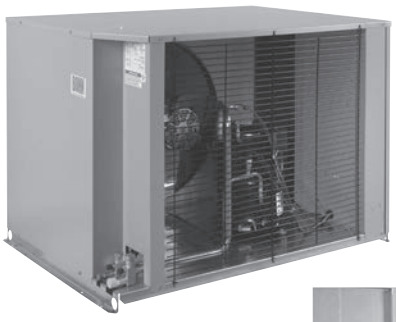
Installation and Operations Manual

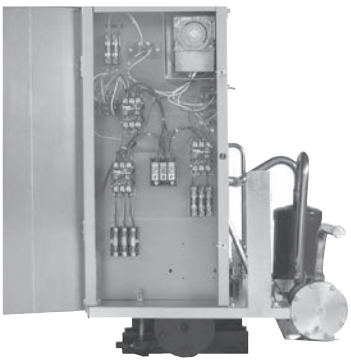
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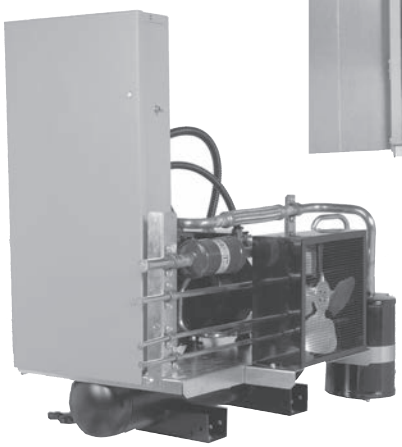
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Condensing Units







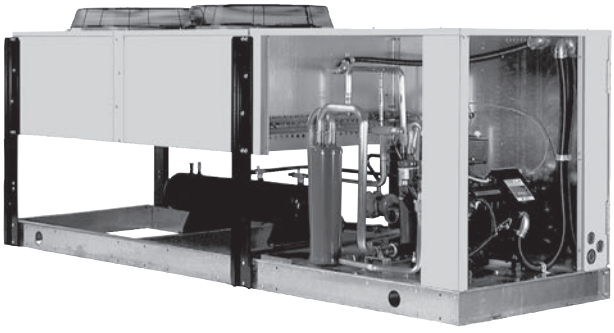


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General Safety Information

1. Installation and maintenance to be performed only by qualified personnel who are familiar with this type of equipment.
2. Refrigeration systems are typically pressurized with a holding charge of dry air or inert gas. It must be evacuated before charging the system with refrigerant. The system pressure must be checked first prior to any preparation work for evacuation. See Check System Pressure section on Pg. 24.
3. Make sure that all field wiring conforms to the requirements of the equipment and all applicable national and local codes.
4. Avoid contact with sharp edges and coil surfaces. They are a potential injury hazard.
5. Make sure all power sources are disconnected before any service work is done on units.

WARNING: Inspect and check system pressure first and safely discharge dry air or nitrogen holding charge before charging the system with refrigerant.
DO NOT OPEN THE SYSTEM OR REMOVE SCHRADER CORE(S) WITHOUT CHECKING THE PRESSURE FIRST!

WARNING: Refrigerant can be harmful if it is inhaled. Refrigerant must be used and recovered responsibly.
Failure to follow this warning may result in personal injury or death.

Inspection

Responsibility should be assigned to a dependable individual at the job site to receive material. Each shipment should be carefully checked against the bill of lading. The shipping receipt should not be signed until all items listed on the bill of lading have been accounted. Check carefully for concealed damage. Any shortage or damages should be reported to the delivering carrier. Damaged material becomes the delivering carrier's responsibility, and should not be returned to the manufacturer unless prior approval is given to do so. When uncrating, care should be taken to prevent damage. Heavy equipment should be left on its shipping base until it has been moved to the final location. Check the serial tag information with invoice. Report any discrepancies to your Heatcraft Refrigeration Products Sales Representative.

Warranty Statement

Seller warrants to its direct purchasers that products, including Service Parts, manufactured by SELLER shall be of a merchantable quality, free of defects in material or workmanship, under normal use and service for a period of one **(1) year from date of original installation, or eighteen (18) months from date of shipmen**t by SELLER, whichever first occurs. Any product covered by this order found to Seller's satisfaction to be defective upon examination at Seller's factory will at SELLER's option, be repaired or replaced and returned to Buyer via lowest common carrier, or SELLER may at its option grant Buyer a credit for the purchase price of the defective article. Upon return of a defective product to SELLER's plant, freight prepaid, by Buyer, correction of such defect by repair or replacement, and return freight via lowest common carrier, shall constitute full performance by SELLER of its obligations hereunder.

SELLER shall have no liability for expenses incurred for repairs made by Buyer except by prior, written authorization. Every claim on account of breach of warranty shall be made to SELLER in writing within the warranty period specified above – otherwise such claim shall be deemed waived. Seller shall have no warranty obligation whatsoever if its products have been subjected to alteration, misuse, negligence, free chemicals in system, corrosive atmosphere, accident, or if operation is contrary to SELLER's or manufacturer's recommendations, or if the serial number has been altered, defaced, or removed.

MOTOR COMPRESSORS:

Motor compressors furnished by SELLER are subject to the standard warranty terms set forth above, except products with LG model compressors which will have warranty of two (2) years from installation or thirty (30) months from shipment, " then continue on with that replacement should be made from nearest authorized compressor wholesaler. The replacement motor compressor shall be identical to the model of the motor compressor being replaced. Additional charges which may be incurred throughout the substitution of other than identical replacements are not covered by this warranty. An optional, non assignable, four (4) year extended compressor warranty may be purchased within the boundaries of the United Sates of America, its territories and possessions, and Canada. With this extended compressor warranty, replacements are administered by an authorized compressor distributor only. Replacements within the first year of the warranty area available through the distributor; the second through fifth years, the purchaser must submit a proof-of-purchase of a compressor and supply it to Heatcraft Refrigeration Products Warranty Claims for reimbursement.

Seller makes no express warranties except as noted above. All implied warranties are limited to the duration of the Express Warranty. Liability for incidental and consequential damages is excluded.

The forgoing is in lieu of all other warranties, express or implied, notwithstanding the provisions of the uniform commercial code, the Magnuson-Moss Warranty - Federal Trade Commission Improvement Act, or any other statutory or common law, federal or state.

SELLER makes no warranty, express or implied, of fitness for any particular purpose, or of any nature whatsoever, with respect to products manufactures or sold by seller hereunder, except as specifically set forth above and on the face hereof. It is expressly understood and agreed that SELLER shall not be liable to buyer, or any customer of buyer, for direct or indirect, special, incidental, consequential or penal damages, or for any expenses incurred by reason of the use or misuse by buyer or third parties of said products. To the extent said products may be considered "consumer products," As defined in Sec. 101 of the Magnuson-Moss Warranty - Federal Trade Commission Improvement Act, SELLER makes no warranty of any kind, express or implied, to "consumers," except as specifically set forth above and on the face hereof.

The following conditions should be adhered to when installing this unit to maintain the manufacturers warranty:

a) System piping must be in accordance with good refrigeration practices.

b) Inert gas must be charged into the piping during brazing.

c) The power supply to the unit must meet the following conditions:
   A. Three phase voltages must be +/- 10% of nameplate ratings. Single phase must be within +10% or -5% of nameplate ratings.
   B. Phase imbalance cannot exceed 2%.

d) All control and safety switch circuits must be properly connected according to the wiring diagram.

e) The factory installed wiring and piping must not be changed without written factory approval.

f) All equipment is installed in accordance with Heatcraft Refrigeration Products specified minimum clearances.

DOE Walk-In Cooler Freezer AWEF Set Points

Based on information currently available, following set points must be adhered to for DOE AWEF test conditions (when adjustable):

Condensing Unit Head Pressure

A1* Models	**A2L* Models**
LT-Revision A 100 psi	LT Revision A 145 psi
LT-Revision B 145 psi	MT Revision A 145 psi
MT-Revision A 145 psi	

* A1 = R-404A,R-507A,R-448A,R-449A,R-407A,R-407F,R-407C
A2L = R-454A, R-454C, R-455A (Offered with Outdoor Condensing Units only)

Evaporator Superheat

6.5°F

Defrost Termination

Low Profile Unit Cooler (LOP) - 55°F
Medium Profile Unit Cooler (MP) - 55°F
Center Mount Unit Cooler (CM) - 85°F
Large Unit Cooler (LUC) - 55°F
Low Velocity Center Mount Unit Cooler (LVCM) - 80°F

Unloader Pressure Control

MT - Below 23°F SST LT - Below -22°F SST

Disclaimer: This communication is provided for informational purposes only and is based on information that is subject to change and interpretation. Heatcraft recommends customers review the applicable laws and regulations to ensure compliance with regulations. For DOE regulations, see US DOE Energy Efficiency and Renewable Energy website for Walk-In Coolers and Freezers at https://www.regulations.doe.gov/ccms

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Space and Location Requirements for Air Cooled Condensing Units and Remote Condensers

The most important consideration which must be taken into account when deciding upon the location of air-cooled equipment is the provision for a supply of ambient air to the condenser, and removal of heated air from the condensing unit or remote condenser area. Where this essential requirement is not adhered to, it will result in higher head pressures, which cause poor operation and potential failure of equipment. Units must not be located in the vicinity of steam, hot air or fume exhausts. Corrosive atmospheres require custom designed condensers.

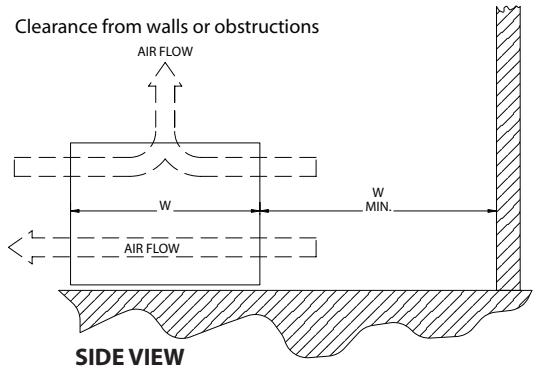
Another consideration which must be taken is that the unit should be mounted away from noise sensitive spaces and must have adequate support to avoid vibration and noise transmission into the building. Units should be mounted over corridors, utility areas, rest rooms and other auxiliary areas where high levels of sound are not an important factor. Sound and structural consultants should be retained for recommendations.

Figure 1. Space and Location Requirements for Condensing Units

Walls or Obstructions

The unit should be located so that air may circulate freely and not be recirculated. For proper air flow and access all sides of the unit should be a minimum of "W" away from any wall or obstruction. It is preferred that this distance be increased whenever possible. Care should be taken to see that ample room is left for maintenance work through access doors and panels. Overhead obstructions are not permitted. When the unit is in an area where it is enclosed by three walls the unit must be installed as indicated for units in a pit.

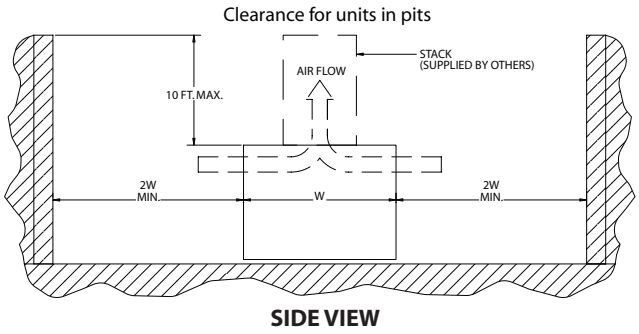
Units Near Walls or Obstructions



Units in Pits

The top of the unit should be level with the top of the pit, and side distance increased to "2W".

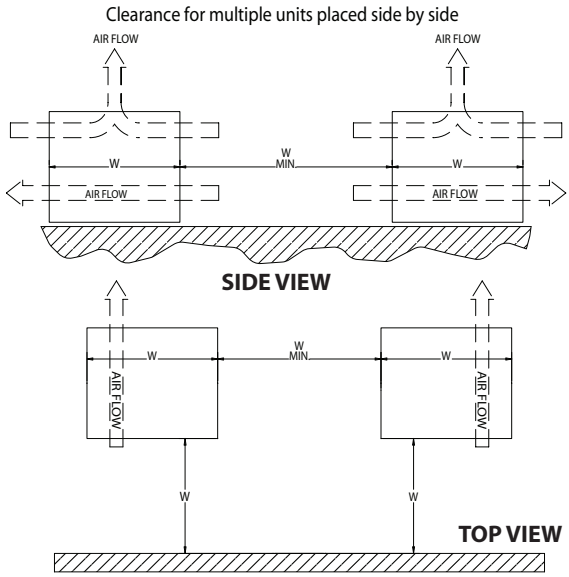
If the top of the unit is not level with the top of pit, discharge cones or stacks must be used to raise discharge air to the top of the pit. This is a minimum requirement.



Multiple Units

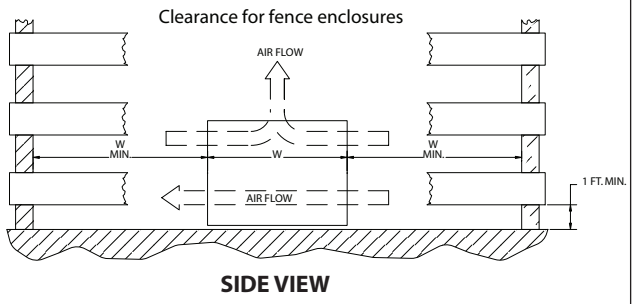
For units placed side by side, the minimum distance between units is the width of the largest unit. If units are placed end to end, the minimum distance between units is 4 feet.

Multiple Units Near Walls or Obstructions

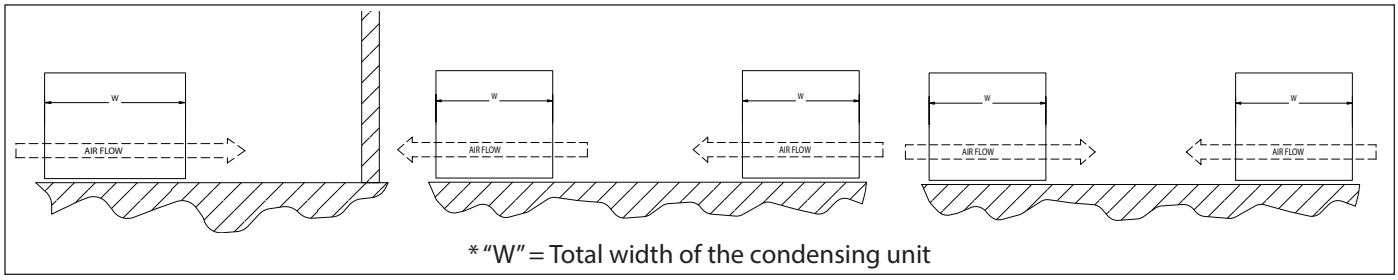


Units Inside Decorative Fence

Fences must have 50% free area, with 1 foot undercut, a "W" minimum clearance, and must not exceed the top of unit. If these requirements are not met, unit must be installed as indicated for "Units in pits".



CONFIGURATIONS BELOW ARE NOT RECOMMENDED



* "W" = Total width of the condensing unit

Condensing Unit Rigging and Mounting

Rigging holes are provided on **all u**nits. Caution should be exercised when moving these units. To prevent damage to the unit housing during rigging, cables or chains used must be held apart by spacer bars. The mounting platform or base should be level and located so as to permit free access of supply air.

Ground Mounting

Before tightening mounting bolts, recheck level of unit.

Roof Mounting

Roof mounted units should be installed level on steel channels or an I-beam frame capable of supporting the weight of the unit. Vibration absorbing pads or springs should be installed between the condensing unit legs or frame and the roof mounting assembly.

Spring Mounted Compressor

Compressors are secured rigidly to make sure there is no transit damage. Before operating the unit, it is necessary to follow these steps:

a) Remove the upper nuts and washers.

b) Discard the shipping spacers.

c) Install the neoprene spacers. (Spacers located in the electrical panel or tied to compressor.)

d) Replace the upper mounting nuts and washers.

e) Allow 1/16 inch space between the mounting nut/washer and rubber spacer. Mounting spring must not be fully compressed when mounting nut is properly installed. See Figures 2 and 3.

Rigid Mounted Compressor

Some products use rigid mounted compressors. Check the compressor mounting bolts to insure they have not vibrated loose during shipment. See Figure 4.

Figure 2. Spring Mount

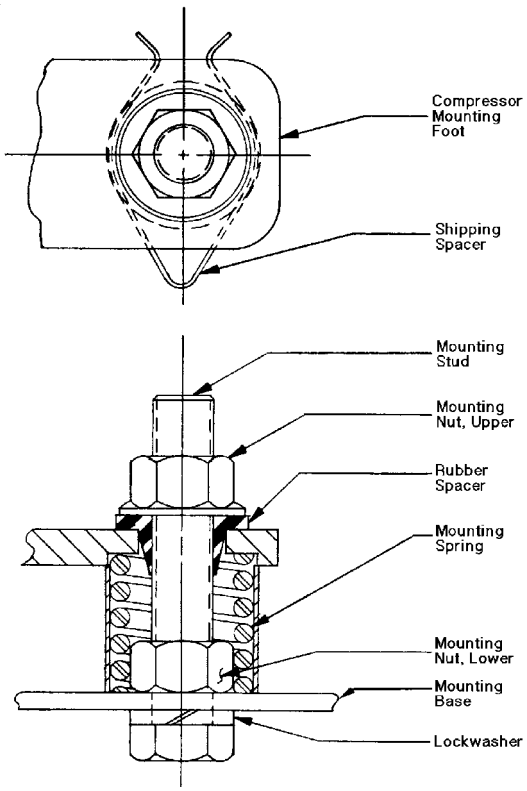
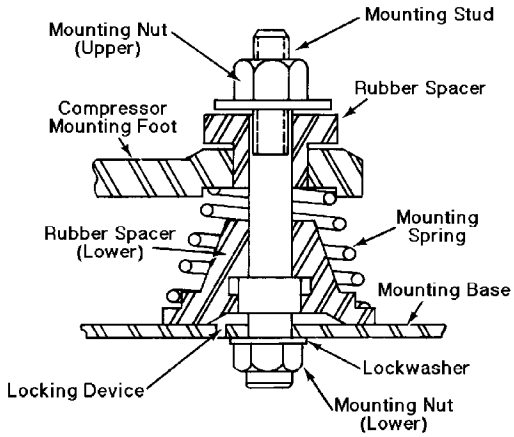


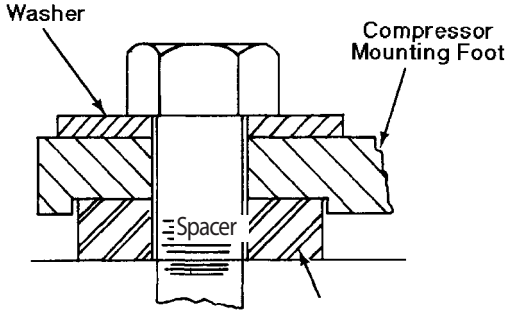
Figure 3. Spring Mount



Mount is shown in properly adjusted position.

Figure 4.

Solid Mount for Mobile or Deep Sump Application



Requirements for Remote and Water Cooled Condensing Units (Not Applicable with A2L Refrigerants)

General Installation

The indoor compressor units are designed to be used with a remote condenser. The water cooled units are similar, except that they have an integral water cooled condenser. Inlet and outlet water connections are to be made in the field. On units having a compressor water jacket, incoming water shall be routed through the jacket prior to entering the condenser. For cleaning purposes, condenser end plates can be removed to give access to the water tubes. Cleaning is accomplished by a simple spiral tool powered by an ordinary electric drill. During installation, allow space for cleaning the condenser. Commercial equipment of this type is intended for installation by qualified refrigeration mechanics.

Typical Arrangements

Diagram 1 illustrates a typical piping arrangement involving a remote condenser located at a higher elevation, as commonly encountered when the condenser is on a roof and the compressor and receiver are on grade level or in a basement equipment room.

In this case, the design of the discharge line is very critical. If properly sized for full load condition, the gas velocity might be too low at reduced loads to carry oil up through the discharge line and condenser coil. Reducing the discharge line size would increase the gas velocity sufficiently at reduced load conditions; however, when operating at full load, the line would be greatly undersized, and thereby creating an excessive refrigerant pressure drop. This condition can be overcome in one of two of the following ways:

1. The discharge line may be properly sized for the desired pressure drop at full load conditions and an oil separator installed at the bottom of the trap in the discharge line from the compressor.
2. A double riser discharge line may be used as shown in Diagram 2. Line "A" should be sized to carry the oil at minimum load conditions and the line "B" should be sized so that at the full load conditions both lines would have sufficient flow velocity to carry the oil to the condenser.

Water Regulating Valve

Using this control on the water cooled condensing units, the head pressure can be maintained by adjusting the flow of water through the condenser section. This type control is most often located on the water entering side of the condenser and is regulated by the refrigerant condensing pressure.

Subcooler

Diagrams 1 and 2 below show typical subcooler piping. Diagram 1 is the preferred connection with receiver as it provides maximum subcooling. Diagram 2 may be used if the receiver is located far from the condenser.

NOTES:

1. All oil traps are to be as short in radius as possible. Common practice is to fabricate the trap using three 90 degree ells.
2. Pressure relief valves are recommended at the condenser for protection of the coil.
3. A pressure valve at the high point in the discharge line is recommended to aid in removing non-condensables.
4. The placement of a subcooler should be that it does not interfere with normal airflow of the condenser. Increased static of the unit could cause a decrease in system capacity and fan motor damage.

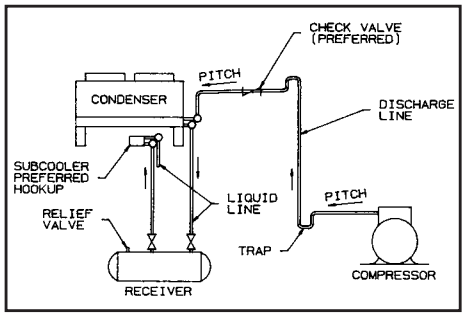


Diagram 1

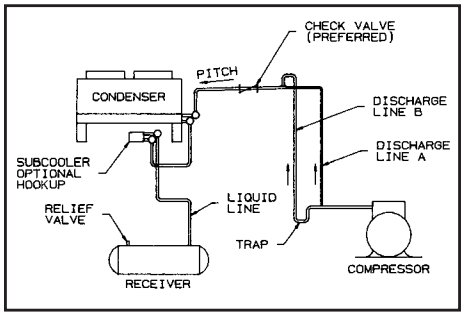


Diagram 2

City & Tower Water Connections

In the refrigeration industry "City" and "Tower" are designations of temperature and flow conditions, not applications. The term "City" refers to operating conditions where incoming water is 75˚F, and condensing temperature is 105˚F. "Tower" refers to a higher temperature relationship which is normally 85˚F, incoming water and 105˚F condensing temperature.

Water circuits in some condenser models provide a center, or Tower, outlet connection to allow divided inlet water flow. This extra water port reduces water velocity, water pressure drop, and condenser wear in applications such as cooling towers where higher inlet temperatures and water flows occur. See Figure 5

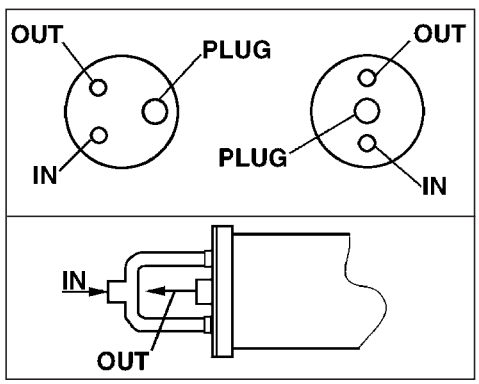
Water Connections for City

For City water (open system) high pressure applications, the Tower connections is plugged.

Water Connections for Tower

For Tower usage and low pressure applications, both normal water connections will be used as inlets and the tower connection as an outlet.

Figure 5. Water Connections



Head Pressure Control

Several types of head pressure control systems are available on condensing units:

A. Dual Valve System. (See section on operation and adjustment.)
B. Single Valve System. (No adjustments possible for standard non-adjustable version, See section on operation and adjustment of adjustable version.)
C. Ambient Fan Cycle Control. (See section on operation and adjustment.)
D. Variable Speed Fan Control

A. Dual Valve System

The system employs an ORI (open on rise of inlet pressure) valve and an ORD (open on rise of differential pressure) valve. The high pressure discharge gas is introduced above the liquid in the receiver tank. The receiver discharge is regulated by the ORI valve.

The discharge pressure of the ORI valve must be adjusted to regulate the unit for proper operating conditions. Adjust the ORI valve shown on the following diagram to maintain a discharge pressure of 150 PSIG on medium temperature systems and 100 PSIG on low temperature systems, see Figure 6.

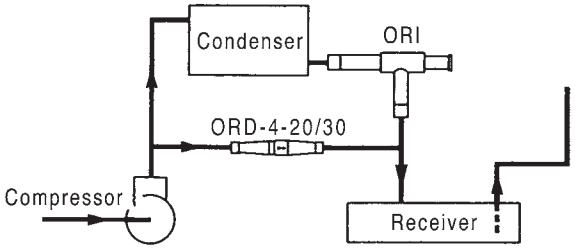
Operation and Adjustment

Condensing units with dual valves require sufficient charge to partially flood the condenser during low ambient conditions.

Valve adjustment should be made with gauges connected to the discharge port of the compressor. Adjustments should be made during mild or low ambient conditions. Turning the valve stem "clockwise" on the ORI valve will increase the discharge pressure, while turning the valve stem "counterclockwise" will decrease the discharge pressure.

If adjustments are made during warm ambient conditions, it may not be possible to adjust the regulator valve as low as desired. Readjustment may be necessary once cooler conditions prevail.

Figure 6. Dual Valve Piping Arrangement



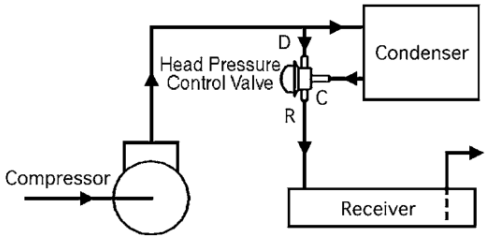
B. Single Valve System

The standard valve used on Medium Temperature Refrigeration systems controls the head pressure at approximately 145 PSIG. There is no adjustment for this valve. On Low Temperature Refrigeration systems the valve controls pressure at approximately 100 PSIG or 145 PSIG depending on the model. For energy efficiency, the 100 PSIG valve is sometimes used on Medium Temperature Refrigeration systems.

At condensing pressures above the valve setting, flow enters Port C and leaves Port R (See Figure 7). When the condensing pressure falls below the valve setting, the valve modulates to permit discharge gas to enter Port D. Metering discharge gas into the refrigerant flow leaving the condenser produces a higher pressure at the condenser outlet, reduces the flow, and causes the level of liquid refrigerant to rise in the condenser. This "flooding" of the condenser with liquid refrigerant reduces the available condensing surface, holding the condensing pressure at the valve setting.

An adjustable single valve is an available option for some systems. These valves are pre-set for the same pressures as the non-adjustable versions.

Figure 7. Single Valve Flooding Valve Piping Arrangement



C. Ambient Fan Cycle Control

This is an automatic winter control method which will maintain a condensing pressure within reasonable limits by cycling fan motors in response to outside air temperature. The thermostat(s) should be field adjusted to shut off the fan when the condensing temperature is reduced to approximately 70˚F. Table 1 lists approximate settings for several system T.D.'s. These settings are approximate as they do not take into account variations in load.

Table 1. Ambient Fan Cycle Thermostat Settings

Models	Design	Thermostat Settings		
	T.D.	T1	T2	T3
	30	40		
2-fan units:	25	45		
	20	50		
4-fan units:	15	55		
	30	40	30	
3-fan units:	25	45	35	
	20	50	40	
6-fan units:	15	55	45	
	30	40	30	20
8-fan units:	25	45	35	25
	20	50	40	30
	15	55	45	35

NOTE: Cycle pairs of fans on double wide units.

D. Variable Speed Fan Control

Variable speed fan controls must be set to maintain a discharge pressure of 145 PSIG on medium temperature systems and 100 PSIG or 145 PSIG depending on the model on low temperature systems.

Units using the Orbus Controller includes jumpers that can be set in the field as required. More information on the Variable Speed Motor with Orbus Controller can be found in the subsequent pages of this document.

For other variable speed controllers, consult control manufacturer information for details on how to set discharge pressure as required.

CAUTION:

When condenser fan cycling in used, at least one condenser motor shall be wired to operate continously while the compressor is running and be positioned to provide cooling air over the compressor body. For models with multiple condenser motors, under no circumstances shall all motors be allowed to cycle off of one control. See Table 15 for additional fan cycling guidance.

Phase Loss Monitor

When phase sequence is correct and full line voltage is present on all three phases, the relay is energized as the normal condition indicator light glows. If compressor fails to operate and the normal condition indicator light on the phase monitor does not glow, then the supplied electrical current is not in phase with the monitor. This problem is easily corrected by the following steps:

1. Turn power off at disconnect switch.
2. Swap any two of the three power input wires.
3. Turn power on. Indicator light should glow and compressor should start.
4. Observe motors for correct rotation.

Polyol Ester Lubricants

Hygroscopicity

Since moisture levels greater than 100 ppm will results in system corrosion and ultimate failure, it is imperative that compressors, components, containers and the entire system be kept sealed as much as possible. Lubricants will be packaged in specially designed, sealed containers. After opening, all the lubricant in a container should be used at once since it will readily absorb moisture if left exposed to the ambient. Any unused lubricant should be properly disposed of. Similarly, work on systems and compressors must be carried out with the open time as short as possible. Leaving the system or compressor open during breaks or overnight **MUST BE AVOIDED!**

Color

As received, the POE lubricant will be clear or straw colored. After use, it may acquire a darker color. This does not indicate a problem as the darker color merely reflects the activity of the lubricant's protective additive.

Oil Level

During Copeland's testing of Polyol ester oil, it was found that this lubricant exhibits a greater tendency to introduce oil into the cylinder during flooded start conditions. If allowed to continue, this condition will cause mechanical failure of the compressor.

A crankcase heater is required with condensing units and it must be turned on several hours before start-up.

Oil level must not exceed 3/4 sight glass.

Polyol Ester Lubricants

The Copeland compressor preferred POE 32 is due to unique additives included in this lubricant.

POE's **must** be used if HFC/HFO refrigerants are used in the system. They are also acceptable for use with any of the traditional refrigerants or interim blends and are compatible with mineral oils. Bitzer compressors use Solest 32.

Refrigerant Piping

Install all refrigerant components in accordance with applicable local and national codes and in accordance with good practice for proper system operation. The thermostatic expansion valve must be the externally equalized type. It can be mounted inside the unit end compartment. Mount the expansion valve bulb on a horizontal run of suction line as close as possible to the suction header. Use the clamps provided with the valve to fasten the bulb securely so there is a tight line-to-line contact between the bulb and the suction line. Suction and hot gas connections are made on the outside of the unit.

Suction lines should be sloped towards the compressor at the rate of one (1) inch per ten (10) feet for good oil return. Vertical risers of more than four (4) feet should be trapped at the bottom with a P-trap. If a P-trap is used, the expansion valve bulb should be installed between the unit and the trap.

Recommended Refrigerant Piping Practices

The system as supplied by **Heatcraft Refrigeration Products**, was thoroughly cleaned and dehydrated at the factory. Foreign matter may enter the system by way of the evaporator to condensing unit piping. Therefore, care must be used during installation of the piping to prevent entrance of foreign matter. Install all refrigeration system components in accordance with applicable local and national codes and in conformance with good practice required for the proper operation of the system.

The refrigerant pipe size should be selected from the Line Sizing Tables. The interconnecting pipe size is not necessarily the same size as the stub-out on the condensing unit or the evaporator.

The following procedures should be followed:

a) Do not leave dehydrated compressors or filter-driers on condensing units open to the atmosphere any longer than is absolutely necessary.

b) Use only refrigeration grade copper tubing, properly sealed against contamination.

c) Suction lines should slope 1/4" per 10 feet towards the compressor.

d) Suitable P-type oil traps should be located at the base of each suction riser to enhance oil return to the compressor.

e) For desired method of superheat measurement, a pressure tap should be installed in each evaporator suction line in the proximity of the expansion valve bulb.

f) When brazing refrigerant lines, an inert gas should be passed through the line at low pressure to prevent scaling and oxidation inside the tubing. Dry nitrogen is preferred.

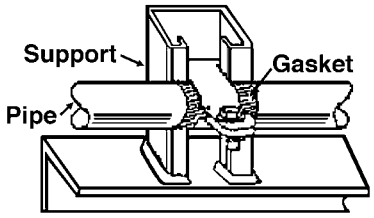
g) Use only a suitable silver solder alloy on suction and liquid lines.

h) Limit the soldering paste or flux to the minimum required to prevent contamination of the solder joint internally. Flux only the male portion of the connection, never the female. After brazing, remove excess flux.

i) See line sizing tables for discharge and liquid drain line sizes for remote condenser connections.

j) If isolation valves are installed at the evaporator, full port ball valves should be used.

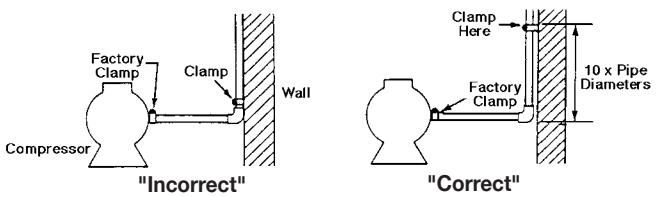
Figure 8. Example of Pipe Support



Refrigerant Pipe Support

1. Normally, any straight run of tubing must be supported in at least two locations near each end of the run. Long runs require additional supports. The refrigerant lines should be supported and fastened properly. As a guide, 3/8 to 7/8 should be supported every 5 feet; 1-1/8 and 1-3/8 every 7 feet; and 1-5/8 and 2-1/8 every 9 to 10 feet. See Figure 8
2. When changing directions in a run of tubing, no corner should be left unsupported. Supports should be placed a maximum of 2 feet in each direction from the corner. See Figure 9
3. Piping attached to a vibrating object (such as a compressor or compressor base) must be supported in such a manner that will not restrict the movement of the vibrating object. Rigid mounting will fatigue the copper tubing.
4. Do not use short radius ells. Short radius elbows have points of excessive stress concentration and are subject to breakage at these points.
5. Thoroughly inspect all piping after the equipment is in operation and add supports wherever line vibration is significantly greater than most of the other piping. Extra supports are relatively inexpensive as compared to refrigerant loss.

Figure 9. Condensing Unit / Compressor to Wall Support



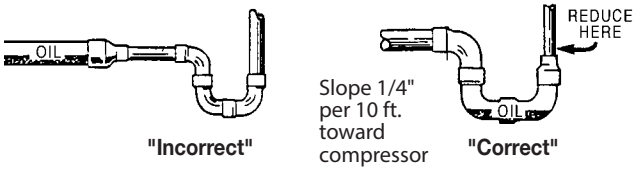
Suction Lines

Horizontal suction lines should slope away from the evaporator toward the compressor at the rate of 1/4 inch per 10 feet for good oil return. When multiple evaporators are connected in series using a common suction line, the branch suction lines must enter the top of the common suction line.

For dual or multiple evaporator systems, the branch lines to each evaporator should be sized for the evaporator capacity. The main common line should be sized for the total system capacity.

Suction lines that are outside of refrigerated space must be insulated.

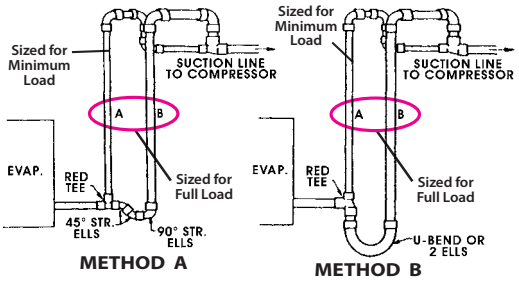
Figure 10. Suction P-Traps



Suction Line Risers

Prefabricated wrought copper traps are available, or a trap can be made by using two street ells and one regular ell. The suction trap must be the same size as the suction line. For long vertical risers, additional traps may be necessary. Generally, one trap is recommended for each length of pipe (approximately 20 feet) to insure proper oil movement. See Figure 10 and Figure 11 for methods of constructing proper suction line P-traps.

Figure 11. Double Suction Riser Construction



NOTE: A suction line trap must be installed at the point where piping changes the direction of refrigerant flow from any horizontal run to an upward vertical run.

Liquid Lines

Liquid lines should be sized for a minimum pressure drop to prevent "flashing". Flashing in the liquid lines would create additional pressure drop and poor expansion valve operation. If a system requires long liquid lines from the receiver to the evaporator or if the liquid has to rise vertically upward any distance, the losses should be calculated to determine whether or not a heat exchanger is required. The use of a suction to liquid heat exchanger may be used to subcool the liquid to prevent flashing. This method of subcooling will normally provide no more than 20˚F subcooling

Unit Cooler Piping

Pipe size example:

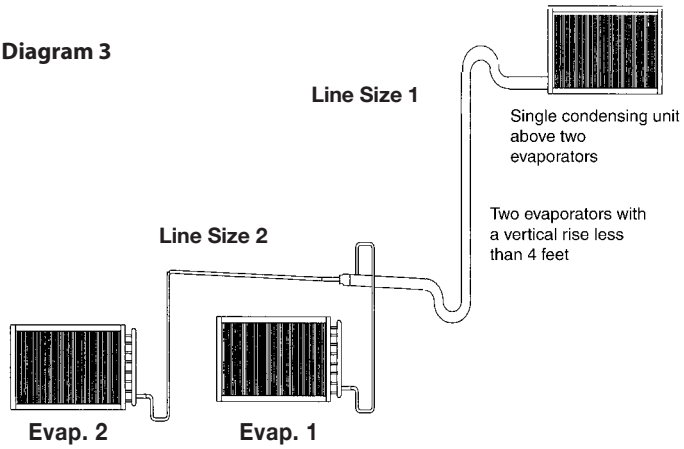
Given: **-10°F Freezer** with one system having (2) evaporators

- One condensing unit rated at 24,000 BTUH's @ -20°F SST R404A refrigerant.
- Two evaporators each rated at 12,000 BTUH's @ 10°F TD.
- 100 feet of actual line run between condensing unit to first evaporator and 20 feet of actual line run between the first evaporator and the second evaporator (see figure below).

How to figure line sizes:

1. Determine equivalent line run = actual run + valves and fitting allowances.
2. Use Line Sizing Tables to size lines.
3. Note any special considerations.

Diagram 3



Fittings in this system:

- (6) 90° elbows in main line plus a 90° turn through a tee.
- (5) addtional 90° elbows to first evaporator.
- (4) additional 90° elbows to second evaporator.

Determine line size 1 (main line from condensing unit):

1. Main line from the condensing unit to be sized for the total capacity (balance) of the whole system of 24,000 BTUH's.
2. Refer to 24,000 @100 feet at -20°F SST R404A on the chart. You will find the suction line to be 1-3/8" and 1/2" liquid line.
3. For every 1-3/8" 90° elbow you must add 4 equivalent feet of pipe and 2.5 equivalent feet of pipe for each 1-3/8" tee.

   Therefore, total equivalent line run =

Actual line run	100 feet
+ (6) 1-3/8" elbows @ 4'	24 feet
+ (1) 1-3/8" tee @ 2.5'	2.5 feet
Total equivalent line run	**126.5 feet**

4. For 126.5 total equivalent feet, the suction line size should be 1-3/8" and the liquid line stays at 1/2" line.

Note: On Table 6, for 24,000 BTUH's, the maximum suction riser is 1-1/8" to insure proper oil return and pressure drop from the bottom p-trap to the top p-trap.

Determine line size 2 (evaporators):

1. Line sizing to each evaporator is based on 12,000 BTUH's and equivalent run from condensing unit. First evaporator has an 105 ft. run and the second evaporator has a 120 ft. run.
2. Line sizing table indicates 1-1/8" suction for the first evaporator and indicates 1-1/8" suction for the second evaporator.
3. Refer to Table 4. Each 1-1/8" 90° elbow adds 3 equivalent feet of pipe. Each 90° turn through a 1-1/8" tee adds 6 equivalent feet.
4.

Actual line run (evap 1)	105 feet
+ (5) 1-1/8" elbows @ 3'	15 feet
+ (1) 90° turn through tee @ 6'	6 feet
Total equivalent line run	**126 feet**

Actual line run (evap 2)	120 feet
+ (4) 1-1/8" elbows @ 3'	12 feet
Total equivalent line run	**132 feet**

5. Table 6 indicates 1-1/8" suction line and 3/8" liquid line from main line to both evaporators.

Line Sizing

The following Tables 5-8 indicate liquid lines and suction lines for all condensing units for R-404A, R-507, R-407A/C/F, R-448A, R-449A, R-454A, R-454C and R-455A

When determining the refrigerant line length, be sure to add an allowance for fittings. See Table 4. Total equivalent length of refrigerant lines is the sum of the actual linear footage and the allowance for fittings.

Table 2. Weight of Refrigerants in Copper Lines During Operation (Pounds per 100 lineal feet of type "L" tubing)

Line Size O.D. (Inches)	Refrigerant	Liquid Line	Hot Gas Line	Suction Line at Suction Temperature				
				-40˚F	-20˚F	0˚F	+20˚F	+40˚F
3/8	R-407A, R-407C, R-407F	3.8	0.25	0.02	0.03	0.04	0.06	0.09
	R-448A, R-449A	3.6	0.24	0.02	0.03	0.04	0.06	0.09
	R-404A, R-507A	3.4	0.27	0.02	0.04	0.06	0.08	0.12
	R-454A	3.4	0.25	0.02	0.03	0.04	0.06	0.09
	R-454C	3.5	0.33	0.02	0.02	0.04	0.06	0.08
	R-455A	3.4	0.57	0.02	0.02	0.04	0.06	0.08
1/2	R-407A, R-407C, R-407F	7	0.46	0.03	0.05	0.07	0.11	0.16
	R-448A, R-449A	6.7	0.44	0.03	0.05	0.07	0.11	0.16
	R-404A, R-507A	6.3	0.51	0.04	0.07	0.11	0.15	0.22
	R-454A	6.3	0.46	0.03	0.05	0.08	0.11	0.16
	R-454C	6.4	0.62	0.03	0.05	0.07	0.10	0.15
	R-455A	6.4	1.06	0.03	0.05	0.07	0.11	0.15
5/8	R-407A, R-407C, R-407F	11.2	0.74	0.05	0.08	0.12	0.18	0.26
	R-448A, R-449A	10.8	0.71	0.05	0.08	0.12	0.18	0.26
	R-404A, R-507A	10.2	0.82	0.07	0.11	0.17	0.25	0.35
	R-454A	10.1	0.74	0.05	0.08	0.12	0.18	0.26
	R-454C	10.4	0.99	0.04	0.07	0.11	0.17	0.24
	R-455A	10.3	1.71	0.05	0.07	0.11	0.17	0.25
7/8	R-407A, R-407C, R-407F	23.3	1.54	0.10	0.16	0.25	0.37	0.55
	R-448A, R-449A	22.3	1.47	0.10	0.16	0.25	0.37	0.54
	R-404A, R-507A	21.1	1.70	0.15	0.23	0.35	0.51	0.74
	R-454A	21	1.54	0.10	0.16	0.25	0.37	0.54
	R-454C	21.5	2.06	0.09	0.15	0.23	0.34	0.50
	R-455A	21.3	3.54	0.10	0.15	0.24	0.35	0.51
1-1/8	R-407A, R-407C, R-407F	39.7	2.62	0.16	0.27	0.42	0.64	0.93
	R-448A, R-449A	38.1	2.51	0.17	0.27	0.42	0.64	0.92
	R-404A, R-507A	36.1	2.89	0.25	0.39	0.60	0.88	1.25
	R-454A	35.8	2.62	0.17	0.28	0.43	0.64	0.92
	R-454C	36.6	3.52	0.16	0.26	0.39	0.59	0.85
	R-455A	36.3	6.04	0.16	0.26	0.41	0.60	0.87
1-3/8	R-407A, R-407C, R-407F	60.5	4.00	0.25	0.41	0.64	0.97	1.42
	R-448A, R-449A	58	3.83	0.26	0.42	0.65	0.97	1.41
	R-404A, R-507A	54.9	4.41	0.38	0.60	0.91	1.34	1.91
	R-454A	54.6	3.99	0.27	0.43	0.65	0.97	1.40
	R-454C	55.8	5.35	0.24	0.39	0.60	0.89	1.29
	R-455A	55.3	9.20	0.25	0.40	0.62	0.92	1.33
1-5/8	R-407A, R-407C, R-407F	85.7	5.66	0.35	0.58	0.91	1.37	2.01
	R-448A, R-449A	82.1	5.42	0.36	0.59	0.92	1.37	1.99
	R-404A, R-507A	77.7	6.24	0.54	0.85	1.29	1.89	2.71
	R-454A	77.3	5.65	0.38	0.60	0.93	1.37	1.98
	R-454C	79	7.58	0.34	0.55	0.85	1.26	1.83
	R-455A	78.3	13.02	0.35	0.57	0.87	1.30	1.88
2-1/8	R-407A, R-407C, R-407F	149	9.84	0.61	1.01	1.58	2.39	3.50
	R-448A, R-449A	143	9.43	0.63	1.02	1.58	2.39	3.47
	R-404A, R-507A	135	10.85	0.94	1.48	2.24	3.29	4.71
	R-454A	134.4	9.83	0.66	1.05	1.61	2.39	3.45
	R-454C	137.4	13.18	0.60	0.96	1.48	2.20	3.18
	R-455A	136.1	22.65	0.61	0.99	1.52	2.26	3.27
2-5/8	R-407A, R-407C, R-407F	230	15.18	0.95	1.55	2.44	3.68	5.39
	R-448A, R-449A	220	14.54	0.97	1.58	2.46	3.68	5.35
	R-404A, R-507A	209	16.73	1.45	2.28	3.45	5.07	7.26
	R-454A	207.3	15.15	1.01	1.62	2.48	3.68	5.31
	R-454C	211.9	20.33	0.92	1.48	2.28	3.39	4.91
	R-455A	209.9	34.93	0.95	1.52	2.34	3.49	5.04

Table 2. Weight of Refrigerants in Copper Lines During Operation (Pounds per 100 lineal feet of type "L" tubing) Cont.

Line Size O.D. (Inches)	Refrigerant	Liquid Line	Hot Gas Line	Suction Line at Suction Temperature				
				-40˚F	-20˚F	0˚F	+20˚F	+40˚F
3-1/8	R-407A, R-407C, R-407F	328	21.66	0.35	2.22	3.48	5.26	7.69
	R-448A, R-449A	314	20.76	1.39	2.25	3.50	5.25	7.64
	R-404A, R-507A	298	23.88	2.06	3.25	4.93	7.24	10.36
	R454A	295.9	21.63	1.44	2.31	3.55	5.26	7.59
	R454C	302.4	29.02	1.31	2.11	3.25	4.84	7.00
	R455A	299.7	49.85	1.35	2.17	3.35	4.97	7.19
3-5/8	R-407A, R-407C, R-407F	444	29.30	1.83	3.00	4.71	7.11	10.41
	R-448A, R-449A	425	28.07	1.87	3.05	4.74	7.10	10.33
	R-404A, R-507A	403	32.30	2.79	4.40	6.67	9.79	14.01
	R454A	400.2	29.25	1.95	3.12	4.80	7.11	10.26
	R454C	409.1	39.25	1.77	2.86	4.40	6.55	9.47
	R455A	405.3	67.43	1.83	2.94	4.53	6.73	9.72
4-1/8	R-407A, R-407C, R-407F	577	38.08	2.37	3.90	6.12	9.24	13.53
	R-448A, R-449A	552	36.49	2.44	3.96	6.16	9.23	13.42
	R-404A, R-507A	523	41.99	3.63	5.72	8.67	12.72	18.21
	R454A	518.1	37.87	2.53	4.05	6.21	9.21	13.28
	R454C	529.6	50.81	2.30	3.70	5.70	8.48	12.26
	R455A	524.7	87.29	2.36	3.80	5.86	8.71	12.59

Table 3. Pressure Loss of Liquid Refrigerants in Liquid Line Risers (Expressed in Pressure Drop, PSIG, and Subcooling Loss, ˚F)

Refrigerant	Liquid Line Rise in Feet																	
	10'		15'		20'		25'		30'		40'		50'		75'		100'	
	PSIG	˚F	PSIG	˚F	PSIG	˚F	PSIG	˚F	PSIG	˚F	PSIG	˚F	PSIG	˚F	PSIG	˚F	PSIG	˚F
R-407A, R-407C, R-407F	4.3	1.4	6.4	2	8.5	2.7	10.6	3.4	12.8	4.1	17	5.4	21.3	6.8	31.9	10.1	42.5	13.5
R-448A, R-449A	4.3	1.1	6.5	1.7	8.7	2.3	10.9	2.8	13	3.4	17.4	4.5	21.7	5.6	32.6	8.3	43.5	10.9
R-507, R-404A	4.1	1.1	6.1	1.6	8.2	2.1	10.2	2.7	12.2	3.3	16.3	4.1	20.4	5.6	30.6	8.3	40.8	11.8
R-454A	4.05	1.03	6.07	1.55	8.1	2.08	10.12	2.6	12.14	3.13	16.19	4.19	20.24	5.26	30.36	8	40.48	10.81
R-454C	4.16	1.21	6.24	1.83	8.31	2.44	10.39	3.06	12.47	3.68	16.63	4.93	20.78	6.2	31.18	9.45	41.57	12.79
R-455A	4.11	1.11	6.17	1.67	8.22	2.23	10.28	2.79	12.33	3.36	16.44	4.5	20.55	5.65	30.83	8.58	41.11	11.6

Based on 110˚F liquid temperature at bottom of riser.

Table 4. Equivalent Feet of Pipe Due to Valve and Fitting Friction

Copper Tube, O.D., Type "L"	1/2	5/8	7/8	1-1/8	1-3/8	1-5/8	2-1/8	2-5/8	3-1/8	3-5/8	4-1/8	5-1/8	6-1/8
Globe Valve (Open)	14	16	22	28	36	42	57	69	83	99	118	138	168
Angle Valve (Open)	7	9	12	15	18	21	28	34	42	49	57	70	83
90˚ Turn Through Tee	3	4	5	6	8	9	12	14	17	20	22	28	34
Tee (Straight Through) or Sweep Below	.75	1	1.5	2	2.5	3	3.5	4	5	6	7	9	11
90˚ Elbow or Reducing Tee (Straight Through)	1	2	2	3	4	4	5	7	8	10	12	14	16

Table 5. Recommended Remote Condenser Line Sizes

Net Evaporator Capacity	Total Equiv. Length	R-407A/C/F, R-448A & R-449A		R-507 & R-404A	
		Discharge Line (O.D.)	Liquid Line Cond. to Receiver (O.D.)	Discharge Line (O.D.)	Liquid Line Cond. to Receiver (O.D.)
3,000	50	3/8	3/8	3/8	3/8
	100	3/8	3/8	3/8	3/8
6,000	50	3/8	3/8	1/2	3/8
	100	1/2	3/8	1/2	3/8
9,000	50	1/2	3/8	1/2	3/8
	100	1/2	3/8	1/2	3/8
12,000	50	1/2	3/8	1/2	3/8
	100	5/8	3/8	5/8	1/2
18,000	50	5/8	3/8	5/8	1/2
	100	5/8	3/8	7/8	1/2
24,000	50	5/8	3/8	5/8	1/2
	100	7/8	1/2	7/8	5/8
36,000	50	7/8	1/2	7/8	5/8
	100	7/8	5/8	7/8	7/8
48,000	50	7/8	5/8	7/8	5/8
	100	7/8	7/8	1-1/8	7/8
60,000	50	7/8	5/8	7/8	7/8
	100	1-1/8	7/8	1-1/8	7/8
72,000	50	7/8	7/8	1-1/8	7/8
	100	1-1/8	7/8	1-1/8	1-1/8
90,000	50	1-1/8	7/8	1-1/8	7/8
	100	1-1/8	7/8	1-1/8	1-1/8
120,000	50	1-1/8	7/8	1-1/8	1-1/8
	100	1-3/8	1-1/8	1-3/8	1-3/8
180,000	50	1-3/8	1-1/8	1-3/8	1-3/8
	100	1-5/8	1-3/8	1-5/8	1-5/8
240,000	50	1-3/8	1-3/8	1-5/8	1-3/8
	100	1-5/8	1-3/8	2-1/8	1-5/8
300,000	50	1-5/8	1-3/8	1-5/8	1-5/8
	100	2-1/8	1-5/8	2-1/8	2-1/8
360,000	50	1-5/8	1-5/8	2-1/8	1-5/8
	100	2-1/8	2-1/8	2-1/8	2-1/8
480,000	50	2-1/8	1-5/8	2-1/8	2-1/8
	100	2-1/8	2-1/8	2-1/8	2-5/8
600,000	50	2-1/8	2-1/8	2-1/8	2-1/8
	100	2-5/8	2-5/8	2-5/8	2-5/8
720,000	50	2-1/8	2-1/8	2-1/8	2-5/8
	100	2-5/8	2-5/8	2-5/8	3-1/8
840,000	50	2-1/8	2-1/8	2-5/8	2-5/8
	100	2-5/8	2-5/8	2-5/8	3-1/8
960,000	50	2-5/8	2-5/8	2-5/8	2-5/8
	100	2-5/8	3-1/8	3-1/8	3-5/8
1,080,000	50	2-5/8	2-5/8	2-5/8	3-1/8
	100	3-1/8	3-1/8	3-1/8	3-5/8
1,200,000	50	2-5/8	2-5/8	2-5/8	3-1/8
	100	3-1/8	3-1/8	3-5/8	4-1/8
1,440,000	50	2-5/8	3-1/8	3-1/8	3-5/8
	100	3-1/8	3-5/8	3-5/8	4-1/8
1,680,000	50	3-1/8	3-1/8	3-1/8	3-5/8
	100	3-5/8	3-5/8	3-5/8	4-1/8

Table 6. Recommended Line Sizes for R-404A, R-507*

Capacity BTUH	Suction Line Size												Maximum Suction Line Riser Size						
	Suction Temperature												R-404A /507 Suction Temperature						
	+40˚F Equivalent Lengths				+20˚F Equivalent Lengths				+10˚F Equivalent Lengths										
	25'	50'	100'	150'	25'	50'	100'	150'	25'	50'	100'	150'	+40	+20	+10	-10	-20	-30	-40
1,000	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	1/2	1/2	1/2
3,000	3/8	3/8	1/2	1/2	3/8	3/8	1/2	1/2	3/8	1/2	1/2	5/8	3/8	3/8	1/2	1/2	1/2	1/2	1/2
4,000	3/8	1/2	1/2	1/2	3/8	1/2	1/2	5/8	1/2	1/2	5/8	5/8	3/8	1/2	1/2	1/2	5/8	5/8	5/8
6,000	1/2	1/2	1/2	5/8	1/2	1/2	5/8	7/8	1/2	1/2	5/8	7/8	1/2	1/2	1/2	1/2	5/8	5/8	7/8
9,000	1/2	5/8	5/8	5/8	5/8	5/8	7/8	7/8	5/8	5/8	7/8	7/8	1/2	5/8	5/8	7/8	7/8	7/8	7/8
12,000	1/2	5/8	7/8	7/8	5/8	7/8	7/8	7/8	5/8	7/8	7/8	7/8	1/2	7/8	7/8	7/8	7/8	1-1/8	1-1/8
15,000	5/8	5/8	7/8	7/8	5/8	7/8	7/8	7/8	7/8	7/8	7/8	1-1/8	5/8	7/8	7/8	7/8	7/8	1-1/8	1-1/8
18,000	5/8	7/8	7/8	7/8	7/8	7/8	7/8	1-1/8	7/8	7/8	1-1/8	1-1/8	5/8	7/8	7/8	1-1/8	1-1/8	1-1/8	1-1/8
24,000	5/8	7/8	7/8	7/8	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-1/8	5/8	1-1/8	1-1/8	1-1/8	1-1/8	1-3/8	1-3/8
30,000	7/8	7/8	7/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	7/8	1-1/8	1-1/8	1-1/8	1-1/8	1-3/8	1-3/8
36,000	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	7/8	1-1/8	1-1/8	1-1/8	1-1/8	1-3/8	1-3/8
42,000	7/8	7/8	1-1/8	1-1/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	7/8	1-3/8	1-3/8	1-3/8	1-3/8	1-5/8	1-5/8
48,000	7/8	1-1/8	1-1/8	1-1/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-5/8	7/8	1-3/8	1-3/8	1-3/8	1-3/8	1-5/8	1-5/8
54,000	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-3/8	1-3/8	1-3/8	1-5/8	1-5/8
60,000	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1-1/8	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8
66,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1-1/8	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8
72,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-5/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1-1/8	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8
78,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	1-5/8	1-1/8	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8
84,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	1-3/8	1-5/8	1-5/8	1-5/8	1-5/8	2-1/8	1-5/8
90,000	1-1/8	1-3/8	1-3/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	1-3/8	1-5/8	1-5/8	2-1/8	1-3/8	1-5/8	1-5/8	1-5/8	2-1/8	2-1/8	2-1/8
120,000	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-5/8	2-1/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-1/8	2-1/8	2-1/8	2-1/8
150,000	1-3/8	1-3/8	1-5/8	2-1/8	1-5/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-1/8	2-1/8	2-1/8	2-5/8
180,000	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	1-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-5/8	2-5/8
210,000	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	2-5/8	2-5/8	2-5/8	2-5/8	3-1/8
240,000	1-5/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	2-5/8	2-5/8	2-5/8	3-1/8	3-1/8
300,000	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	2-5/8	3-1/8	2-1/8	2-5/8	2-5/8	2-5/8	2-5/8	3-5/8	3-5/8
360,000	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	3-1/8	2-1/8	2-5/8	2-5/8	3-1/8	2-5/8	2-5/8	3-1/8	3-5/8	3-5/8	3-5/8	4-1/8
480,000	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	3-1/8	3-1/8	2-5/8	2-5/8	2-5/8	3-5/8	2-5/8	3-1/8	3-5/8	3-5/8	3-5/8	3-5/8	4-1/8
600,000	2-1/8	2-5/8	2-5/8	3-1/8	2-5/8	2-5/8	3-1/8	3-5/8	2-5/8	2-5/8	3-1/8	3-5/8	3-1/8	3-5/8	3-5/8	3-5/8	3-5/8	4-1/8	4-1/8

*** NOTES:**

1. Sizes that are highlighted indicate maximum suction line sizes that should be used for risers. Riser size should not exceed horizontal size. Properly placed suction traps must also be used for adequate oil return. All sizes shown are for O.D. Type L copper tubing.
2. Suction line sizes selected at pressure drop equivalent to 2˚F. Reduce estimate of system capacity accordingly.
3. Recommended liquid line size may increase with reverse cycle hot gas systems.
4. If system load drops below 40% of design, consideration to installing double suction risers should be made.

Table 6a. Recommended Line Sizes for R-404A, R-507* (cont.)

Capacity BTUH	Suction Line Size																Liquid Line Size			
	Suction Temperature																Receiver to Expansion Valve Equivalent Lengths			
	-10 ˚F Equivalent Lengths				-20˚F Equivalent Lengths				-30˚F Equivalent Lengths				-40˚F Equivalent Lengths							
	25'	50'	100'	150'	25'	50'	100'	150'	25'	50'	100'	150'	25'	50'	100'	150'	25'	50'	100'	150'
1,000	3/8	3/8	1/2	1/2	3/8	3/8	1/2	1/2	3/8	3/8	1/2	1/2	3/8	1/2	1/2	5/8	3/8	3/8	3/8	3/8
3,000	1/2	1/2	5/8	5/8	1/2	1/2	5/8	7/8	1/2	1/2	5/8	7/8	1/2	1/2	5/8	7/8	3/8	3/8	3/8	3/8
4,000	1/2	5/8	5/8	7/8	1/2	5/8	7/8	7/8	5/8	5/8	7/8	7/8	1/2	5/8	7/8	7/8	3/8	3/8	3/8	3/8
6,000	1/2	5/8	7/8	7/8	5/8	5/8	7/8	7/8	5/8	5/8	7/8	7/8	5/8	5/8	7/8	7/8	3/8	3/8	3/8	3/8
9,000	5/8	7/8	7/8	7/8	5/8	7/8	7/8	1-1/8	5/8	7/8	7/8	1-1/8	5/8	7/8	7/8	1-1/8	3/8	3/8	3/8	3/8
12,000	7/8	7/8	7/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	7/8	1-1/8	1-1/8	3/8	3/8	3/8	3/8
15,000	7/8	7/8	1-1/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	7/8	1-1/8	1-1/8	3/8	3/8	3/8	1/2
18,000	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	7/8	1-1/8	1-1/8	1-3/8	7/8	1-1/8	1-1/8	1-3/8	3/8	3/8	1/2	1/2
24,000	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	3/8	3/8	1/2	1/2
30,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	3/8	1/2	1/2	1/2
36,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1/2	1/2	1/2	1/2
42,000	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-3/8	1-5/8	1/2	1/2	1/2	5/8
48,000	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-3/8	1-5/8	1/2	1/2	5/8	5/8
54,000	1-3/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	1-5/8	1/2	1/2	5/8	5/8
60,000	1-3/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	1-5/8	1/2	1/2	5/8	5/8
66,000	1-3/8	1-5/8	1-5/8	1-5/8	1-3/8	1-5/8	1-5/8	1-5/8	1-3/8	1-5/8	1-5/8	1-5/8	1-3/8	1-5/8	1-5/8	1-5/8	1/2	1/2	5/8	5/8
72,000	1-3/8	1-5/8	1-5/8	1-5/8	1-3/8	1-5/8	1-5/8	1-5/8	1-3/8	1-5/8	1-5/8	1-5/8	1-3/8	1-5/8	1-5/8	1-5/8	1/2	5/8	5/8	5/8
78,000	1-3/8	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8	2-1/8	1-5/8	1-5/8	1-5/8	2-1/8	1-5/8	1-5/8	1-5/8	2-1/8	5/8	5/8	5/8	5/8
84,000	1-3/8	1-5/8	1-5/8	2-1/8	1-5/8	1-5/8	2-1/8	2-1/8	1-5/8	1-5/8	2-1/8	2-1/8	1-5/8	1-5/8	2-1/8	2-1/8	5/8	5/8	5/8	7/8
90,000	1-5/8	1-5/8	2-1/8	2-1/8	1-5/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-1/8	1-5/8	1-5/8	2-1/8	2-1/8	5/8	5/8	7/8	7/8
120,000	1-5/8	2-1/8	2-1/8	2-5/8	1-5/8	2-1/8	2-1/8	2-5/8	1-5/8	2-1/8	2-1/8	2-5/8	1-5/8	2-1/8	2-1/8	2-5/8	5/8	5/8	7/8	7/8
150,000	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	5/8	7/8	7/8	7/8
180,000	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	7/8	7/8	7/8	1-1/8
210,000	2-1/8	2-1/8	2-5/8	3-1/8	2-1/8	2-5/8	2-5/8	3-1/8	2-1/8	2-5/8	2-5/8	3-1/8	2-1/8	2-5/8	2-5/8	3-1/8	7/8	7/8	1-1/8	1-1/8
240,000	2-1/8	2-5/8	2-5/8	3-1/8	2-1/8	2-5/8	2-5/8	3-1/8	2-5/8	2-5/8	3-1/8	3-1/8	2-5/8	2-5/8	3-1/8	3-1/8	7/8	7/8	1-1/8	1-1/8
300,000	2-5/8	2-5/8	3-1/8	3-1/8	2-5/8	2-5/8	3-1/8	3-5/8	2-5/8	2-5/8	3-1/8	3-5/8	2-5/8	2-5/8	3-5/8	3-5/8	7/8	1-1/8	1-1/8	1-3/8
360,000	2-5/8	2-5/8	3-1/8	3-5/8	2-5/8	2-5/8	3-5/8	3-5/8	2-5/8	3-1/8	3-5/8	3-5/8	2-5/8	3-1/8	3-5/8	4-1/8	1-1/8	1-1/8	1-3/8	1-3/8
480,000	2-5/8	3-1/8	3-5/8	3-5/8	2-5/8	3-1/8	3-5/8	3-5/8	3-1/8	3-5/8	4-1/8	4-1/8	3-1/8	3-5/8	4-1/8	4-1/8	1-1/8	1-1/8	1-3/8	1-5/8
600,000	3-1/8	3-1/8	3-5/8	4-1/8	3-1/8	3-1/8	3-5/8	3-5/8	3-1/8	3-5/8	4-1/8	4-1/8	3-1/8	3-5/8	4-1/8	4-1/8	1-1/8	1-3/8	1-5/8	1-5/8

*** NOTES:**

1. Sizes that are highlighted indicate maximum suction line sizes that should be used for risers. Riser size should not exceed horizontal size. Properly placed suction traps must also be used for adequate oil return. All sizes shown are for O.D. Type L copper tubing.
2. Suction line sizes selected at pressure drop equivalent to 2˚F. Reduce estimate of system capacity accordingly.
3. Recommended liquid line size may increase with reverse cycle hot gas systems.
4. If system load drops below 40% of design, consideration to installing double suction risers should be made.

Table 7. Recommended Line Sizes for R-407A/R-407C/R-407F*

Capacity BTUH	Suction Line Size												Maximum Suction Line Riser Size						
	Suction Temperature												R-407A/C/F Suction Temperature						
	+40˚F Equivalent Lengths				+20˚F Equivalent Lengths				+10˚F Equivalent Lengths										
	25'	50'	100'	150'	25'	50'	100'	150'	25'	50'	100'	150'	+40	+20	+10	-10	-20	-30	-40
1,000	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8
3,000	3/8	3/8	3/8	1/2	3/8	3/8	1/2	1/2	1/2	1/2	1/2	5/8	3/8	3/8	1/2	1/2	1/2	5/8	5/8
4,000	3/8	3/8	1/2	1/2	3/8	1/2	1/2	5/8	1/2	5/8	5/8	5/8	1/2	1/2	1/2	1/2	5/8	5/8	5/8
6,000	3/8	1/2	1/2	5/8	1/2	1/2	5/8	5/8	1/2	5/8	7/8	7/8	1/2	1/2	1/2	5/8	5/8	7/8	7/8
9,000	1/2	1/2	5/8	5/8	1/2	5/8	7/8	7/8	5/8	7/8	7/8	7/8	5/8	5/8	5/8	5/8	7/8	7/8	1-1/8
12,000	1/2	5/8	7/8	7/8	5/8	5/8	7/8	7/8	5/8	7/8	7/8	7/8	5/8	7/8	5/8	7/8	7/8	1-1/8	1-3/8
15,000	5/8	5/8	7/8	7/8	5/8	7/8	7/8	7/8	7/8	7/8	7/8	1-1/8	7/8	7/8	7/8	7/8	1-1/8	1-3/8	1-3/8
18,000	5/8	7/8	7/8	7/8	5/8	7/8	7/8	7/8	7/8	7/8	1-1/8	1-1/8	7/8	7/8	7/8	1-1/8	1-1/8	1-3/8	1-5/8
24,000	5/8	7/8	7/8	7/8	7/8	7/8	7/8	1-1/8	7/8	1-1/8	1-1/8	1-1/8	7/8	1-1/8	7/8	1-1/8	1-3/8	1-5/8	1-5/8
30,000	7/8	7/8	7/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	7/8	1-1/8	1-1/8	1-3/8	1-5/8	1-5/8	2-1/8
36,000	7/8	7/8	1-1/8	1-1/8	7/8	7/8	1-1/8	1-1/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-1/8	1-5/8	1-5/8	1-5/8	2-1/8
42,000	7/8	7/8	1-1/8	1-1/8	7/8	7/8	1-1/8	1-1/8	1-1/8	1-3/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-5/8	1-5/8	2-1/8	2-1/8
48,000	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-3/8	1-5/8	1-5/8	2-1/8	2-5/8
54,000	7/8	1-1/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-3/8	1-5/8	2-1/8	2-1/8	2-5/8
60,000	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	1-5/8	2-1/8	2-5/8	2-5/8
66,000	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-5/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	2-1/8	2-5/8	3-1/8
72,000	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-3/8	1-5/8	1-5/8	2-1/8	1-3/8	1-3/8	1-5/8	2-1/8	2-1/8	2-5/8	3-1/8
78,000	7/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-3/8	1-5/8	1-5/8	2-1/8	1-3/8	1-3/8	1-5/8	2-1/8	2-5/8	2-5/8	3-1/8
84,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-5/8	1-3/8	1-5/8	1-5/8	2-1/8	1-3/8	1-5/8	1-5/8	2-1/8	2-5/8	3-1/8	3-1/8
90,000	1-1/8	1-3/8	1-3/8	1-3/8	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-5/8	2-1/8	2-1/8	1-3/8	1-5/8	1-5/8	2-1/8	2-5/8	3-1/8	3-1/8
120,000	1-1/8	1-3/8	1-5/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1-5/8	2-1/8	2-1/8	2-1/8	1-5/8	1-5/8	1-5/8	2-5/8	3-1/8	3-1/8	3-5/8
150,000	1-3/8	1-3/8	1-5/8	1-5/8	1-3/8	1-5/8	1-5/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	1-5/8	2-1/8	2-5/8	3-1/8	3-1/8	3-5/8	4-1/8
180,000	1-3/8	1-3/8	1-5/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	3-1/8	3-5/8	3-5/8	4-1/8
210,000	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	1-5/8	2-1/8	2-1/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	3-5/8	3-5/8	4-1/8	5-1/8
240,000	1-5/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-1/8	2-1/8	2-5/8	2-5/8	2-5/8	2-1/8	2-1/8	3-1/8	3-5/8	3-5/8	4-1/8	5-1/8
300,000	1-5/8	2-1/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-5/8	2-5/8	3-1/8	2-1/8	2-5/8	3-1/8	3-5/8	4-1/8	5-1/8	5-1/8
360,000	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	3-1/8	3-1/8	2-5/8	2-5/8	3-5/8	4-1/8	5-1/8	5-1/8	5-1/8
480,000	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	2-5/8	3-1/8	2-5/8	3-1/8	3-1/8	3-5/8	2-5/8	3-1/8	3-5/8	5-1/8	5-1/8	6-1/8	6-1/8
600,000	2-1/8	2-5/8	2-5/8	3-1/8	2-5/8	2-5/8	3-1/8	3-1/8	2-5/8	3-1/8	3-5/8	3-5/8	3-1/8	3-1/8	4-1/8	5-1/8	5-1/8	6-1/8	8-1/8

*** NOTES:**

1. Sizes that are highlighted indicate maximum suction line sizes that should be used for risers. Riser size should not exceed horizontal size. Properly placed suction traps must also be used for adequate oil return. All sizes shown are for O.D. Type L copper tubing.
2. Suction line sizes selected at pressure drop equivalent to 2˚F. Reduce estimate of system capacity accordingly.
3. Recommended liquid line size may increase with reverse cycle hot gas systems.
4. If system load drops below 40% of design, consideration to installing double suction risers should be made.

Table 7a. Recommended Line Sizes for R-407A/R-407C/R-407F* (cont.)

Capacity BTUH	Suction Line Size																Liquid Line Size			
	Suction Temperature																Receiver to Expansion Valve Equivalent Lengths			
	-10˚F Equivalent Lengths				-20˚F Equivalent Lengths				-30˚F Equivalent Lengths				-40˚F Equivalent Lengths							
	25'	50'	100'	150'	25'	50'	100'	150'	25'	50'	100'	150'	25'	50'	100'	150'	25'	50'	100'	150'
1,000	3/8	3/8	1/2	1/2	3/8	1/2	1/2	1/2	3/8	1/2	1/2	5/8	3/8	5/8	5/8	5/8	3/8	3/8	3/8	3/8
3,000	1/2	1/2	5/8	5/8	1/2	5/8	7/8	7/8	5/8	5/8	7/8	7/8	5/8	5/8	7/8	7/8	3/8	3/8	3/8	3/8
4,000	1/2	5/8	7/8	7/8	5/8	7/8	7/8	7/8	5/8	7/8	7/8	7/8	5/8	7/8	7/8	1-1/8	3/8	3/8	3/8	3/8
6,000	5/8	5/8	7/8	7/8	5/8	5/8	7/8	1-1/8	7/8	7/8	1-1/8	1 1/8	7/8	7/8	1-1/8	1-1/8	3/8	3/8	3/8	3/8
9,000	5/8	7/8	7/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	3/8	3/8	3/8	3/8
12,000	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-5/8	3/8	3/8	3/8	3/8
15,000	7/8	1-1/8	1-1/8	1-1/8	7/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-5/8	1-5/8	3/8	3/8	3/8	3/8
18,000	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	3/8	3/8	3/8	1/2
24,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1-3/8	1-3/8	1-5/8	1-5/8	1-3/8	1-5/8	2-1/8	2-1/8	3/8	3/8	1/2	1/2
30,000	1-1/8	1-1/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-5/8	1-5/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	3/8	1/2	1/2	1/2
36,000	1-1/8	1-3/8	1-3/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-1/8	3/8	1/2	1/2	5/8
42,000	1-3/8	1-3/8	1- 5/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	3/8	1/2	1/2	5/8
48,000	1-3/8	1-5/8	1-5/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	1/2	1/2	5/8	5/8
54,000	1-3/8	1-5/8	2-1/8	2-1/8	1-3/8	1- 5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	1/2	1/2	5/8	5/8
60,000	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	1/2	1/2	5/8	5/8
66,000	1-3/8	1- 5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-1/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	1/2	1/2	5/8	5/8
72,000	1- 5/8	1- 5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	2-5/8	3-1/8	1/2	5/8	5/8	5/8
78,000	1- 5/8	2-1/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	2-5/8	3-1/8	1/2	5/8	5/8	7/8
84,000	1-5/8	2-1/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	2-5/8	3-1/8	1/2	5/8	5/8	7/8
90,000	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	3-1/8	3-1/8	1/2	5/8	7/8	7/8
120,000	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	3-1/8	2-1/8	2-5/8	3-1/8	3-1/8	2-5/8	2-5/8	3-1/8	3-5/8	5/8	5/8	7/8	7/8
150,000	2-1/8	2-1/8	2-5/8	2-5/8	2-5/8	2-5/8	3-1/8	3-1/8	2-5/8	2-5/8	3-1/8	3-5/8	2-5/8	3-1/8	3-5/8	3-5/8	5/8	7/8	7/8	7/8
180,000	2-1/8	2-5/8	2-5/8	3-1/8	2-5/8	2-5/8	3-1/8	3-1/8	2-5/8	3-1/8	3-1/8	3-5/8	2-5/8	3-1/8	3-5/8	4-1/8	7/8	7/8	7/8	1-1/8
210,000	2-1/8	2-5/8	3-1/8	3-1/8	2-5/8	2-5/8	3-1/8	3-5/8	2-5/8	3-1/8	3-5/8	3-5/8	3-1/8	3-5/8	4-1/8	4-1/8	7/8	7/8	7/8	1-1/8
240,000	2-5/8	2-5/8	3-1/8	3-1/8	2-5/8	3-1/8	3-5/8	3-5/8	2-5/8	3-1/8	3-5/8	4-1/8	3-1/8	3-5/8	4-1/8	5-1/8	7/8	7/8	1-1/8	1-1/8
300,000	2-5/8	3-1/8	3-1/8	3-5/8	2-5/8	3-1/8	3-5/8	4-1/8	3-1/8	3-5/8	4-1/8	4-1/8	3-5/8	3-5/8	5-1/8	5-1/8	7/8	7/8	1-1/8	1-1/8
360,000	2-5/8	3-1/8	3-5/8	3-5/8	3-1/8	3-5/8	4-1/8	4-1/8	3-1/8	3-5/8	4-1/8	5-1/8	3-5/8	4-1/8	5-1/8	5-1/8	7/8	1-1/8	1-1/8	1-1/8
480,000	3-1/8	3-5/8	4-1/8	4-1/8	3-1/8	3-5/8	4-1/8	5-1/8	3-5/8	4-1/8	5-1/8	5-1/8	4-1/8	5-1/8	5-1/8	6-1/8	7/8	1-1/8	1-3/8	1-3/8
600,000	3-1/8	3-5/8	4 -1/8	5-1/8	3-5/8	4-1/8	5-1/8	5-1/8	4-1/8	5-1/8	5-1/8	6-1/8	4-1/8	5-1/8	6-1/8	6-1/8	1-1/8	1-1/8	1-3/8	1-3/8

*** NOTES:**

1. Sizes that are highlighted indicate maximum suction line sizes that should be used for risers. Riser size should not exceed horizontal size. Properly placed suction traps must also be used for adequate oil return. All sizes shown are for O.D. Type L copper tubing.
2. Suction line sizes selected at pressure drop equivalent to 2˚F. Reduce estimate of system capacity accordingly.
3. Recommended liquid line size may increase with reverse cycle hot gas systems.
4. If system load drops below 40% of design, consideration to installing double suction risers should be made.

Table 8. Recommended Line Sizes for R-448A/R-449A*

Capacity BTUH	Suction Line Size												Maximum Suction Line Riser Size						
	Suction Temperature												R-448A/R-449A Suction Temperature						
	+40˚F Equivalent Lengths				+20˚F Equivalent Lengths				+10˚F Equivalent Lengths										
	25'	50'	100'	150'	25'	50'	100'	150'	25'	50'	100'	150'	+40	+20	+10	-10	-20	-30	-40
1,000	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	1/2	1/2
3,000	3/8	3/8	1/2	1/2	3/8	3/8	1/2	1/2	3/8	1/2	1/2	5/8	3/8	3/8	1/2	1/2	1/2	1/2	5/8
4,000	3/8	1/2	1/2	1/2	3/8	1/2	1/2	5/8	1/2	1/2	5/8	5/8	3/8	1/2	1/2	1/2	5/8	5/8	5/8
6,000	1/2	1/2	1/2	5/8	1/2	1/2	5/8	7/8	1/2	1/2	5/8	7/8	1/2	1/2	1/2	1/2	5/8	5/8	7/8
9,000	1/2	5/8	5/8	5/8	5/8	5/8	7/8	7/8	5/8	5/8	7/8	7/8	1/2	5/8	5/8	7/8	7/8	7/8	7/8
12,000	1/2	5/8	5/8	7/8	5/8	7/8	7/8	7/8	5/8	7/8	7/8	7/8	1/2	7/8	7/8	7/8	7/8	1-1/8	1-1/8
15,000	5/8	5/8	7/8	7/8	5/8	7/8	7/8	7/8	7/8	7/8	7/8	1-1/8	5/8	7/8	7/8	7/8	7/8	1-1/8	1-1/8
18,000	5/8	7/8	7/8	7/8	7/8	7/8	7/8	1-1/8	7/8	7/8	1-1/8	1-1/8	5/8	7/8	7/8	1-1/8	1-1/8	1-1/8	1-1/8
24,000	5/8	7/8	7/8	7/8	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-1/8	5/8	1-1/8	1-1/8	1-1/8	1-1/8	1-3/8	1-3/8
30,000	5/8	7/8	7/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	7/8	1-1/8	1-1/8	1-1/8	1-1/8	1-3/8	1-3/8
36,000	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	7/8	1-1/8	1-1/8	1-1/8	1-1/8	1-3/8	1-3/8
42,000	7/8	7/8	1-1/8	1-1/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	7/8	1-3/8	1-3/8	1-3/8	1-3/8	1-5/8	1-5/8
48,000	7/8	1-1/8	1-1/8	1-1/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-5/8	7/8	1-3/8	1-3/8	1-3/8	1-3/8	1-5/8	1-5/8
54,000	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-3/8	1-3/8	1-3/8	1-5/8	1-5/8
60,000	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1-1/8	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8
66,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1-1/8	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8
72,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-5/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1-1/8	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8
78,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	1-5/8	1-3/8	1-5/8	1-5/8	1-5/8	1-5/8	2-1/8	2-1/8
84,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	1-3/8	1-5/8	1-5/8	1-5/8	1-5/8	2-1/8	2-1/8
90,000	1-1/8	1-3/8	1-3/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	1-3/8	1-5/8	1-5/8	2-1/8	1-3/8	1-5/8	1-5/8	1-5/8	2-1/8	2-1/8	2-1/8
120,000	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-5/8	2-1/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-1/8	2-1/8	2-5/8	2-5/8
150,000	1-3/8	1-3/8	1-5/8	2-1/8	1-5/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-1/8	2-1/8	2-5/8	2-5/8
180,000	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	1-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-5/8	2-5/8
210,000	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	2-5/8	2-5/8	2-5/8	3-1/8	3-1/8
240,000	1-5/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	2-5/8	2-5/8	2-5/8	3-1/8	3-1/8
300,000	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	2-5/8	3-1/8	2-5/8	2-5/8	2-5/8	2-5/8	2-5/8	3-1/8	3-1/8
360,000	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	3-1/8	2-1/8	2-5/8	2-5/8	3-1/8	2-5/8	2-5/8	3-1/8	3-1/8	3-1/8	3-5/8	3-5/8
480,000	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	3-1/8	3-1/8	2-5/8	2-5/8	2-5/8	3-5/8	3-1/8	3-1/8	3-5/8	3-5/8	3-5/8	4-1/8	4-1/8
600,000	2-1/8	2-5/8	2-5/8	3-1/8	2-5/8	2-5/8	3-1/8	3-5/8	2-5/8	2-5/8	3-1/8	3-5/8	3-1/8	3-5/8	3-5/8	3-5/8	3-5/8	4-1/8	4-1/8

*** NOTES:**

1. Sizes that are highlighted indicate maximum suction line sizes that should be used for risers. Riser size should not exceed horizontal size. Properly placed suction traps must also be used for adequate oil return. All sizes shown are for O.D. Type L copper tubing.
2. Suction line sizes selected at pressure drop equivalent to 2˚F. Reduce estimate of system capacity accordingly.
3. Recommended liquid line size may increase with reverse cycle hot gas systems.
4. If system load drops below 40% of design, consideration to installing double suction risers should be made.

Table 8a. Recommended Line Sizes for R-448A/R-449A* (cont.)

Capacity BTUH	Suction Line Size																Liquid Line Size			
	Suction Temperature																Receiver to Expansion Valve Equivalent Lengths			
	-10˚F Equivalent Lengths				-20˚F Equivalent Lengths				-30˚F Equivalent Lengths				-40˚F Equivalent Lengths							
	25'	50'	100'	150'	25'	50'	100'	150'	25'	50'	100'	150'	25'	50'	100'	150'	25'	50'	100'	150'
1,000	3/8	3/8	1/2	1/2	3/8	3/8	1/2	1/2	3/8	3/8	1/2	1/2	3/8	1/2	1/2	5/8	3/8	3/8	3/8	3/8
3,000	1/2	1/2	5/8	5/8	1/2	1/2	5/8	7/8	1/2	1/2	5/8	7/8	1/2	1/2	5/8	7/8	3/8	3/8	3/8	3/8
4,000	1/2	5/8	5/8	7/8	1/2	5/8	7/8	7/8	5/8	5/8	7/8	7/8	1/2	5/8	7/8	7/8	3/8	3/8	3/8	3/8
6,000	1/2	5/8	7/8	7/8	5/8	5/8	7/8	7/8	5/8	5/8	7/8	7/8	5/8	5/8	7/8	7/8	3/8	3/8	3/8	3/8
9,000	5/8	7/8	7/8	7/8	5/8	7/8	7/8	1-1/8	5/8	7/8	7/8	1-1/8	5/8	7/8	7/8	1-1/8	3/8	3/8	3/8	3/8
12,000	7/8	7/8	7/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	7/8	1-1/8	1-1/8	3/8	3/8	3/8	3/8
15,000	7/8	7/8	1-1/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	7/8	1-1/8	1-1/8	3/8	3/8	3/8	3/8
18,000	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	7/8	1-1/8	1-1/8	1-3/8	7/8	1-1/8	1-1/8	1-3/8	3/8	3/8	3/8	1/2
24,000	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	3/8	3/8	1/2	1/2
30,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	3/8	3/8	1/2	1/2
36,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	3/8	1/2	1/2	1/2
42,000	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-3/8	1-5/8	3/8	1/2	1/2	1/2
48,000	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-3/8	1-5/8	1/2	1/2	1/2	1/2
54,000	1-3/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	1-5/8	1/2	1/2	1/2	5/8
60,000	1-3/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	1-5/8	1/2	1/2	5/8	5/8
66,000	1-3/8	1-5/8	1-5/8	1-5/8	1-3/8	1-5/8	1-5/8	1-5/8	1-3/8	1-5/8	1-5/8	1-5/8	1-3/8	1-5/8	1-5/8	1-5/8	1/2	1/2	5/8	5/8
72,000	1-3/8	1-5/8	1-5/8	1-5/8	1-3/8	1-5/8	1-5/8	1-5/8	1-3/8	1-5/8	1-5/8	1-5/8	1-3/8	1-5/8	1-5/8	1-5/8	1/2	1/2	5/8	5/8
78,000	1-3/8	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8	2-1/8	1-5/8	1-5/8	1-5/8	2-1/8	1-5/8	1-5/8	1-5/8	2-1/8	1/2	1/2	5/8	5/8
84,000	1-3/8	1-5/8	1-5/8	2-1/8	1-5/8	1-5/8	2-1/8	2-1/8	1-5/8	1-5/8	2-1/8	2-1/8	1-5/8	1-5/8	2-1/8	2-1/8	1/2	5/8	5/8	5/8
90,000	1-5/8	1-5/8	2-1/8	2-1/8	1-5/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-1/8	1-5/8	1-5/8	2-1/8	2-1/8	1/2	5/8	5/8	7/8
120,000	1-5/8	2-1/8	2-1/8	2-5/8	1-5/8	2-1/8	2-1/8	2-5/8	1-5/8	2-1/8	2-1/8	2-5/8	1-5/8	2-1/8	2-1/8	2-5/8	5/8	5/8	7/8	7/8
150,000	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	5/8	7/8	7/8	7/8
180,000	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	5/8	7/8	7/8	7/8
210,000	2-1/8	2-1/8	2-5/8	3-1/8	2-1/8	2-5/8	2-5/8	3-1/8	2-1/8	2-5/8	2-5/8	3-1/8	2-1/8	2-5/8	2-5/8	3-1/8	7/8	7/8	7/8	7/8
240,000	2-1/8	2-5/8	2-5/8	3-1/8	2-1/8	2-5/8	2-5/8	3-1/8	2-5/8	2-5/8	3-1/8	3-1/8	2-5/8	2-5/8	3-1/8	3-1/8	7/8	7/8	7/8	1-1/8
300,000	2-5/8	2-5/8	3-1/8	3-1/8	2-5/8	2-5/8	3-1/8	3-5/8	2-5/8	2-5/8	3-1/8	3-5/8	2-5/8	2-5/8	3-5/8	3-5/8	7/8	7/8	1-1/8	1-1/8
360,000	2-5/8	2-5/8	3-1/8	3-5/8	2-5/8	2-5/8	3-5/8	3-5/8	2-5/8	3-1/8	3-5/8	3-5/8	2-5/8	3-1/8	3-5/8	4-1/8	7/8	7/8	1-1/8	1-1/8
480,000	2-5/8	3-1/8	3-5/8	3-5/8	2-5/8	3-1/8	3-5/8	3-5/8	3-1/8	3-5/8	4-1/8	4-1/8	3-1/8	3-5/8	4-1/8	4-1/8	1-1/8	1-1/8	1-1/8	1-3/8
600,000	3-1/8	3-1/8	3-5/8	4-1/8	3-1/8	3-1/8	3-5/8	3-5/8	3-1/8	3-5/8	4-1/8	4-1/8	3-1/8	3-5/8	4-1/8	4-1/8	1-1/8	1-1/8	1-1/8	1-3/8

*** NOTES:**

1. Sizes that are highlighted indicate maximum suction line sizes that should be used for risers. Riser size should not exceed horizontal size. Properly placed suction traps must also be used for adequate oil return. All sizes shown are for O.D. Type L copper tubing.
2. Suction line sizes selected at pressure drop equivalent to 2˚F. Reduce estimate of system capacity accordingly.
3. Recommended liquid line size may increase with reverse cycle hot gas systems.
4. If system load drops below 40% of design, consideration to installing double suction risers should be made.

Table 9. Recommended Line Sizes for R-454A

Capacity BTUH	Suction Line Size												Maximum suction line riser size						
	Suction Temperature												Suction Temperature						
	+40˚F Equivalent Lengths				+20˚F Equivalent Lengths				+10˚F Equivalent Lengths										
	25'	50'	100'	150'	25'	50'	100'	150'	25'	50'	100'	150'	+40	+20	+10	-10	-20	-30	-40
1,000	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	1/2
3,000	3/8	3/8	3/8	3/8	3/8	3/8	3/8	1/2	3/8	3/8	1/2	1/2	3/8	3/8	1/2	1/2	1/2	5/8	5/8
4,000	3/8	3/8	3/8	1/2	3/8	3/8	1/2	1/2	3/8	3/8	1/2	1/2	3/8	1/2	1/2	1/2	5/8	5/8	7/8
6,000	3/8	1/2	1/2	1/2	3/8	1/2	1/2	5/8	1/2	1/2	1/2	5/8	1/2	1/2	1/2	5/8	7/8	7/8	7/8
9,000	1/2	1/2	5/8	5/8	1/2	1/2	5/8	5/8	1/2	1/2	5/8	5/8	1/2	5/8	5/8	7/8	7/8	7/8	1-1/8
12,000	1/2	1/2	5/8	5/8	1/2	5/8	5/8	7/8	1/2	5/8	7/8	7/8	5/8	5/8	7/8	7/8	7/8	1-1/8	1-1/8
15,000	1/2	5/8	5/8	7/8	5/8	5/8	7/8	7/8	5/8	5/8	7/8	7/8	5/8	7/8	7/8	7/8	1-1/8	1-1/8	1-1/8
18,000	5/8	5/8	7/8	7/8	5/8	5/8	7/8	7/8	5/8	7/8	7/8	7/8	5/8	7/8	7/8	1-1/8	1-1/8	1-1/8	1-3/8
24,000	5/8	7/8	7/8	7/8	5/8	7/8	7/8	7/8	7/8	7/8	7/8	1-1/8	7/8	7/8	7/8	1-1/8	1-1/8	1-3/8	1-3/8
30,000	5/8	7/8	7/8	7/8	7/8	7/8	7/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	7/8	1-1/8	1-1/8	1-3/8	1-3/8	1-5/8
36,000	7/8	7/8	7/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	1-3/8	1-5/8	1-5/8
42,000	7/8	7/8	1-1/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	1-3/8	1-5/8	1-5/8
48,000	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-1/8	1-3/8	1-5/8	1-5/8	2-1/8
54,000	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-5/8	1-5/8	2-1/8
60,000	7/8	1-1/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-5/8	1-5/8	2-1/8	2-1/8
66,000	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1-5/8	2-1/8	2-1/8
72,000	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	2-1/8	2-1/8	2-1/8
78,000	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-5/8	1-1/8	1-3/8	1-3/8	1-5/8	2-1/8	2-1/8	2-1/8
84,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	2-1/8	2-1/8	2-1/8
90,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-3/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	2-1/8	2-1/8	2-5/8
120,000	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	1-3/8	1-5/8	1-5/8	2-1/8	2-1/8	2-5/8	2-5/8
150,000	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	1-5/8	2-1/8	2-1/8	2-5/8	2-5/8	3-1/8
180,000	1-3/8	1-3/8	1-5/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-5/8	3-1/8
210,000	1-3/8	1-5/8	2-1/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	2-5/8	3-1/8	3-1/8
240,000	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-1/8	2-5/8	3-1/8	3-1/8	3-5/8
300,000	1-5/8	2-1/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	3-1/8	3-1/8	3-5/8	3-5/8
360,000	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	2-5/8	3-1/8	3-1/8	3-5/8	4-1/8
480,000	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	2-5/8	3-1/8	2-1/8	2-5/8	2-5/8	3-1/8	2-5/8	2-5/8	3-1/8	3-5/8	3-5/8	4-1/8	5-1/8
600,000	2-1/8	2-5/8	2-5/8	3-1/8	2-1/8	2-5/8	3-1/8	3-1/8	2-5/8	2-5/8	3-1/8	3-1/8	2-5/8	3-1/8	3-1/8	3-5/8	4-1/8	5-1/8	5-1/8

*** NOTES:**

1. Sizes that are highlighted indicate maximum suction line sizes that should be used for risers. Riser size should not exceed horizontal size. Properly placed suction traps must also be used for adequate oil return.
   All sizes shown are for O.D. Type L copper tubing.
2. Suction line sizes selected at pressure drop equivalent to 2˚F. Reduce estimate of system capacity accordingly.
3. Recommended liquid line size may increase with reverse cycle hot gas systems.
4. If system load drops below 40% of design, consideration to installing double suction risers should be made.

Table 9a. Recommended Line Sizes for R-454A (cont.)

Capacity BTUH	Suction Line Size																Liquid Line Size			
	Suction Temperature																Receiver to Expansion Valve Equivalent Lengths			
	-10˚F Equivalent Lengths				-20˚F Equivalent Lengths				-30˚F Equivalent Lengths				-40˚F Equivalent Lengths							
	25'	50'	100'	150'	25'	50'	100'	150'	25'	50'	100'	150'	25'	50'	100'	150'	25'	50'	100'	150'
1,000	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8
3,000	3/8	3/8	1/2	1/2	3/8	1/2	1/2	1/2	3/8	1/2	1/2	1/2	3/8	1/2	1/2	5/8	3/8	3/8	3/8	3/8
4,000	3/8	1/2	1/2	1/2	3/8	1/2	1/2	5/8	1/2	1/2	5/8	5/8	1/2	1/2	5/8	5/8	3/8	3/8	3/8	3/8
6,000	1/2	1/2	5/8	5/8	1/2	1/2	5/8	5/8	1/2	5/8	5/8	7/8	1/2	5/8	7/8	7/8	3/8	3/8	3/8	3/8
9,000	1/2	5/8	5/8	7/8	5/8	5/8	7/8	7/8	5/8	5/8	7/8	7/8	5/8	7/8	7/8	7/8	3/8	3/8	3/8	3/8
12,000	5/8	5/8	7/8	7/8	5/8	7/8	7/8	7/8	5/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	3/8	3/8	3/8	3/8
15,000	5/8	7/8	7/8	7/8	5/8	7/8	7/8	7/8	7/8	7/8	7/8	1-1/8	7/8	7/8	1-1/8	1-1/8	3/8	3/8	3/8	1/2
18,000	5/8	7/8	7/8	7/8	7/8	7/8	7/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	7/8	1-1/8	1-1/8	3/8	3/8	1/2	1/2
24,000	7/8	7/8	1-1/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	3/8	3/8	1/2	1/2
30,000	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	3/8	1/2	1/2	1/2
36,000	7/8	1-1/8	1-1/8	1-3/8	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1/2	1/2	1/2	1/2
42,000	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1/2	1/2	1/2	5/8
48,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-3/8	1-5/8	1/2	1/2	5/8	5/8
54,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-5/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1/2	1/2	5/8	5/8
60,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	1-5/8	1/2	1/2	5/8	5/8
66,000	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	1/2	1/2	5/8	5/8
72,000	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	1-3/8	1-5/8	1-5/8	2-1/8	1/2	5/8	5/8	5/8
78,000	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1/2	5/8	5/8	5/8
84,000	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	1-3/8	1-5/8	1-5/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1/2	5/8	5/8	7/8
90,000	1-3/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	5/8	5/8	5/8	7/8
120,000	1-3/8	1-5/8	2-1/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-1/8	5/8	5/8	7/8	7/8
150,000	1-5/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	1-5/8	2-1/8	2-1/8	2-5/8	5/8	7/8	7/8	7/8
180,000	1-5/8	2-1/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	5/8	7/8	7/8	1-1/8
210,000	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	7/8	7/8	1-1/8	1-1/8
240,000	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	2-5/8	3-1/8	7/8	7/8	1-1/8	1-1/8
300,000	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	2-5/8	3-1/8	2-1/8	2-5/8	2-5/8	3-1/8	2-1/8	2-5/8	3-1/8	3-1/8	7/8	1-1/8	1-1/8	1-1/8
360,000	2-1/8	2-5/8	2-5/8	3-1/8	2-1/8	2-5/8	3-1/8	3-1/8	2-5/8	2-5/8	3-1/8	3-1/8	2-5/8	2-5/8	3-1/8	3-5/8	1-1/8	1-1/8	1-1/8	1-3/8
480,000	2-5/8	2-5/8	3-1/8	3-1/8	2-5/8	2-5/8	3-1/8	3-5/8	2-5/8	3-1/8	3-5/8	3-5/8	2-5/8	3-1/8	3-5/8	3-5/8	1-1/8	1-1/8	1-3/8	1-3/8
600,000	2-5/8	3-1/8	3-1/8	3-5/8	2-5/8	3-1/8	3-5/8	3-5/8	2-5/8	3-1/8	3-5/8	4-1/8	3-1/8	3-5/8	4-1/8	4-1/8	1-1/8	1-3/8	1-3/8	1-3/8

*** NOTES:**

1. Sizes that are highlighted indicate maximum suction line sizes that should be used for risers. Riser size should not exceed horizontal size. Properly placed suction traps must also be used for adequate oil return. All sizes shown are for O.D. Type L copper tubing.
2. Suction line sizes selected at pressure drop equivalent to 2˚F. Reduce estimate of system capacity accordingly.
3. Recommended liquid line size may increase with reverse cycle hot gas systems.
4. If system load drops below 40% of design, consideration to installing double suction risers should be made.

Table 10. Recommended Line Sizes for R-454C

Capacity BTUH	Suction Line Size												Maximum suction line riser size						
	Suction Temperature												Suction Temperature						
	+40˚F Equivalent Lengths				+20˚F Equivalent Lengths				+10˚F Equivalent Lengths										
	25'	50'	100'	150'	25'	50'	100'	150'	25'	50'	100'	150'	+40	+20	+10	-10	-20	-30	-40
1,000	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	1/2	1/2
3,000	3/8	3/8	3/8	1/2	3/8	3/8	1/2	1/2	3/8	3/8	1/2	1/2	3/8	1/2	1/2	1/2	5/8	5/8	7/8
4,000	3/8	3/8	1/2	1/2	3/8	3/8	1/2	1/2	3/8	1/2	1/2	1/2	1/2	1/2	1/2	5/8	5/8	7/8	7/8
6,000	3/8	1/2	1/2	1/2	1/2	1/2	1/2	5/8	1/2	1/2	5/8	5/8	1/2	5/8	5/8	7/8	7/8	7/8	7/8
9,000	1/2	1/2	5/8	5/8	1/2	5/8	5/8	5/8	1/2	5/8	5/8	7/8	5/8	5/8	7/8	7/8	7/8	1-1/8	1-1/8
12,000	1/2	5/8	5/8	7/8	1/2	5/8	7/8	7/8	5/8	5/8	7/8	7/8	5/8	7/8	7/8	7/8	1-1/8	1-1/8	1-1/8
15,000	1/2	5/8	7/8	7/8	5/8	5/8	7/8	7/8	5/8	7/8	7/8	7/8	5/8	7/8	7/8	1-1/8	1-1/8	1-1/8	1-3/8
18,000	5/8	5/8	7/8	7/8	5/8	7/8	7/8	7/8	5/8	7/8	7/8	7/8	7/8	7/8	7/8	1-1/8	1-1/8	1-3/8	1-3/8
24,000	5/8	7/8	7/8	7/8	7/8	7/8	7/8	1-1/8	7/8	7/8	7/8	1-1/8	7/8	7/8	1-1/8	1-1/8	1-3/8	1-3/8	1-5/8
30,000	7/8	7/8	7/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	1-3/8	1-5/8	1-5/8
36,000	7/8	7/8	1-1/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-1/8	1-1/8	1-1/8	1-1/8	1-3/8	1-5/8	1-5/8	2-1/8
42,000	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-5/8	2-1/8	2-1/8
48,000	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	7/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1-5/8	2-1/8	2-1/8
54,000	7/8	1-1/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	2-1/8	2-1/8	2-1/8
60,000	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	2-1/8	2-1/8	2-1/8
66,000	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-5/8	2-1/8	2-1/8	2-1/8	2-5/8
72,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	2-1/8	2-1/8	2-5/8
78,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-3/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	2-1/8	2-1/8	2-5/8
84,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-5/8	1-5/8	2-1/8	2-1/8	2-5/8	2-5/8
90,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-5/8	1-5/8	2-1/8	2-1/8	2-5/8	2-5/8
120,000	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	1-3/8	1-5/8	1-5/8	2-1/8	1-5/8	1-5/8	2-1/8	2-1/8	2-5/8	2-5/8	3-1/8
150,000	1-3/8	1-3/8	1-5/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	2-5/8	3-1/8	3-1/8
180,000	1-3/8	1-5/8	2-1/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-1/8	2-1/8	2-1/8	2-1/8	2-5/8	3-1/8	3-1/8	3-5/8
210,000	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	3-1/8	3-1/8	3-5/8
240,000	1-5/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	3-1/8	3-1/8	3-5/8	3-5/8
300,000	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	2-5/8	3-1/8	3-5/8	3-5/8	4-1/8
360,000	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	2-5/8	3-1/8	2-5/8	2-5/8	3-1/8	3-5/8	3-5/8	4-1/8	5-1/8
480,000	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	2-5/8	3-1/8	2-1/8	2-5/8	3-1/8	3-1/8	2-5/8	3-1/8	3-1/8	3-5/8	4-1/8	5-1/8	5-1/8
600,000	2-1/8	2-5/8	2-5/8	3-1/8	2-5/8	2-5/8	3-1/8	3-1/8	2-5/8	2-5/8	3-1/8	3-5/8	2-5/8	3-1/8	3-5/8	4-1/8	5-1/8	5-1/8	6-1/8

*** NOTES:**

1. Sizes that are highlighted indicate maximum suction line sizes that should be used for risers. Riser size should not exceed horizontal size. Properly placed suction traps must also be used for adequate oil return. All sizes shown are for O.D. Type L copper tubing.
2. Suction line sizes selected at pressure drop equivalent to 2˚F. Reduce estimate of system capacity accordingly.
3. Recommended liquid line size may increase with reverse cycle hot gas systems.
4. If system load drops below 40% of design, consideration to installing double suction risers should be made.

Table 10a. Recommended Line Sizes for R-454C (cont.)

Capacity BTUH	Suction Line Size																Liquid Line Size			
	Suction Temperature																Receiver to Expansion Valve Equivalent Lengths			
	-10˚F Equivalent Lengths				-20˚F Equivalent Lengths				-30˚F Equivalent Lengths				-40˚F Equivalent Lengths							
	25'	50'	100'	150'	25'	50'	100'	150'	25'	50'	100'	150'	25'	50'	100'	150'	25'	50'	100'	150'
1,000	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8
3,000	3/8	1/2	1/2	1/2	3/8	1/2	1/2	5/8	1/2	1/2	1/2	5/8	1/2	1/2	5/8	5/8	3/8	3/8	3/8	3/8
4,000	1/2	1/2	1/2	5/8	1/2	1/2	5/8	5/8	1/2	1/2	5/8	5/8	1/2	5/8	5/8	5/8	3/8	3/8	3/8	3/8
6,000	1/2	5/8	5/8	5/8	1/2	5/8	5/8	7/8	1/2	5/8	7/8	7/8	5/8	5/8	7/8	7/8	3/8	3/8	3/8	3/8
9,000	5/8	5/8	7/8	7/8	5/8	5/8	7/8	7/8	5/8	7/8	7/8	7/8	5/8	7/8	7/8	7/8	3/8	3/8	3/8	3/8
12,000	5/8	7/8	7/8	7/8	5/8	7/8	7/8	7/8	7/8	7/8	7/8	1-1/8	7/8	7/8	7/8	1-1/8	3/8	3/8	3/8	3/8
15,000	5/8	7/8	7/8	7/8	7/8	7/8	7/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	7/8	1-1/8	1-1/8	3/8	3/8	3/8	1/2
18,000	7/8	7/8	7/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-1/8	3/8	3/8	1/2	1/2
24,000	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	7/8	1-1/8	1-3/8	1-3/8	3/8	3/8	1/2	1/2
30,000	7/8	1-1/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	3/8	1/2	1/2	1/2
36,000	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1/2	1/2	1/2	1/2
42,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1/2	1/2	1/2	5/8
48,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	1-5/8	1/2	1/2	5/8	5/8
54,000	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	1/2	1/2	5/8	5/8
60,000	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	1-3/8	1-5/8	1-5/8	2-1/8	1/2	1/2	5/8	5/8
66,000	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1/2	1/2	5/8	5/8
72,000	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	1-3/8	1-5/8	1-5/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1/2	5/8	5/8	5/8
78,000	1-3/8	1-3/8	1-5/8	1-5/8	1-3/8	1-5/8	1-5/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	5/8	5/8	5/8	5/8
84,000	1-3/8	1-3/8	1-5/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	1-5/8	2-1/8	2-1/8	5/8	5/8	5/8	7/8
90,000	1-3/8	1-5/8	1-5/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-1/8	5/8	5/8	7/8	7/8
120,000	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	1-5/8	2-1/8	2-1/8	2-5/8	5/8	5/8	7/8	7/8
150,000	1-5/8	2-1/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	5/8	7/8	7/8	7/8
180,000	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	2-5/8	3-1/8	7/8	7/8	7/8	1-1/8
210,000	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	2-5/8	3-1/8	2-1/8	2-5/8	2-5/8	3-1/8	7/8	7/8	1-1/8	1-1/8
240,000	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	2-5/8	3-1/8	2-1/8	2-5/8	2-5/8	3-1/8	2-1/8	2-5/8	3-1/8	3-1/8	7/8	7/8	1-1/8	1-1/8
300,000	2-1/8	2-5/8	2-5/8	3-1/8	2-1/8	2-5/8	3-1/8	3-1/8	2-5/8	2-5/8	3-1/8	3-1/8	2-5/8	2-5/8	3-1/8	3-5/8	7/8	1-1/8	1-1/8	1-3/8
360,000	2-1/8	2-5/8	3-1/8	3-1/8	2-5/8	2-5/8	3-1/8	3-1/8	2-5/8	3-1/8	3-1/8	3-5/8	2-5/8	3-1/8	3-5/8	3-5/8	1-1/8	1-1/8	1-3/8	1-3/8
480,000	2-5/8	3-1/8	3-1/8	3-5/8	2-5/8	3-1/8	3-5/8	3-5/8	2-5/8	3-1/8	3-5/8	4-1/8	3-1/8	3-5/8	3-5/8	4-1/8	1-1/8	1-1/8	1-3/8	1-3/8
600,000	2-5/8	3-1/8	3-5/8	3-5/8	3-1/8	3-1/8	3-5/8	4-1/8	3-1/8	3-5/8	4-1/8	4-1/8	3-1/8	3-5/8	4-1/8	5-1/8	1-1/8	1-3/8	1-3/8	1-5/8

*** NOTES:**

1. Sizes that are highlighted indicate maximum suction line sizes that should be used for risers. Riser size should not exceed horizontal size. Properly placed suction traps must also be used for adequate oil return. All sizes shown are for O.D. Type L copper tubing.
2. Suction line sizes selected at pressure drop equivalent to 2˚F. Reduce estimate of system capacity accordingly.
3. Recommended liquid line size may increase with reverse cycle hot gas systems.
4. If system load drops below 40% of design, consideration to installing double suction risers should be made.

Table 11. Recommended Line Sizes for R-455A

Capacity BTUH	Suction Line Size												Maximum suction line riser size						
	Suction Temperature												Suction Temperature						
	+40˚F Equivalent Lengths				+20˚F Equivalent Lengths				+10˚F Equivalent Lengths										
	25'	50'	100'	150'	25'	50'	100'	150'	25'	50'	100'	150'	+40	+20	+10	-10	-20	-30	-40
1,000	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	1/2	1/2
3,000	3/8	3/8	3/8	3/8	3/8	3/8	1/2	1/2	3/8	3/8	1/2	1/2	3/8	1/2	1/2	1/2	5/8	5/8	7/8
4,000	3/8	3/8	1/2	1/2	3/8	3/8	1/2	1/2	3/8	1/2	1/2	1/2	1/2	1/2	1/2	5/8	5/8	7/8	7/8
6,000	3/8	1/2	1/2	1/2	1/2	1/2	1/2	5/8	1/2	1/2	5/8	5/8	1/2	1/2	5/8	7/8	7/8	7/8	7/8
9,000	1/2	1/2	5/8	5/8	1/2	1/2	5/8	5/8	1/2	5/8	5/8	7/8	5/8	5/8	5/8	7/8	7/8	1-1/8	1-1/8
12,000	1/2	5/8	5/8	7/8	1/2	5/8	7/8	7/8	5/8	5/8	7/8	7/8	5/8	7/8	7/8	7/8	1-1/8	1-1/8	1-1/8
15,000	1/2	5/8	7/8	7/8	5/8	5/8	7/8	7/8	5/8	7/8	7/8	7/8	5/8	7/8	7/8	1-1/8	1-1/8	1-1/8	1-3/8
18,000	5/8	5/8	7/8	7/8	5/8	7/8	7/8	7/8	5/8	7/8	7/8	7/8	7/8	7/8	7/8	1-1/8	1-1/8	1-3/8	1-3/8
24,000	5/8	7/8	7/8	7/8	7/8	7/8	7/8	1-1/8	7/8	7/8	7/8	1-1/8	7/8	7/8	1-1/8	1-1/8	1-3/8	1-3/8	1-5/8
30,000	7/8	7/8	7/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	1-3/8	1-5/8	1-5/8
36,000	7/8	7/8	7/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	1-3/8	1-5/8	2-1/8
42,000	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-5/8	1-5/8	2-1/8
48,000	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-5/8	1-5/8	2-1/8	2-1/8
54,000	7/8	1-1/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1-5/8	2-1/8	2-1/8
60,000	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	2-1/8	2-1/8	2-1/8
66,000	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	2-1/8	2-1/8	2-1/8
72,000	7/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	2-1/8	2-1/8	2-1/8	2-5/8
78,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-5/8	1-1/8	1-3/8	1-3/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	2-1/8	2-1/8	2-5/8
84,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	2-1/8	2-1/8	2-5/8
90,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-5/8	1-5/8	2-1/8	2-1/8	2-5/8	2-5/8
120,000	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	1-3/8	1-5/8	1-5/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	2-5/8	2-5/8	3-1/8
150,000	1-3/8	1-3/8	1-5/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	2-5/8	3-1/8	3-1/8
180,000	1-3/8	1-5/8	1-5/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	2-5/8	3-1/8	3-1/8
210,000	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-1/8	2-1/8	2-1/8	2-1/8	2-5/8	3-1/8	3-1/8	3-5/8
240,000	1-5/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	3-1/8	3-5/8	3-5/8
300,000	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	2-5/8	3-1/8	3-5/8	3-5/8	4-1/8
360,000	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	2-5/8	3-1/8	3-5/8	4-1/8	4-1/8
480,000	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	2-5/8	3-1/8	2-1/8	2-5/8	3-1/8	3-1/8	2-5/8	3-1/8	3-1/8	3-5/8	4-1/8	5-1/8	5-1/8
600,000	2-1/8	2-5/8	2-5/8	3-1/8	2-5/8	2-5/8	3-1/8	3-1/8	2-5/8	2-5/8	3-1/8	3-5/8	2-5/8	3-1/8	3-5/8	4-1/8	4-1/8	5-1/8	5-1/8

*** NOTES:**

1. Sizes that are highlighted indicate maximum suction line sizes that should be used for risers. Riser size should not exceed horizontal size. Properly placed suction traps must also be used for adequate oil return. All sizes shown are for O.D. Type L copper tubing.
2. Suction line sizes selected at pressure drop equivalent to 2˚F. Reduce estimate of system capacity accordingly.
3. Recommended liquid line size may increase with reverse cycle hot gas systems.
4. If system load drops below 40% of design, consideration to installing double suction risers should be made.

Table 11a. Recommended Line Sizes for R-455A (cont.)

Capacity BTUH	Suction Line Size																Liquid Line Size			
	Suction Temperature																Receiver to Expansion Valve Equivalent Lengths			
	-10˚F Equivalent Lengths				-20˚F Equivalent Lengths				-30˚F Equivalent Lengths				-40˚F Equivalent Lengths							
	25'	50'	100'	150'	25'	50'	100'	150'	25'	50'	100'	150'	25'	50'	100'	150'	25'	50'	100'	150'
1,000	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8
3,000	3/8	1/2	1/2	1/2	3/8	1/2	1/2	1/2	3/8	1/2	1/2	5/8	1/2	1/2	5/8	5/8	3/8	3/8	3/8	3/8
4,000	3/8	1/2	1/2	5/8	1/2	1/2	5/8	5/8	1/2	1/2	5/8	5/8	1/2	5/8	5/8	5/8	3/8	3/8	3/8	3/8
6,000	1/2	1/2	5/8	5/8	1/2	5/8	5/8	7/8	1/2	5/8	7/8	7/8	5/8	5/8	7/8	7/8	3/8	3/8	3/8	3/8
9,000	5/8	5/8	7/8	7/8	5/8	5/8	7/8	7/8	5/8	7/8	7/8	7/8	5/8	7/8	7/8	7/8	3/8	3/8	3/8	3/8
12,000	5/8	7/8	7/8	7/8	5/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	1-1/8	3/8	3/8	3/8	3/8
15,000	5/8	7/8	7/8	7/8	7/8	7/8	7/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	7/8	1-1/8	1-1/8	3/8	3/8	3/8	1/2
18,000	7/8	7/8	7/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-1/8	3/8	3/8	1/2	1/2
24,000	7/8	7/8	1-1/8	1-1/8	7/8	7/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	7/8	1-1/8	1-1/8	1-3/8	3/8	3/8	1/2	1/2
30,000	7/8	1-1/8	1-1/8	1-1/8	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	3/8	1/2	1/2	1/2
36,000	7/8	1-1/8	1-1/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1/2	1/2	1/2	1/2
42,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1/2	1/2	1/2	5/8
48,000	1-1/8	1-1/8	1-3/8	1-3/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1/2	1/2	5/8	5/8
54,000	1-1/8	1-1/8	1-3/8	1-5/8	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	1/2	1/2	5/8	5/8
60,000	1-1/8	1-3/8	1-3/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	1-5/8	1-3/8	1-5/8	1-5/8	2-1/8	1/2	1/2	5/8	5/8
66,000	1-1/8	1-3/8	1-5/8	1-5/8	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1/2	1/2	5/8	5/8
72,000	1-1/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	1-3/8	1-5/8	1-5/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1/2	5/8	5/8	5/8
78,000	1-3/8	1-3/8	1-5/8	1-5/8	1-3/8	1-3/8	1-5/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	5/8	5/8	5/8	5/8
84,000	1-3/8	1-3/8	1-5/8	2-1/8	1-3/8	1-5/8	1-5/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	1-5/8	2-1/8	2-1/8	5/8	5/8	5/8	7/8
90,000	1-3/8	1-3/8	1-5/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	1-5/8	2-1/8	2-1/8	5/8	5/8	7/8	7/8
120,000	1-3/8	1-5/8	2-1/8	2-1/8	1-5/8	1-5/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	5/8	5/8	7/8	7/8
150,000	1-5/8	2-1/8	2-1/8	2-1/8	1-5/8	2-1/8	2-1/8	2-5/8	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	5/8	7/8	7/8	7/8
180,000	1-5/8	2-1/8	2-1/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	7/8	7/8	7/8	1-1/8
210,000	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	2-5/8	3-1/8	7/8	7/8	1-1/8	1-1/8
240,000	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-1/8	2-5/8	2-5/8	2-1/8	2-5/8	2-5/8	3-1/8	2-1/8	2-5/8	3-1/8	3-1/8	7/8	7/8	1-1/8	1-1/8
300,000	2-1/8	2-5/8	2-5/8	3-1/8	2-1/8	2-5/8	3-1/8	3-1/8	2-1/8	2-5/8	3-1/8	3-1/8	2-5/8	2-5/8	3-1/8	3-5/8	7/8	1-1/8	1-1/8	1-3/8
360,000	2-1/8	2-5/8	3-1/8	3-1/8	2-5/8	2-5/8	3-1/8	3-1/8	2-5/8	2-5/8	3-1/8	3-5/8	2-5/8	3-1/8	3-5/8	3-5/8	1-1/8	1-1/8	1-1/8	1-3/8
480,000	2-5/8	2-5/8	3-1/8	3-5/8	2-5/8	3-1/8	3-5/8	3-5/8	2-5/8	3-1/8	3-5/8	3-5/8	3-1/8	3-1/8	3-5/8	4-1/8	1-1/8	1-1/8	1-3/8	1-3/8
600,000	2-5/8	3-1/8	3-5/8	3-5/8	3-1/8	3-1/8	3-5/8	4-1/8	3-1/8	3-5/8	4-1/8	4-1/8	3-1/8	3-5/8	4-1/8	5-1/8	1-1/8	1-3/8	1-3/8	1-5/8

*** NOTES:**

1. Sizes that are highlighted indicate maximum suction line sizes that should be used for risers. Riser size should not exceed horizontal size. Properly placed suction traps must also be used for adequate oil return. All sizes shown are for O.D. Type L copper tubing.
2. Suction line sizes selected at pressure drop equivalent to 2˚F. Reduce estimate of system capacity accordingly.
3. Recommended liquid line size may increase with reverse cycle hot gas systems.
4. If system load drops below 40% of design, consideration to installing double suction risers should be made.

Check System Pressure

Safe discharge of dry air or nitrogen holding charge is required prior to installing field mounted components, such as filter driers, or making piping connections. Slowly open the suction and liquid service valves to release holding charge. System piping varies from system to system. Check system pressure at all pressure accessible points with a refrigeration gauge to confirm and ensure safe working conditions.

WARNING:

Inspect and check system pressure first and safely discharge dry air or nitrogen holding charge before charging the system with refrigerant.

DO NOT OPEN THE SYSTEM OR REMOVE SCHRADER CORE(S) WITHOUT CHECKING THE PRESSURE FIRST!

DO NOT USE PORTS ON THE FILTER DRIERS FOR RELEASING THE SYSTEM HOLDING CHARGE.

Evacuation and Leak Detection

Due to the smaller molecule size of HFC's, they will tend to leak more readily than CFC's. Consequently, it is of the utmost importance that proper system evacuation and leak detection procedures be employed.

1. After completing all necessary piping connections and joints, ensure that all service valves are open
2. Pressurize the system to 150 psig with dry nitrogen (or dry CO2). Do not use compressed air or oxygen for pressure or leak testing.
3. After a period of 12 hours, verify that the system is still pressurized to 150 psig
4. Vent the nitrogen pressure from the system
5. Attach an appropriate vacuum pull and pull a vacuum of 1,500 microns
6. Break the vacuum using dry nitrogen (or dry CO2) until pressure rises above 0 psig
7. Pull a second vacuum on the system, this time achieving at least a 500 micron vacuum
8. Isolate the vacuum pump from the system and recheck the vacuum after one hour
9. If the vacuum has not increased more than 50 microns, break the vacuum with the system specified refrigerant and carry out the system charging procedure
10. Repeat this operation a second time.
11. Open the compressor service valves and evacuate the entire system to 500 microns absolute pressure. Raise the pressure to 2 psig with the refrigerant and remove the vacuum pump.

NOTE:

Refrigerant used during evacuation cannot be vented. Reclaim all used refrigerant. EPA regulations are constantly being updated. Ensure your procedure follows correct regulations.

WARNING:

HFC-134a has been shown to be combustible at pressure as low as 5.5 psig (at 350˚F) when mixed with air at concentrations more than 60% air by volume.

At lower temperature, higher pressures are required to support combustion. Therefore, air should never be mixed with HFC-134a for leak detection.

Evacuation

CAUTION:

Do not use the refrigeration compressor to evacuate the system. Do not start the compressor while it is in a vacuum.

A deep vacuum pump should be connected to both the low and high side of the system with large diameter, short length copper tubing or high vacuum hoses (1/4" ID minimum). A shut off valve between the vacuum pump and the system must be provided to allow the pressure to be checked during and after evacuation. Do not turn off the vacuum pump when connected to an evacuated system without first closing the shut off valve. A vacuum gauge capable of displaying pressure in microns must be connected to the system downstream of the vacuum pump shut off valve.

NOTE:

Refrigerant used during evacuation cannot be vented. Reclaim all used refrigerant. EPA regulations are constantly being updated. Ensure your procedure follows correct regulations.

Refrigerant Charging Instructions

1. A liquid line filter drier should be installed between the refrigerant supply container and the system access point. This extra drier will ensure that all refrigerant supplied to the system is clean and dry.
2. When initially charging a system that is in a vacuum, liquid refrigerant may be added directly into the receiver tank.
3. Refrigerant charge must be calculated per installation. Refrigerant charge includes receiver volume (15-20% for liquid seal), condenser volume, refrigerant line volumes, and any additional seasonal charge that may be required. The specific values for charge amounts can be found in the equipment technical bulletins (receiver volume), and weight of refrigerant table (Table 2 of this manual). Do not add more refrigerant than prescribed.

Charging Procedure

NOTE:

Head Pressure Systems- If you are charging the system by using a clear sight glass as an indication of proper charge the following must be considered. Check the condensing temperature. It must be above 105°F. If not, it will be necessary to reduce the amount of air going through the condenser from fans still running. Simply reduce the effective condenser face area to raise the discharge pressure above the equivalent 105°F condensing temperature and then proceed to charge to clear the sight glass. Adjust evaporator superheat at this time. Return to full condenser face area and allow the system to balance.

1) Connect charging hoses to the receiver and compressor suction line
2) Ensure compressor service valves are open, if equipped
3) Ensure service and isolation valves are open, where applicable
4) Weigh the refrigerant container before charging

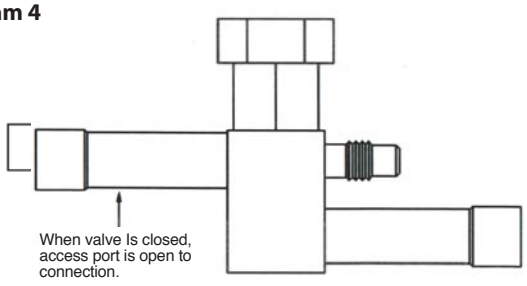
   4a) An accurate record of the weight of refrigerant put into the system must be kept
5) Charge liquid refrigerant into the receiver
6) When refrigerant flow slows, and system pressure exceeds the cut in pressure of the low pressure switch, energize the compressor
7) Add refrigerant to the compressor suction line, as a vapor only, until bubbles are no longer present in the sight glass. Be careful not to exceed charge required.

   7a) A system operating above the design target room temperature, with operation at or near design temperature is required to complete charging procedure.
8) Allow the system to operate and reach the temperature setpoint
9) Verify that the sight glass remains free of bubbles when the room is at or near set point temperature.

NOTE:

Refrigerant used during evacuation cannot be vented. Reclaim all used refrigerant. EPA regulations are constantly being updated. Ensure your procedure follows correct regulations. Refrigerant used during evacuation cannot be vented. Reclaim all used refrigerant. EPA regulations are constantly being updated. Ensure your procedure follows correct regulations.

Diagram 4



Corrective Maintenence Leaking

Within the last several years, manufacturers have developed fluorescent dye leak detection systems for use with refrigerants. These dyes mix with the lubricant and, when exposed to an ultraviolet light "fluoresce," indicates the location of leaks. For units with Copeland compressors it has been tested and approved with the Rigid "System Safe" dye and found it to be compatible with the compressor materials in systems.

Refrigerant Flooding Charge

The following tables summarize the coil charges for High Side products.
Winter charge assumes a 90% flooded coil; Summer charge assumes a 10% flooded coil (For units without subcooling circuit).
Winter charge assumes a 90% flooded coil; Summer charge assumes a 25% flooded coil (For units with subcooling circuit).

These charges are approximate and should not be used as absolute rules for charging the system.
To determine total system charge, the liquid line and unit cooler must be taken into account.

Table 12. HTS 1/2 - 6hp (Microchannel Coil)

R-404A (lbs)							
Group	Model	Microchannel			RTPF (Round Tube Plate Fin)		
		Summer	Winter	Additional	Summer	Winter	Additional
Hermetic Low Temp	#C*0011L^ACH	0.5	1.5	1.0	1.5	3.5	2.0
	#C*0014L^ACH	0.5	1.5	1.0	1.5	3.5	2.0
	#C*0019L^ACH	1.0	2.0	1.0	2.5	5.5	3.0
	#C*0025L^ACH	1.0	2.0	1.0	2.5	5.5	3.0
	#C*0031L^ACH	1.0	2.0	1.0	2.5	5.5	3.0
Hermetic Medium Temp	#C*0015M^ACH	1.0	2.0	1.0	2.5	5.5	3.0
	#C*0020M^ACH	1.0	2.0	1.0	2.5	5.5	3.0
	#C*0025M^ACH	1.0	2.0	1.0	2.5	5.5	3.0
	#C*0030M^ACH	1.5	3.5	2.0	4.5	10.0	5.5
	#C*0032M^ACH	1.5	3.5	2.0	4.5	10.0	5.5
Scroll Low Temp	#C*0006L^AC§	0.5	1.5	1	1.5	3.5	2
	#C*0008L^AC§	0.5	1.5	1	1.5	3.5	2
	#C*0010L^AC§	0.5	1.5	1	1.5	3.5	2
	#C*0022L^AC§	0.5	1.5	1	1.5	3.5	2
	#C*0025L^AC§	1	2	1	2.5	5.5	3
	#C*0030L^AC§	1	2	1	2.5	5.5	3
	#C*0035L^AC§	1	2	1	2.5	5.5	3
	#C*0045L^AC§	1.5	3.5	2	4.5	10	5.5
	#C*0055L^AC§	1.5	3.5	2	4.5	10	5.5
	#C*0060L^AC§	1.5	3.5	2	4.5	10	5.5
Scroll Medium Temp	#C*0005M^AC§	0.5	1.5	1	1.5	3.5	2
	#C*0008M^AC§	0.5	1.5	1	1.5	3.5	2
	#C*0009M^AC§	0.5	1.5	1	1.5	3.5	2
	#C*0010M^A‡§	0.5	1.5	1	1.5	3.5	2
	#C*0015M^A‡§	1	2	1	2.5	5.5	3
	#C*0020M^A‡§	1	2	1	2.5	5.5	3
	#C*0025M^A‡§	1	2	1	2.5	5.5	3
	#C*0030M^A‡§	1.5	3.5	2	4.5	10	5.5
	#C*0035M^A‡§	1.5	3.5	2	4.5	10	5.5
	#C*0045M^A‡§	1.5	3.5	2	4.5	10	5.5
	#C*0050M^A‡§	1.5	3.5	2	4.5	10	5.5
	#C*0055M^A‡§	1.5	3.5	2	4	10	6
	#C*0060M^A‡§	1.5	3.5	2	4	10	6

NOTES:

B = Bohn, L = Larkin, C = Climate Control, H = Chandler
* H = Outdoor (A1 & A2L Refrigerants) N = Indoor (A1 Refrigerants Only)
^ B = 208-230/1/60, C = 208-230/3/60, D = 460/3/60
‡ C = Copeland, L = LG
§ Z = A1 Refrigerants, Y = A2L Refrigerants (Outdoor Use Only)
Charge amounts are estimated operating values only and do not take into account actual system configurations.
Charge amounts should be adjusted to match actual system requirements.
For refrigerant charges with other refrigerants, use the correction factor table.

Correction Factor Table

	Refrigerant	Charge Factor
A1	R-404A	1
	R-407A	1.1
	R-407C	1.09
	R-407F	1.07
	R-448A	1.05
	R-449A	1.05
	R-507A	1
A2L	R-454A	0.98
	R-454C	1
	R-455A	0.99

Table 13. HCU 1 and 2-Fan standard chassis 3-22hp

R-404A (lbs)								
Group	A1 Model	RTPF (Round Tube Plate Fin)			A2L Model	RTPF (Round Tube Plate Fin)		
		Summer	Winter	Additional		Summer	Winter	Additional
Discus Medium Temp	#CH0050M@ACD	5.0	11.5	6.5	#CH0050M@ACE	5.0	11.5	6.5
	#CH0051M@ACD	5.0	11.5	6.5	#CH0051M@ACE	5.0	11.5	6.5
	#CH0075M@ACD	7.0	15.5	8.5	#CH0075M@ACE	7.0	15.5	8.5
	#CH0076M@ACD	6.5	15.0	8.5	#CH0076M@ACE	6.5	15.0	8.5
	#CH0080M@ACD	8.5	19.5	11.0	#CH0080M@ACE	9.0	20.0	11.0
	#CH0100M@ACD	8.5	19.5	11.0	#CH0100M@ACE	9.0	20.0	11.0
	#CH0120M@ACD	8.5	19.5	11.0	#CH0120M@ACE	8.5	20.0	11.5
	#CH0150M@ACD	12.0	27.0	15.0	#CH0150M@ACE	12.0	27.5	15.5
Discus Low Temp	#CH0030L@ACD	3.5	7.5	4.0	#CH0030L@ACE	3.5	7.5	4.0
	#CH0040L@ACD	3.5	7.5	4.0	#CH0040L@ACE	3.5	7.5	4.0
	#CH0060L@ACD	3.5	7.5	4.0	#CH0060L@ACE	3.5	7.5	4.0
	#CH0061L@ACD	3.5	7.5	4.0	#CH0061L@ACE	3.5	7.5	4.0
	#CH0075L@ACD	5.0	11.5	6.5	#CH0075L@ACE	5.0	11.5	6.5
	#CH0090L@ACD	6.5	15.0	8.5	#CH0090L@ACE	9.0	20.0	11.0
	#CH0100L@ACD	6.5	15.0	8.5	#CH0100L@ACE	9.0	20.0	11.0
	#CH0120L@ACD	12.5	27.5	15.0	#CH0120L@ACE	12.5	27.5	15.0
	#CH0150L@ACD	12.5	27.5	15.0	#CH0150L@ACE	12.5	27.5	15.0
	#CH0220L@ACD	12.0	27.5	15.5	#CH0220L@ACE	12.5	27.5	15.0
Scroll Medium Temp	#CH0065M@ACZ	7.0	15.5	8.5	#CH0065M@ACY	7.0	15.5	8.5
	#CH0070M@ACZ	6.5	15.0	8.5	#CH0070M@ACY	6.5	15.0	8.5
	#CH0075M@ACZ	9.0	19.5	10.5	#CH0075M@ACY	9.0	20.0	11.0
	#CH0086M@ACZ	8.5	19.5	11.0	#CH0086M@ACY	9.0	20.0	11.0
	#CH0100M@ACZ	8.5	19.5	11.0	#CH0100M@ACY	8.5	20.0	11.5
	#CH0141M@ACZ	12.0	27.0	15.0	#CH0141M@ACY	12.0	27.5	15.5
Scroll Low Temp	#CH0075L@ACZ	5.5	11.5	6.0	#CH0075L@ACY	9.5	20.0	10.5
	#CH0100L@ACZ	7.0	15.5	8.5	#CH0100L@ACY	9.5	20.0	10.5
	#CH0130L@ACZ	9.0	19.5	10.5	#CH0130L@ACY	13.0	27.5	14.5
	#CH0150L@ACZ	9.0	19.5	10.5	#CH0150L@ACY	12.5	27.5	15.0
Bitzer Medium Temp	#CH0056M@ABX	6.5	15.0	8.5	#CH0056M@ABV	6.5	15.0	8.5
	#CH0076M@ABX	9.0	19.5	10.5	#CH0076M@ABV	9.0	20.0	11.0
	#CH0091M@ABX	12.0	27.5	15.5	#CH0091M@ABV	12.0	27.5	15.5
	#CH0101M@ABX	12.0	27.5	15.5	#CH0101M@ABV	12.0	27.5	15.5
Bitzer Low Temp	#CH0041L@ABX	3.5	7.5	4.0	#CH0041L@ABV	5.5	11.5	6.0
	#CH0056L@ABX	5.5	11.5	6.0	#CH0056L@ABV	5.5	11.5	6.0
	#CH0061L@ABX	4.5	10.0	5.5	#CH0061L@ABV	7.0	15.0	8.0
	#CH0062L@ABX	4.5	10.0	5.5	#CH0062L@ABV	7.0	15.0	8.0
	#CH0076L@ABX	6.5	15.0	8.5	#CH0076L@ABV	6.5	15.0	8.5
	#CH0101L@ABX	9.0	20.0	11.0	#CH0101L@ABV	9.5	20.0	10.5
	#CH0121L@ABX	12.5	27.5	15.0	#CH0121L@ABV	12.5	27.5	15.0
	#CH0131L@ABX	12.5	27.5	15.0	#CH0131L@ABV	12.5	27.5	15.0

NOTES:

B = Bohn, L = Larkin, C = Climate Control, H = Chandler

@ C = 208-230/3/60, D = 460/3/60, K = 230/3/60, E = 575/3/60

Charge amounts are estimated operating values only and do not take into account actual system configurations.

Charge amounts should be adjusted to match actual system requirements.

For refrigerant charges with other refrigerants, use the correction factor table.

Correction Factor Table

	Refrigerant	Charge Factor
A1	R-404A	1
	R-407A	1.1
	R-407C	1.09
	R-407F	1.07
	R-448A	1.05
	R-449A	1.05
	R-507A	1
A2L	R-454A	0.98
	R-454C	1
	R-455A	0.99

Table 14. (D)VCU 12-110hp

R-404A (lbs)								
Group	A1 Model	RTPF (Round Tube Plate Fin)			A2L Model	RTPF (Round Tube Plate Fin)		
		Summer	Winter	Additional		Summer	Winter	Additional
Discus Medium Temp	#CV0150M^ACD	20.5	44.5	24	#CV0150M^ACE	20.5	44.5	24
	#CV0200M^ACD	20	44.5	24.5	#CV0200M^ACE	20	44.5	24.5
	#CV0250M^ACD	20	44.5	24.5	#CV0250M^ACE	20	44.5	24.5
	#CV0260M^ACD	15	33.5	18.5	#CV0260M^ACE	20	44	24
	#CV0300M^ACD	20	44.5	24.5	#CV0300M^ACE	36	77	41
	#CV0350M^ACD	21.5	49.5	28	#CV0350M^ACE	52	115	63
	#CV0400M^ACD	38	86	48	#CV0400M^ACE	51	115	64
	#CV0500M^ACD	68	152	84	#CV0500M^ACE	68	152	84
	#CV0151M^ACD	15	33.5	18.5	#CV0151M^ACE	15	33.5	18.5
	#CV0201M^ACD	14.5	33.5	19	#CV0201M^ACE	14.5	33.5	19
	#CV0251M^ACD	22	49.5	27.5	#CV0251M^ACE	22	49.5	27.5
	#CV0301M^ACD	29.5	66.5	37	#CV0301M^ACE	39	86	47
	#CV0351M^ACD	68	153	85	#CV0351M^ACE	68	153	85
	#CV0401M^ACD	67	152.5	85.5	#CV0401M^ACE	67	152.5	85.5
Discus Low Temp	#CV0120L^ACD	21	44.5	23.5	#CV0120L^ACE	21	44.5	23.5
	#CV0150L^ACD	21	44.5	23.5	#CV0150L^ACE	21	44.5	23.5
	#CV0220L^ACD	20.5	44.5	24	#CV0220L^ACE	20.5	44.5	24
	#CV0270L^ACD	20.5	44.5	24	#CV0270L^ACE	38	77	39
	#CV0300L^ACD	20	44.5	24.5	#CV0300L^ACE	20	44.5	24.5
	#CV0400L^ACD	54	115	61	#CV0400L^ACE	54	115	61
Bitzer Medium Temp	#CV0150M^ABX	15	33.5	18.5	#CV0150M^ABV	15	33.5	18.5
	#CV0200M^ABX	15	33.5	18.5	#CV0200M^ABV	15	33.5	18.5
	#CV0220M^ABX	20	44.5	24.5	#CV0220M^ABV	20	44.5	24.5
	#CV0250M^ABX	20	44.5	24.5	#CV0250M^ABV	20	44.5	24.5
	#CV0300M^ABX	39	86	47	#CV0300M^ABV	39	86	47
	#CV0330M^ABX	38.5	86	47.5	#CV0330M^ABV	38.5	86	47.5
	#CV0350M^ABX	52	115	63	#CV0350M^ABV	52	115	63
	#CV0400M^ABX	68.5	153	84.5	#CV0400M^ABV	68.5	153	84.5
	#CV0500M^ABX	68	152.5	84.5	#CV0500M^ABV	68	152.5	84.5
Bitzer Low Temp	#CV0130L^ABX	15.5	33.5	18	#CV0130L^ABV	15.5	33.5	18
	#CV0150L^ABX	15.5	33.5	18	#CV0150L^ABV	21	45	24
	#CV0200L^ABX	21	44.5	23.5	#CV0200L^ABV	21	44.5	23.5
	#CV0220L^ABX	15.5	33.5	18	#CV0220L^ABV	21	45	24
	#CV0250L^ABX	21	44.5	23.5	#CV0250L^ABV	21	44.5	23.5
	#CV0300L^ABX	20.5	44.5	24	#CV0300L^ABV	20.5	44.5	24
	#CV0400L^ABX	54.5	115	60.5	#CV0400L^ABV	54.5	115	60.5
Mohave Medium Temp	#CM0077M^ACX	28.5	58	29.5	#CM0077M^ACE	28.5	58	29.5
	#CM0078M^ACX	28	58	30	#CM0078M^ACE	28	58	30
	#CM0082M^ACX	38	77.5	39.5	#CM0082M^ACE	38	77.5	39.5
	#CM0102M^ACX	37.5	77.5	40	#CM0102M^ACE	37.5	77.5	40
	#CM0122M^ACX	37	77.5	40.5	#CM0122M^ACE	37	77.5	40.5
	#CM0152M^ACX	27	58	31	#CM0152M^ACE	27	58	31
	#CM0202M^ACX	36	77	41	#CM0202M^ACE	36	77	41
	#CM0252M^ACX	39.5	86.5	47	#CM0252M^ACE	39.5	86.5	47
	#CM0302M^ACX	39	86	47	#CM0302M^ACE	39	86	47
	#CM0352M^ACX	52	115	63	#CM0352M^ACE	52	115	63
	#CM0402M^ACX	52	114.5	62.5	#CM0402M^ACE	69	152	83
Mohave Low Temp	#CM0062L^ACX	30	58	28	#CM0062L^ACE	20	39	19
	#CM0077L^ACX	39.5	77.5	38	#CM0077L^ACE	19	39	20
	#CM0092L^ACX	39	77.5	38.5	#CM0092L^ACE	39	77.5	38.5
	#CM0102L^ACX	38.5	77.5	39	#CM0102L^ACE	38.5	77.5	39
	#CM0122L^ACX	38.5	77.5	39	#CM0122L^ACE	38.5	77.5	39
	#CM0152L^ACX	38	77.5	39.5	#CM0152L^ACE	38	77.5	39.5
	#CM0222L^ACX	37.5	77.5	40	#CM0222L^ACE	37.5	77.5	40
	#CM0272L^ACX	37	77.5	40.5	#CM0272L^ACE	37	77.5	40.5
	#CM0302L^ACX	36.5	77.5	41	#CM0302L^ACE	36.5	77.5	41

Table 15. (D)VCU 12-110hp (cont.)

R-404A (lbs)								
Group	A1 Model	RTPF (Round Tube Plate Fin)			A2L Model	RTPF (Round Tube Plate Fin)		
		Summer	Winter	Additional		Summer	Winter	Additional
Dual-Discus Medium Temp	#CD0300M^ACD	41	89	48	#CD0300M^ACE	41	89	48
	#CD0400M^ACD	40.5	89	48.5	#CD0400M^ACE	40.5	89	48.5
	#CD0500M^ACD	40	89	49	#CD0500M^ACE	40	89	49
	#CD0520M^ACD	29.5	66.5	37	#CD0520M^ACE	40	89	49
	#CD0600M^ACD	39.5	89	49.5	#CD0600M^ACE	72	154	82
	#CD0700M^ACD	43	99.5	56.5	#CD0700M^ACE	105	229	124
	#CD0800M^ACD	76	172	96	#CD0800M^ACE	102	229	127
Dual-Discus Low Temp	#CD0240L^ACD	42	89.5	47.5	#CD0240L^ACE	42	89.5	47.5
	#CD0300L^ACD	41.5	89.5	48	#CD0300L^ACE	41.5	89.5	48
	#CD0440L^ACD	41	89.5	48.5	#CD0440L^ACE	41	89.5	48.5
	#CD0540L^ACD	41	89	48	#CD0540L^ACE	75	154	79
	#CD0600L^ACD	40	89.5	49.5	#CD0600L^ACV	40	89.5	49.5
Dual-Bitzer Medium Temp	#CD0300M^ABX	32.5	67	34.5	#CD0300M^ABV	32.5	67	34.5
	#CD0400M^ABX	32	67	35	#CD0400M^ABV	32	67	35
	#CD0440M^ABX	43.5	89.5	46	#CD0440M^ABV	43.5	89.5	46
	#CD0500M^ABX	43	89.5	46.5	#CD0500M^ABV	40	89	49
	#CD0600M^ABX	83.5	173	89.5	#CD0600M^ABV	78	172	94
	#CD0660M^ABX	83.5	173	89.5	#CD0660M^ABV	78	172	94
	#CD0700M^ABX	112	231	119	#CD0700M^ABV	105	229	124
	#CD0800M^ABX	147	306.5	159.5	#CD0800M^ABV	138	305	167
	#CD1100M^ABX	145	306.5	161.5	#CD1100M^ABV	137	305	168
Dual-Bitzer Low Temp	#CD0260L^ABX	31.5	67	35.5	#CD0260L^ABV	31.5	67	35.5
	#CD0300L^ABX	31	67	36	#CD0300L^ABV	42	89	47
	#CD0400L^ABX	41.5	89.5	48	#CD0400L^ABV	41.5	89.5	48
	#CD0440L^ABX	31	67	36	#CD0440L^ABV	42	89	47
	#CD0500L^ABX	41.5	89	47.5	#CD0500L^ABV	41.5	89	47.5
	#CD0600L^ABX	41	89	48	#CD0600L^ABV	41	89	48
	#CD0800L^ABX	109	230.5	121.5	#CD0800L^ABV	109	230.5	121.5
Dual-Discus Medium Temp	#CD0520M^ACD, Alternate (non-EC)	29.5	66.5	37	#CD0520M^ACE	40	89	49
	#CD0600M^ACD, Alternate (non-EC)	39.5	89	49.5	#CD0600M^ACE	72	154	82
	#CD0700M^ACD, Alternate (non-EC)	43	99.5	56.5	#CD0700M^ACE	105	229	124
	#CD0800M^ACD, Alternate (non-EC)	76	172	96	#CD0800M^ACE	102	229	127

NOTES:

B = Bohn, L = Larkin, C = Climate Control, H = Chandler

^ C = 208-230/3/60, D = 460/3/60, K = 230/3/60, E = 575/3/60

Charge amounts are esitmated operating values only and do not take into account actual system configurations.

Charge amounts should be adjusted to match actual system requirements.

For refrigerant charges with other refrigerants, use the correction factor table.

Correction Factor Table

	Refrigerant	Charge Factor
A1	R-404A	1
	R-407A	1.1
	R-407C	1.09
	R-407F	1.07
	R-448A	1.05
	R-449A	1.05
	R-507A	1
A2L	R-454A	0.98
	R-454C	1
	R-455A	0.99

Field Wiring

WARNING:
All wiring must be done in accordance with applicable codes and local ordinances.

The field wiring should enter the areas as provided on the unit. The wiring diagram for each unit is located on the inside of the electrical panel door. All field wiring should be done in a professional manner and in accordance with all governing codes. Before operating unit, double check all wiring connections, including the factory terminals. Factory connections can vibrate loose during shipment.

1. The serial data tag on the unit is marked with the electrical characteristic for wiring the unit.
2. Consult the wiring diagram in the unit cooler and in the condensing unit for proper connections.
3. Wire type should be of copper conductor only and of the proper size to handle the connected load.
4. The unit must be grounded.
5. For multiple evaporator systems, the defrost termination controls should be wired in series. Follow the wiring diagrams for multiple evaporator systems carefully. This will assure complete defrost of all evaporators in the system.
6. Multiple evaporator systems should operate off of one thermostat.
7. If a remote defrost timer is to be used, the timer should be located outside the refrigerated space.
8. For air cooled condensers, due to multiple low amp motors, we recommend using time delay fuse protection instead of circuit breakers.

Check Out and Start Up

After the installation has been completed, the following points should be covered before the system is placed in operation:

a) Check all electrical and refrigerant connections. Be sure they are all tight.

b) Observe compressor oil level before start-up. The oil level should be at or slightly above the 1/4 level of the sight glass. Refer to compressor manufacturers OEM instruction and operations manual for oil specifications before adding.

c) Remove upper mounting nuts on the compressor feet. Remove the shipping spacers. Install the neoprene washers onto the compressor feet. Replace the upper mounting nuts and washers, allowing 1/16" space between the mounting nut and the neoprene spacer.

d) Check high and low pressure controls, pressure regulating valves, oil pressure safety controls, and all other safety controls, and adjust if necessary.

e) Check the room thermostat for normal operation and adjust.

f) Wiring diagrams, instruction bulletins, etc. attached to the condensing units should be read and filed for future reference.

g) All fan motors should be checked for proper rotation. Fan motor mounts should be carefully checked for tightness and proper alignment.

h) Electric and hot gas evaporator fan motors should be temporarily wired for continuous operation until the room temperature has stabilized.

i) Observe system pressures during charging and initial operation. Do not add oil while the system is short of refrigerant unless oil level is dangerously low.

j) Continue charging until system has sufficient refrigerant for proper operation. Do not overcharge. Remember that bubbles in a sight glass may be caused by a restriction as well as a shortage of refrigerant.

Check Out and Start Up (Cont.)

k) Do not leave unit unattended until the system has reached normal operating conditions and the oil charge has been properly adjusted to maintain the oil level between 1/4 and bottom of the sight glass.

l) Make sure all Schrader valve caps are in place and tight.

m) Make sure ALL service valves are properly back-seated and tighten valve packing if necessary.

Start Up A2L Units

1. When using flammable refrigerant, read through "A2L Check out and Start up" section
2. Per ASHRAE Standard 15, fusible plugs and pressure relief valves may need to be externally piped when using flammable refrigerants
3. Units using A2L refrigerants must be installed in accordance with UL 60335-2-89 and ASHRAE 15 standards
4. Red tags when removed, must be replaced on all service locations per UL 60335-2-89 clause 7.1ADV.5
5. Customer connection tube protections when removed, must be re-installed to protect the piping within the unit.
6. Coil Grille when removed, must be re-installed to protect the piping within the unit.

CAUTION:
Extreme care must be taken in starting compressors for the first time after system charging. At this time, all of the oil and most of the refrigerant might be in the compressor creating a condition which could cause compressor damage due to slugging. Activating the crankcase heater for 24 hours prior to start-up is required. If no crankcase heater is present, then directing a 500 watt heat lamp or other safe heat source on the lower shell of the compressor for approximately thirty minutes will be beneficial in eliminating this condition which might never reoccur.

WARNING:
3 phase Scroll compressor is directional dependent. If noisy, change phase of input wiring.

Operational Check Out

After the system has been charged and has operated for at least two hours at normal operating conditions without any indication of malfunction, it should be allowed to operate overnight on automatic controls. Then a thorough recheck of the entire system operation should be made as follows:

a) Check compressor discharge and suction pressures. If not within system design limits, determine why and take corrective action.

b) Check liquid line sight glass and expansion valve operation. If there are indications that more refrigerant is required, leak test all connections and system components and repair any leaks before adding refrigerant.

c) Observe oil level in compressor crankcase sight glass. Add oil as necessary to bring level to bottom 1/4 of the sight glass.

d) Thermostatic expansion valves must be checked for proper superheat settings. Feeler bulbs must be in positive contact with the suction line and should be insulated. Valves set at high superheat will lower refrigeration capacity. Low superheat promotes liquid slugging and compressor bearing washout.

e) Using suitable instruments, carefully check line voltage and amperage at the compressor terminals. Voltage must be within 10% of that indicated on the condensing unit nameplate. If high or low voltage is indicated, notify the power company. If amperage draw is excessive, immediately determine the cause and take corrective action. On three phase motor compressors, check to see that a balanced load is drawn by each phase.

f) The maximum approved settings for high pressure controls on our air cooled condensing equipment is 425 psig. On air cooled systems, check as follows:
Disconnect the fan motors or block the condenser inlet air. Watch high pressure gauge for cutout point. Recheck all safety and operating controls for proper operation and adjust if necessary.

g) Check defrost controls for initiation and termination settings, and length of defrost period. Set fail safe at length of defrost + 25%.

Example: 20 minute defrost + 5 minutes = 25 minute fail safe

h) Check drain pan for proper drainage.

i) Check winter head pressure controls for pressure setting.

j) Check crankcase heater operation if used.

k) Install instruction card and control system diagram for use of building manager or owner.

System Balancing - Compressor Superheat

IMPORTANT:

In order to obtain the maximum capacity from a system, and to ensure trouble-free operation, it is necessary to balance each and every system.

This is extremely important with any refrigeration system.

The critical value which must be checked is suction superheat.

Suction superheat should be checked **at the compressor** as follows:

1. Measure the suction pressure at the suction service valve of the compressor and determine the saturation temperature corresponding to this pressure from a "Temperature-Pressure" chart.
2. Measure the suction temperature of the suction line about one foot back from the compressor using an accurate thermometer.
3. Subtract the saturated temperature from the actual suction line temperature. The difference is superheat.

Too low a suction superheat can result in liquid being returned to the compressor. This will cause dilution of the oil and eventual failure of the bearings and rings or in the extreme case, valve failure.

Too high a suction superheat will result in excessive discharge temperatures which cause a break down of the oil and results in piston ring wear, piston and cylinder wall damage.

It should also be remembered that the system capacity decreases as the suction superheat increases. For maximum system capacity, suction superheat should be kept as low as is practical. We recommend that the superheat **at the semi-hermetic compressor** be between 20˚F and 30˚F, to meet compressor manufacture guidelines.

If adjustments to the suction superheat need to be made, the expansion valve at the evaporator should be adjusted.

NOTE:

Most adjustable controls have to be field adjusted to meet desired operation. This includes low pressure, high pressure, pressure fan cycling, adjustable dual valve head pressure systems and expansion valves. Exceptions are adjustable single valve head pressure valves which are pre-set.

Table 16. Recommended Low Pressure Control Settings for Outdoor Air Cooled Condensing Units

Minimum Expected Ambient Temperature	Cut-In PSIG		Box Set point Temperature	Cut-Out PSIG	
	R-404A/R-407A/ R-448A/R-454A/ R-454C	R407C/R455A		R-404A/R-407A/ R-448A/R-454A/ R-454C	R407C/R455A
50	30	25	50	5	5
40	30	25	40	5	5
30	30	25	30	5	5
20	30	25	20	5	5
10	30	25	10	5	5
0	20	15	0	5	5
-10*	15	10	-10	2	0
-20*	12	8	-20	1	0
-30*	8	5	-30	0	0

*Low Ambient Kit should be considered to assist compressor start-up.

(1) The standard preset low pressure switch used for pumpdown is set for 15 PSIG cut-in / 5 PSIG cut-out and is a good setting for most pumpdown systems

(2) ZB (A1) and YB (A2L) Scroll compressors should be set for 35 PSI cut-in / 17 PSI cut-out (R404A/R507) and 27 PSI cut-in / 9 PSI cut-out (R407A/R407C/R448A/ R454A/R454C/R455A)

(3) Models with ZB Scroll compressors may require a low ambient kit to start reliably at ambient temperatures below 20°F.

Minimum ambient or box temperature anticipated, high pressure control setting: R404-A, R-507, R-407A, R-407C, R-407F, R-448A, 400 PSI

General Sequence of Operation

Refrigeration Cycle

1. Power is supplied to the timer at terminals "1" and "N".
2. The fan delay and the defrost termination thermostat is closed in the fan delay position and open in the defrost termination position. The unit cooler fans run continuously.
3. The defrost heaters are off.
4. The room thermostat closes when the temperature rises above the desired setting.
5. The liquid line solenoid is energized and opens, which allows liquid refrigerant to flow through the unit cooler.
6. The low pressure control closes when the suction pressure rises above the cutin setting of the control.
7. On systems with oil pumps, the oil safety control is closed. If the net oil pressure is less than 9 PSIG for more than 120 seconds, the oil safety opens, thus breaking the circuit to the compressor contactor holding coil. The compressor will not operate. This control is reset manually and must be reset before the compressor can be restarted.
8. The compressor contactor closes. The compressor and condenser fan start simultaneously.
9. The room temperature gradually decreases to the desired temperature.
10. Once the desired temperature is reached, the thermostat opens and the liquid line solenoid closes, stopping refrigerant flow through the evaporator.
11. Suction pressure decreases and the compressor contactor opens when the pressure drops below the cutout setting on the low pressure control. The compressor and condenser fan stop running.
12. This cycle is repeated as many times as necessary to satisfy the room thermostat.
13. Frost starts to form on the evaporator coil and continues to form until the defrost cycle is initiated.

Defrost Cycle

1. The defrost cycle starts automatically by the timer at predetermined times. Typical settings are two to four defrost cycles per day for freezers. For heavier frost loads additional settings may be required.
2. Switch "2" to "4" opens in the timer which breaks the circuit to the room thermostat, liquid line solenoid, and evaporator fan motors, allowing the compressor to pump down and shut off. Simultaneously switch "1" to "3" closes in the timer allowing current to flow to one side of the defrost heater contactor. When the compressor shuts off, an auxiliary contact will send power to the contactor holding coil; thus, energizing the defrost heaters.
3. The heaters raise the temperature of the coil to 32˚F causing the frost to melt off the coil.
4. When the coil warms to 45˚F to 55˚F, the defrost termination thermostat closes, which allows current to the switching solenoid in the timer allowing the refrigeration cycle to begin again.
5. The evaporator heaters are off. If the termination thermostat fails to close, the fail-safe set on the timer will terminate defrost.
6. The low pressure control closes and the compressor will start.
7. When the coil temperature reaches 23˚F to 30˚F, the fan delay closes. This allows the current to flow to the fan motors. The fan motors start running.
8. The system will now operate in the refrigeration cycle until another defrost period is initiated by the timer.

Demand Cooling System Design

When Demand Cooling operates, it "diverts" refrigeration capacity in the form of injected saturated refrigerant from the evaporator to the compressor.

1. Compressor Return Gas Temperature: Suction lines should be well insulated to reduce suction line heat gain. Return gas superheat should be as low as possible consistent with safe compressor operation.

2. Condensing Temperatures: It is important when using R-407 A/C/F or R-448A/449A as a low temperature refrigerant that condensing temperatures be minimized to reduce compression ratios and compressor discharge temperature.

3. Suction Pressure: Evaporator design and system control settings should provide the maximum suction pressure consistent with the application in order to have as low a compression ratio as possible.

In most cases, with floating head systems where condensing temperatures are low during most of the year, Demand Cooling will operate primarily as a compressor protection control much as the oil failure control protects the compressor during periods of low oil pressure. Demand Cooling will be allowed to operate only during those periods when condensing temperatures and return gas temperatures are high or in periods where a system failure (such as an ice evaporator, an expansion valve which does not control superheat, blocked condenser, or a failed condenser fan) raises condensing temperatures or return gas temperatures to abnormally high levels or lowers suction pressure to abnormally low levels.

Operating Range

Demand Cooling is designed to protect the compressor from high discharge temperatures over the evaporating and condensing temperature ranges shown in Figure 12 at a maximum return gas temperature of 65˚F.

The Copeland Demand Cooling System

It is required for all single stage R-22, R-407A/C/F or R-448A/R-449-A applications with saturated suction temperatures below 0˚F.

The Demand Cooling module uses the signal of a discharge head temperature sensor to monitor discharge gas temperature. If a critical temperature is reached, the module energizes along life injection valve which meters a controlled amount of saturated refrigerant into the compressor suction cavity to cool the suction gas.

This process controls the discharge temperature to a safe level. If for some reason the discharge temperature rises above a preset maximum level, the Demand Cooling module will turn the compressor off (requiring a manual reset) and actuate its alarm contact. To minimize the amount of refrigerant which must be injected, the suction gas cooling process is performed after the gas has passed around and through the motor.

Copeland Demand Cooling for Discus L6 Models

Energy efficiency regulations drive continuous change in the availability of refrigerants to the marketplace. With the introduction of R-22 as a replacement for R-502, compressors began to experience internal discharge temperatures that exceed the safe operational limits for long term stability of refrigerant oil. In response to this, Demand Cooling was developed as a reliable method to keep discharge temperatures reduced to a safe level without inhibiting the operating limits of the compressor. With the phase out of R-22, the following refrigerants have become viable alternatives: R-407A/C/F and R-448A/R-449-A. All of these refrigerants require special attention to discharge temperature control. Also for this reason suction to liquid heat exchangers are not recommended unless they are necessary to prevent another potential problem.

Electric Defrost Troubleshooting

The electric defrost units are relatively simple and trouble-free in operation:

Timer

If the system does not go through its proper sequence , check timer operation through a defrost cycle. Check for loose wires or terminals. Before replacing timer, check other components.

Operation of Paragon Timer

To set time of day grasp knob which is in the center of the inner (fail-safe) dial and rotate it in a counter-clockwise direction. This will cause the outer (24 hour) dial to revolve. Line up the correct time of day on the outer dial with the time pointer. Do not try to set the time control by grasping the other (24 hour) dial. Place pins in the outer dial at the time of day that defrost is required.

Operation of Electronic Timer

To set the time, turn the minute hand clockwise until the time of day (and AM or PM) on the outer dial is aligned with the triangle marker on the inner dial. **Do not rotate minute hand counter-clockwise**. Move the white tab (tripper) on the outer dial outward at each desired initiation time. Each white tab (tripper) is a 15 minute interval and provides 15 minutes of defrost. For longer defrost duration, move additional tabs (following in time) from the initiation tab. For example, if a 45 minute defrost is to start at 7:00 AM, move the tabs outward that lie between 7:00 - 7:15, 7:15 - 7:30 and 7:30 - 7:45 on the AM side of the dial. The defrost will initiate at 7:00 AM and time terminate at 7:45 AM (if temperature termination does not occur first). For models with plastic cover on timer assembly; re-install cover after adjustment.

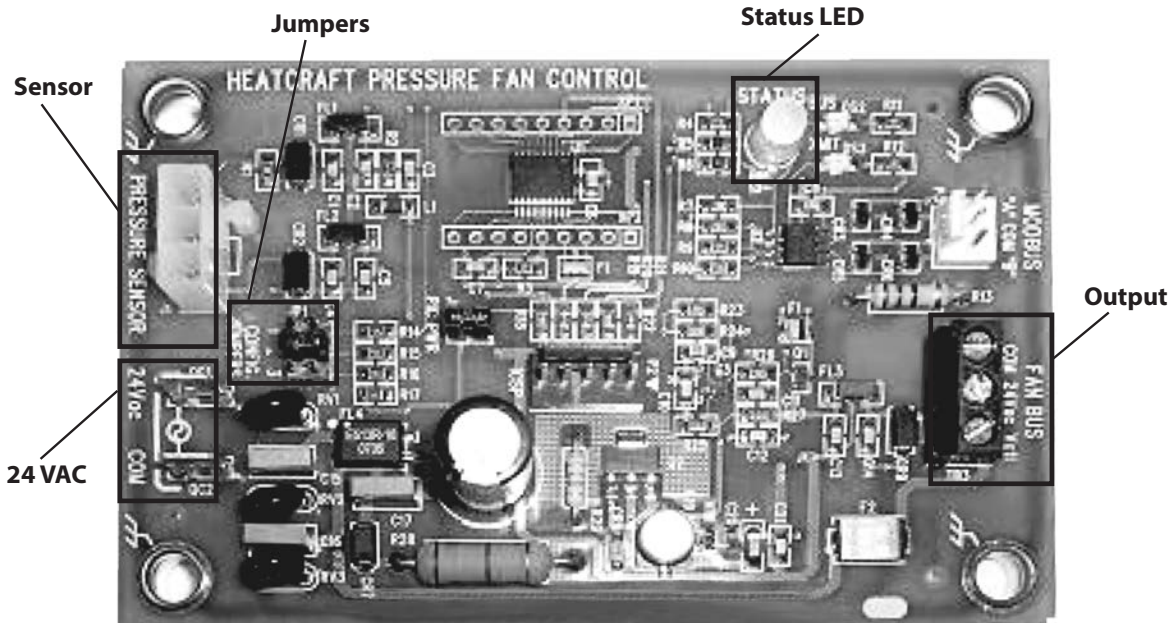
NOTE:

After correcting faulty condition it is essential that the coil and unit be free of ice before placing unit back on automatic operation.

NOTES:

1. Lockout relays or normally closed switch of auxiliary contact on the compressor contactor may be wired to defrost contactor. Its purpose is to prevent energizing of the defrost heaters until the compressor has pumped down and stopped, thus keeping power demand to a minimum.
2. If the control voltage is to remain energized for any period of time with the compressor disabled, remove the defrost clock pins to prevent the defrost heaters from energizing.
3. A Preventative Maintenance schedule should be set up as soon as possible after start-up to maintain equipment integrity.

ORBUS™ CONTROL BOARD



Optional Variable Speed EC Motor with Orbus Controller

How does the Orbus Controller work?

Orbus is a simple way for variable speed head pressure control. It reads the system pressure via a transducer and then outputs a 0-10 VDC signal that is linearly proportional to fan speed. All of the communication electronics necessary for variable speed are built into the motor housing. To control the speed of the motor, an analog signal (0-10VDC) is supplied to the motor. The motor interprets the analog signal and changes the speed proportionally to match the input signal.

The Orbus Controller measures system head pressure, compares the measurements to the head pressure set point, and through a proprietary algorithm outputs a 0-10V signal to the variable speed EC Motor. The Orbus board requires a 24VAC for operation. The controller has two predefined set points selectable by a jumper. For R-404A systems the set point is 150 psig. To diagnose issues it has a blinking LED that will provide status/error codes to aid in troubleshooting.

Sensor

Requires 0-500 psig pressure transducer

- Transducer should supply 0.5VDC at 0 psig
- Transducer should supply 4.5VDC at 500 psig

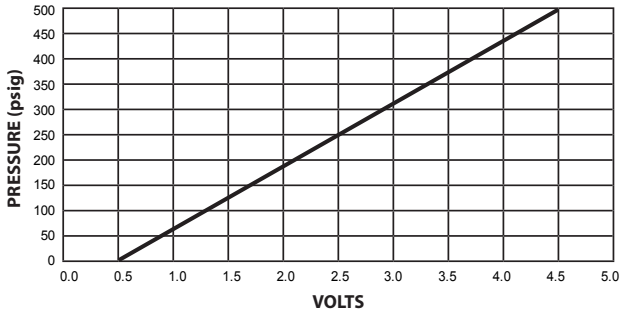
Jumpers

- Jumper #1 – 150 psig, 100 throttling range
- Jumper #2 – 125 psig, 100 throttling range
- Jumper #3 – 100 psig, 100 throttling range
- All three – Test condition, output ramps up and down

Status LED

- **Control board status is indicated by a multi-color LED**
- **On startup, LED cycles from red to yellow to green**
- **Blinking green means everything ok**
  - Length of flash is an indicator of speed
  - Short on, long off indicates low speed
  - Long on, short off indicates high speed
- **Alternating green and one red**
  - Transducer is missing, open or shorted
  - Fan runs full speed
- **Alternating green and two red**
  - Main oscillator dead, running on backup
  - Normal function still available
- **Three reds in a row indicate both oscillator failure and transducer failure**

Diagram 5



Troubleshooting

- To check transducer operation, measure DC voltage between Signal and Common
- Compare transducer value to pressure measured using gage set
- Unplugging sensor will cause output to be 0VDC and should produce one red blink
- If system pressure is above set point plus throttling range, control board should output 0VDC
- If system pressure is below set point, control board should output 10VDC

Table 17. System Troubleshooting Chart

PROBLEM	POSSIBLE CAUSES	POSSIBLE CORRECTIVE STEPS
Compressor will not run	1. Main switch open. 2. Fuse blown. 3. Thermal overloads tripped. 4. Defective contactor or coil. 5. System shut down by safety devices. 6. No cooling required. 7. Liquid line solenoid will not open. 8. Motor electrical trouble. 9. Loose wiring. 10. Phase loss monitor inoperative.	1. Close switch. 2. Check electrical circuits and motor winding for shorts or grounds. Investigate for possible overloading. Replace fuse after fault is corrected. 3. Overloads are automatically reset. Check unit closely when unit comes back on line. 4. Repair or replace. 5. Determine type and cause of shutdown and correct it before resetting safety switch. 6. None. Wait until calls for cooling. 7. Repair or replace coil. 8. Check motor for open windings, short circuit or burn out. 9. Check all wire junctions. Tighten all terminal screws. 10. Refer to page 23.
Compressor noisy or vibrating	1. Flooding of refrigerant into crankcase. 2. Improper piping support on suction or liquid line. 3. Worn compressor. 4. Scroll compressor rotation reversed.	1. Check setting of expansion valves. 2. Relocate, add or remove hangers. 3. Replace. 4. Rewire for phase change.
High discharge pressure	1. Non-condensables in system. 2. System overcharges with refrigerant. 3. Discharge shutoff valve partially closed. 4. Fan not running. 5. Head pressure control setting. 6. Dirty condenser coil.	1. Remove the non-condensables. 2. Remove excess. 3. Open valve. 4. Check electrical circuit. 5. Adjust. 6. Clean.
Low discharge pressure	1. Faulty condenser temperature regulation. 2. Suction shutoff valve partially closed. 3. Insufficient refrigerant in system. 4. Low suction pressure. 5. Variable head pressure valve.	1. Check condenser control operation. 2. Open valve. 3. Check for leaks. Repair and add charge. 4. See corrective steps for low suction pressure. 5. Check valve setting.
High suction pressure	1. Excessive load. 2. Expansion valve overfeeding.	1. Reduce load or add additional equipment. 2. Check remote bulb. Regulate superheat.
Low suction pressure	1. Lack of refrigerant. 2. Evaporator dirty or iced. 3. Clogged liquid line filter drier. 4. Clogged suction line or compressor suction gas strainers. 5. Expansion valve malfunctioning. 6. Condensing temperature too low. 7. Improper TXV.	1. Check for leaks. Repair and add charge. 2. Clean. 3. Replace cartridge(s). 4. Clean strainers. 5. Check and reset for proper superheat. 6. Check means for regulating condensing temperature. 7. Check for proper sizing.
Little or no oil pressure	1. Clogged suction oil strainer. 2. Excessive liquid in crankcase. 3. Low oil pressure safety switch defective. 4. Worn oil pump. 5. Oil pump reversing gear stuck in wrong position. 6. Worn bearings. 7. Low oil level. 8. Loose fitting on oil lines. 9. Pump housing gasket leaks.	1. Clean. 2. Check crankcase heater. Reset expansion valve for higher superheat. Check liquid line solenoid valve operation. 3. Replace. 4. Replace. 5. Reverse direction of compressor rotation. 6. Replace compressor. 7. Add oil and/or through defrost. 8. Check and tighten system. 9. Replace gasket.
Compressor loses oil	1. Lack of refrigerant. 2. Excessive compression ring blow by. 3. Refrigerant flood back. 4. Improper piping or traps.	1. Check for leaks and repair. Add refrigerant. 2. Replace compressor. 3. Maintain proper superheat at compressor. 4. Correct piping.
Compressor thermal protector switch open	1. Operating beyond design conditions. 2. Discharge valve partially shut. 3. Blown valve plate gasket. 4. Dirty condenser coil. 5. Overcharged system.	1. Add components to bring conditions within acceptable limits (i.e., CPR/EPR valves, additional condenser surface, liquid injection, etc.). 2. Open valve. 3. Replace gasket. 4. Clean coil. 5. Reduce charge.
System does not start reliably in cold weather. (Low pressure switch not closing	1. Low pressure switch not correctly adjusted. 2. Low ambient kit not installed.	1. Adjust low pressure switch (see page 24) 2. Install low ambient kit (low pressure switch settings can be lowered temporarily to allow system to start) 3. Review " low suction pressure possible causes". 4. Call Heatcraft tech support.

Table 17. System Troubleshooting Chart (cont.)

PROBLEM	POSSIBLE CAUSES	POSSIBLE CORRECTIVE STEPS
System will not run reliably in cold weather. (Short cycling on low pressure switch)	1. Low pressure switch not correctly adjusted. 2. Lack of refrigerant. 3. Low ambient kit not installed.	1. Adjust low pressure switch (see page 24) 2. Check for leaks. Repair and add charge. 3. Install pressure fan cycling control to reduce the time required to reach the head pressure valve setpoint. The control operation shall not defeat the head pressure valve setpoint. See Table 15. 4. Call Heatcraft tech support.
System will not run reliably in cold weather. (Head pressure does not reach minimum setting during cooling cycle	1. Lack of refrigerant. 2. Head pressure builds too slowly to reach setpoint during cooling cycle. 3. Head pressure valve defective.	1. Check for leaks. Repair and add charge. 2. Install pressure fan cycling control to reduce the time required to reach the head pressure valve setpoint. The control operation shall not defeat the head pressure valve setpoint. See Table 15. 3. Replace head pressure valve.
Low compressor superheat observed at compressor in cold weather.	1. Unit cooler has ice accumulation 2. Superheat low when measured at unit cooler. 3. Suction accumulator not installed.	1. Defrost unit cooler completely. 2. Raise superheat at unit cooler by 5°F (3°C). 3. Install suction accumulator
Slow initial room pull-down in cold weather.	1. Expansion valve capacity less than pull-down load. 2. Expansion valve not sized for minimum head pressure and the installed distributor nozzle.	1. Temporarily reduce the condenser coil face area to elevate the discharge pressure to equivalent 105°F condensing temperature during pull-down. (Remove blockage after pull-down). 2. Replace expansion valve with correct size.

Table 18. Pressure Fan Cycling Recommended Settings

Head Pressure Valve Setpoint	Control cut-in setting psi	Control cut-out setting psi
150 psi	175	140
100 psi	125	90

NOTE: Use pressure fan cycling for fan nearest compressor. Use ambient fan cycling (see Table 1) for other fans

Preventive Maintenance Guidelines

Air-Cooled Condensing Units

Quarterly

1) Visually inspect unit

- Look for signs of oil stains on interconnection piping and condenser coil. Pay close attention to areas around solder joints, building penetrations and pipe clamps. Check any suspect areas with an electronic leak detector. Repair any leaks found and add refrigerant as needed.
- Check condition of moisture indicator/sightglass in the sight glass if so equipped. Replace liquid line drier if there is indication of slight presence of moisture. Replace refrigerant, oil and drier if moisture concentration is indicated to be high.
- Check moisture indicator/sightglass for flash gas. If found check entire system for refrigerant leaks and add refrigerant as needed after repairing any leaks.
- Check compressor sightglass (if equipped) for proper oil level.
- Check condition of condenser. Look for accumulation of dirt and debris (clean as required).
- Check for unusual noise or vibration. Take corrective action as required.
- Inspect wiring for signs of wear or discoloration and repair if needed.
- Check and tighten all flare connections.

Semi-Annually

2) Repeat all quarterly inspection items.

3) Clean condenser coil and blades

- Periodic cleaning can be accomplished by using a brush, pressurized water and a commercially available foam coil cleaner. If foam cleaner is used, it should not be an acid based cleaner. Follow label directions for appropriate use.
- Rinse until no residue remains.

4) Check operation of condenser fans

- Check that each fan rotates freely and quietly. Replace any fan motor that does not rotate smoothly or makes excessive noise.
- Check all fan blade set screws and tighten as required.
- Check all fan blades for signs of cracks, wear or stress. Pay close attention to the hub and spider. Replace blades as required.
- Verify that all motors are mounted securely.
- Lubricate motors if applicable. Do not lubricate permanently sealed, ball bearing motors.

5) Inspect electrical wiring and components

- Verify that all electrical and ground connections are secure, tighten as required.
- Check condition of compressor and heater contactors. Look for discoloration and pitting. Replace as required.
- Check operation and calibration of all timers, relays pressure controls and safety controls.
- Clean electrical cabinet. Look for signs of moisture, dirt, debris, insects and wildlife. Take corrective action as required.
- Verify operation of crankcase heater by measuring amp draw.

6) Check refrigeration cycle

- Check suction, discharge and net oil pressure readings. If abnormal take appropriate action.
- Check operation of demand cooling, liquid injection or unloaders if so equipped.
- Check pressure drop across all filters and driers. Replace as required.
- Verify that superheat at the compressor conforms to specification. (30°F to 45°F)
- Check pressure and safety control settings and verify proper operation.

Annually

7) In addition to quarterly and semiannual maintenance checks, submit an oil sample for analysis

- Look for high concentrations of acid or moisture. Change oil and driers until test results read normal.
- Investigate source of high metal concentrations, which normally are due to abnormal bearing wear. Look for liquid refrigerant in the crankcase, low oil pressure or low superheat as a possible source.

8) Inspect suction accumulator (if equipped)

- If the accumulator is insulated remove insulation and inspect for leaks and corrosion.
- Pay close attention to all copper to steel brazed connections
- Wire brush all corroded areas and peeling paint.
- Apply an anticorrosion primer and paint as required. Re-insulate if applicable.

A2L Condensing Units

A2L condensing units function in much the same way as standard A1 condensing units with some exceptions. This manual describes recommendations and requirements unique to A2L condensing units.

Symbols

Listed below are the warning symbols and their meanings used on the A2L condensing units.



WARNING: Risk of fire/flammable materials

WARNING

Do not use means to accelerate the defrosting process or to clean, other than those recommended by the manufacturer.

The appliance shall only be installed outdoors.

Do not pierce or burn.

Be aware that refrigerants may not contain an odour.

In Canada, the French translation is:

MISE EN GARDE

N'utilisez pas de moyens pour accélérer le processus dégivrage ou pour nettoyer, autres que ceux recommandés par le fabricant.

L'appareil ne doit être installé *qu*'à l'extérieur.

Ne pas percer ni brûler.

Sachez que les fluides frigorigènes peuvent ne pas contenir d'odeur.

Installation Instructions

a) This product shall not be installed within 6.1 m (20 feet) of any building opening.

b) If this product is enclosed within a penthouse, lean-to, or other open structure, natural or mechanical ventilation shall be provided.

c) Any pressure-relief devices and fusible plugs shall discharge to the atmosphere at a location not less than 4,57 m (15 ft) above the adjoining ground level and not less than 6,1 m (20 ft) from any window, ventilation opening, or exit in any building.

d) Refrigerant circuit access ports located outdoors shall be secured to prevent unauthorized access.

Instructions for partial units with A2L Refrigerant

i) Solenoid valves shall be correctly positioned in the piping to avoid hydraulic shock.

ii) Solenoid valves shall not block in liquid refrigerant unless adequate relief is provided to the refrigerant system low pressure side.

iii) Where safety shut off valves are required in the field-installed interconnecting refrigerant piping, the installation location of the valve in the REFRIGERATING SYSTEM, relative to the occupied spaces shall be provided.

iv) The maximum operating pressure is considered when connecting to any condensers.

v) PARTIAL UNITS shall only be connected to an appliance suitable for the same refrigerant.

General Information

a) information for spaces where refrigerant pipes are allowed

i) piping material, pipe routing, and installation shall include protection from physical damage in operation and service and be in compliance with national and local codes and standards, such as ANSI/ASHRAE 15, IAPMO Uniform Mechanical Code, ICC International Mechanical Code, or CSA B52. All field joints shall be accessible for inspection prior to being covered or enclosed;

ii) the installation of pipe-work shall be kept to a minimum;

iii) pipe-work in the case of flammable refrigerants shall be protected and not be installed in an area where it can be damaged.

iv) mechanical connections where connections are brazed or joined in the field shall be accessible for maintenance purposes;

v) provision shall be made for expansion and contraction of long runs of piping;

vi) protection devices, piping, and fittings shall be protected as far as possible against adverse environmental effects, for example, the danger of water collecting and freezing in relief pipes or the accumulation of dirt and debris;

vii) piping in refrigeration systems shall be so designed and installed to minimize the likelihood of hydraulic shock damaging the system;

viii) steel pipes and components shall be protected against corrosion with a rustproof coating before applying any insulation;

ix) flexible pipe elements shall be protected against mechanical damage, excessive stress by torsion, or other forces, and that they should be checked for mechanical damage annually;

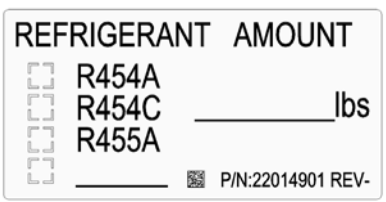
x) precautions shall be taken to avoid excessive vibration or pulsation;

xii) after completion of field piping for split systems, the field pipework shall be pressure tested with an inert gas and then vacuum tested prior to refrigerant charging, according to the following requirements:

1. The minimum test pressure for the low side of the system shall be the low side design pressure and the minimum test pressure for the high side of the system shall be the high side design pressure, unless the high side of the system cannot be isolated from the low side of the system n which case the entire system shall be pressure tested to the low side design pressure.
2. The test pressure after removal of pressure source shall be maintained for at least 1 h with no decrease of pressure indicated by the test gauge, with test gauge resolution not exceeding 5% of the test pressure.
3. During the evacuation test, after achieving a vacuum level specified in the manual or less, the refrigeration system shall be isolated from the vacuum pump and the pressure shall not rise above 1500 microns within 10 min. The vacuum pressure level shall be specified in the manual and shall be the lessor of 500 microns or the value required for compliance with national and local codes and standards, which may vary between residential, commercial, and industrial buildings.

b) See the refrigerant charging instruction section in the condensing unit name plate to determine the REFRIGERANT CHARGE needed and how to complete the REFRIGERANT CHARGE on the label to note the resulting total refrigerant charge for each refrigerating system per clause. Refer the below label on refrigerant charge located on the condensing unit.

LABEL REFRIGERANT CHARGE A2L



General Information (cont.)

d) See correct working procedures section for information on handling, installation, cleaning, servicing and disposal of refrigerant;

e) For A2L condensing units using FLAMMABLE REFRIGERANTS, instructions shall include the REFRIGERANT CHARGE mc in both SI and IP units

f) Notice that servicing shall be performed only as recommended by Heatcraft;

g) WARNING - THIS UNIT SHALL ONLY BE CONNECTED TO AN APPLIANCE SUITABLE FOR THE SAME REFRIGERANT

Qualification of workers

Working personnel for maintenance, service, and repair operations should be trained and qualified to work on A2L refrigeration systems. Personnel should have the appropriate technical training and experience necessary to be aware of hazards to which he or she is exposed in performing a task and of measures necessary to minimize the danger to themselves or other persons. Every working procedure that affects safety means shall only be carried out by competent persons after undergoing training of the procedures by national training organizations or manufacturers that are accredited to teach the relevant national competency standards that may be set in legislation.

Examples for such working procedures are

a) breaking into the refrigerating circuit;

b) opening of sealed components;

c) opening of ventilated enclosures.

General Information for Service Personnel

The below sections contain specific information for service personnel

Checks to the area

Prior to beginning work on systems containing FLAMMABLE REFRIGERANTS, safety checks are necessary to ensure that the risk of ignition is minimized. For repair to the REFRIGERATING SYSTEM, sections listed below for service personnel shall be completed prior to conducting work on the system.

Work procedure

Work shall be undertaken under a controlled procedure so as to minimize the risk of a flammable gas or vapour being present while the work is being performed.

General work area

All maintenance staff and others working in the local area shall be instructed on the nature of work being carried out. Work in confined spaces shall be avoided.

Checking for presence of refrigerant

The area shall be checked with an appropriate refrigerant detector prior to and during work, to ensure the technician is aware of potentially toxic or flammable atmospheres. Ensure that the leak detection equipment being used is suitable for use with all applicable refrigerants, i.e., non sparking, adequately sealed, or intrinsically safe.

Presence of fire extinguisher

If any hot work is to be conducted on the refrigerating equipment or any associated parts, appropriate fire extinguishing equipment shall be available on hand. A dry chemical or CO2 fire extinguisher should be adjacent to the charging area.

No ignition sources

No person carrying out work in relation to a REFRIGERATING SYSTEM which involves exposing any pipe work shall use any sources of ignition in such a manner that it may lead to the risk of fire or explosion. All possible ignition sources, including cigarette smoking, should be kept sufficiently far away from the site of installation, repairing, removing and disposal, during which refrigerant can possibly be released to the surrounding space. Prior to work taking place, the area around the equipment shall be surveyed to make sure that there are no flammable hazards or ignition risks. "No Smoking" signs shall be displayed.

Ventilated area

Ensure that the area is in the open or that it is adequately ventilated before breaking into the system or conducting any hot work. A degree of ventilation shall continue during the period that the work is carried out. The ventilation should safely disperse any released refrigerant and preferably expel it externally into the atmosphere.

Checks to the refrigerating equipment

Where electrical components are being changed, they shall be fit for the purpose and to the correct specification. At all times, the maintenance and service guidelines shall be followed. If in doubt, consult Heatcraft's technical department for assistance.

The following checks shall be applied to installations using FLAMMABLE REFRIGERANTS:

- b) the ventilation machinery and outlets are operating adequately and are not obstructed;

c) if an indirect refrigerating circuit is being used, the secondary circuit shall be checked for the presence of refrigerant;

d) marking to the equipment continues to be visible and legible. Markings and signs that are illegible shall be corrected;

e) refrigerating pipe or components are installed in a position where they are unlikely to be exposed to any substance which may corrode refrigerant containing components, unless the components are constructed of materials which are inherently resistant to being corroded or are suitably protected against being so corroded.

Checks to electrical devices

Repair and maintenance to electrical components shall include initial safety checks and component inspection procedures. If a fault exists that could compromise safety, then no electrical supply shall be connected to the circuit until it is satisfactorily dealt with. If the fault cannot be corrected immediately but it is necessary to continue operation, an adequate temporary solution shall be used. This shall be reported to the owner of the equipment, so all parties are advised.

Initial safety checks shall include:

a) that capacitors are discharged: this shall be done in a safe manner to avoid possibility of sparking;

b) that no live electrical components and wiring are exposed while charging, recovering or purging the system;

c) that there is continuity of earth bonding.

Repairs to sealed components

During repairs to sealed components, all electrical supplies shall be disconnected from the equipment being worked upon prior to any removal of sealed covers, etc. If it is absolutely necessary to have an electrical supply to equipment during servicing, then a permanently operating form of leak detection shall be located at the most critical point to warn of a potentially hazardous situation.

Particular attention shall be paid to the following to ensure that by working on electrical components, the casing is not altered in such a way that the level of protection is affected. This shall include damage to cables, excessive number of connections, terminals not made to original specification, damage to seals, incorrect fitting of glands, etc.

Ensure that the apparatus is mounted securely.

Ensure that seals or sealing materials have not degraded to the point that they no longer serve the purpose of preventing the ingress of flammable atmospheres. Replacement parts shall be in accordance with Heatcraft's specifications.

Repair to intrinsically safe components

Do not apply any permanent inductive or capacitance loads to the circuit without ensuring that this will not exceed the permissible voltage and current permitted for the equipment in use.

Intrinsically safe components are the only types that can be worked on while live in the presence of a flammable atmosphere. The test apparatus shall be at the correct rating.

Replace components only with parts specified by Heatcraft. Other parts can result in the ignition of refrigerant in the atmosphere from a leak.

NOTE ***The use of silicon sealant can inhibit the effectiveness of some types of leak detection equipment. Intrinsically safe components do not have to be isolated prior to working on them.***

Cabling

Check that cabling will not be subject to wear, corrosion, excessive pressure, vibration, sharp edges, or any other adverse environmental effects. The check shall also take into account the effects of aging or continual vibration from sources such as compressors or fans.

Detection of flammable refrigerants

Under no circumstances shall potential sources of ignition be used in the searching for or detection of refrigerant leaks. A halide torch (or any other detector using a naked flame) shall not be used.

The following leak detection methods are deemed acceptable for all refrigerant systems.

Electronic leak detectors may be used to detect refrigerant leaks but, in the case of FLAMMABLE REFRIGERANTS, the sensitivity might not be adequate, or might need re- calibration. (Detection equipment shall be calibrated in a refrigerant-free area.) Ensure that the detector is not a potential source of ignition and is suitable for the refrigerant used. Leak detection equipment shall be set at a percentage of the LFL of the refrigerant and shall be calibrated to the refrigerant employed, and the appropriate percentage of gas (25 % maximum) is confirmed.

Leak detection fluids are also suitable for use with most refrigerants but the use of detergents containing chlorine shall be avoided as the chlorine can react with the refrigerant and corrode the copper pipework.

NOTE Examples of leak detection fluids are

– bubble method,
– fluorescent method agents.

If a leak is suspected, all naked flames shall be removed/extinguished. If a leakage of refrigerant is found which requires brazing, all of the refrigerant shall be recovered from the system, or isolated (by means of shut off valves) in a part of the system remote from the leak. Removal of refrigerant shall be according to clause Removal and evacuation.

Removal and evacuation

When breaking into the refrigerant circuit to make repairs – or for any other purpose – conventional procedures shall be used. However, for flammable refrigerants it is important that best practice be followed, since flammability is a consideration. The following procedure shall be adhered to:

a) safely remove refrigerant following local and national regulations;
b) purge the circuit with inert gas;
c) evacuate (optional for A2L);
d) purge with inert gas (optional for A2L);
e) open the circuit by cutting or brazing.

The refrigerant charge shall be recovered into the correct recovery cylinders if venting is not allowed by local and national codes. For appliances containing flammable refrigerants, the system shall be purged with oxygen-free nitrogen to render the appliance safe for flammable refrigerants. This process might need to be repeated several times. Compressed air or oxygen shall not be used for purging refrigerant systems.

For appliances containing flammable refrigerants, refrigerants purging shall be achieved by breaking the vacuum in the system with oxygen-free nitrogen and continuing to fill until the working pressure is achieved, then venting to atmosphere, and finally pulling down to a vacuum (optional for A2L). This process shall be repeated until no refrigerant is within the system (optional for A2L). When the final oxygen-free nitrogen charge is used, the system shall be vented down to atmospheric pressure to enable work to take place.

Ensure that the outlet for the vacuum pump is not close to any potential ignition sources and that ventilation is available.

Charging procedures

In addition to conventional charging procedures, the following requirements shall be followed.

a) Ensure that contamination of different refrigerants does not occur when using charging equipment. Hoses or lines shall be as short as possible to minimize the amount of refrigerant contained in them.
b) Cylinders shall be kept in an appropriate position according to the instructions.
c) Ensure that the REFRIGERATING SYSTEM is earthed prior to charging the system with refrigerant.
d) Label the system when charging is complete (if not already).
e) Extreme care shall be taken not to overfill the REFRIGERATING SYSTEM.

Prior to recharging the system, it shall be pressure-tested with the appropriate purging gas. The system shall be leak-tested on completion of charging but prior to commissioning. A follow up leak test shall be carried out prior to leaving the site.

Decommissioning

Before carrying out this procedure, it is essential that the technician is completely familiar with the equipment and all its detail. It is recommended good practice that all refrigerants are recovered safely. Prior to the task being carried out, an oil and refrigerant sample shall be taken in case analysis is required prior to re-use of recovered refrigerant. It is essential that electrical power is available before the task is commenced.

a) Become familiar with the equipment and its operation.
b) Isolate the system electrically.
c) Before attempting the procedure, ensure that:
   i) mechanical handling equipment is available, if required, for handling refrigerant cylinders;
   ii) all personal protective equipment is available and being used correctly;
   iii) the recovery process is supervised at all times by a competent person;
   iv) recovery equipment and cylinders conform to the appropriate standards.
d) Pump down refrigerant system, if possible.
e) if a vacuum is not possible, make a manifold so that refrigerant can be removed from various parts of the system.
f) Make sure that cylinder is situated on the scales before recovery takes place.
g) Start the recovery machine and operate in accordance with instructions.
h) Do not overfill cylinders (no more than 80 % volume liquid charge).
i) Do not exceed the maximum working pressure of the cylinder, even temporarily.
j) When the cylinders have been filled correctly and the process completed, make sure that the cylinders and the equipment are removed from site promptly and all isolation valves on the equipment are closed off.
k) Recovered refrigerant shall not be charged into another REFRIGERATING SYSTEM unless it has been cleaned and checked.

Labeling

Equipment shall be labelled stating that it has been de-commissioned and emptied of refrigerant. The label shall be dated and signed. For appliances containing FLAMMABLE REFRIGERANTS, ensure that there are labels on the equipment stating the equipment contains FLAMMABLE REFRIGERANT.

Recovery

When removing refrigerant from a system, either for servicing or decommissioning, it is recommended good practice that all refrigerants are removed safely.

When transferring refrigerant into cylinders, ensure that only appropriate refrigerant recovery cylinders are employed. Ensure that the correct number of cylinders for holding the total system charge is available. All cylinders to be used are designated for the recovered refrigerant and labelled for that refrigerant (i.e., special cylinders for the recovery of refrigerant). Cylinders shall be complete with pressure-relief valve and associated shut-off valves in good working order. Empty recovery cylinders are evacuated and, if possible, cooled before recovery occurs.

The recovery equipment shall be in good working order with a set of instructions concerning the equipment that is at hand and shall be suitable for the recovery of all appropriate refrigerants including, when applicable, FLAMMABLE REFRIGERANTS. In addition, a set of calibrated weighing scales

shall be available and in good working order. Hoses shall be complete with leak-free disconnect couplings and in good condition.

Before using the recovery machine, check that it is in satisfactory working order, has been properly maintained and that any associated electrical components are sealed to prevent ignition in the event of a refrigerant release. Consult Heatcraft if in doubt.

The recovered refrigerant shall be returned to the refrigerant supplier in the correct recovery cylinder, and the relevant waste transfer note arranged. Do not mix refrigerants in recovery units and especially not in cylinders.

If compressors or compressor oils are to be removed, ensure that they have been evacuated to an acceptable level to make certain that FLAMMABLE REFRIGERANT does not remain within the lubricant. The evacuation process shall be carried out prior to returning the compressor to the suppliers. Only electric heating to the compressor body shall be employed to accelerate this process. When oil is drained from a system, it shall be carried out safely.

l) Pump down refrigerant system, if possible.

m) If a vacuum is not possible, make a manifold so that refrigerant can be removed from various parts of the system.

n) Make sure that cylinder is situated on the scales before recovery takes place.

o) Start the recovery machine and operate in accordance with instructions.

p) Do not overfill cylinders (no more than 80 % volume liquid charge).

q) Do not exceed the maximum working pressure of the cylinder, even temporarily.

r) When the cylinders have been filled correctly and the process completed, make sure that the cylinders and the equipment are removed from site promptly and all isolation valves on the equipment are closed off.

s) Recovered refrigerant shall not be charged into another REFRIGERATING SYSTEM unless it has been cleaned and checked.

Correct working procedures:

Commissioning

i) Ensure that the floor area is sufficient for the REFRIGERANT CHARGE or that the ventilation duct is assembled in a correct manner.

ii) Connect the pipes and carry out a leak test before charging with refrigerant.

iii) Check safety equipment before putting into service.

Maintenance

i) Portable equipment is to be repaired outside or in a workshop specially equipped for servicing units with FLAMMABLE REFRIGERANTS.

ii) Ensure sufficient ventilation at the repair place.

iii Be aware that malfunction of the equipment can be caused by refrigerant loss and a refrigerant leak is possible.

iv) Discharge capacitors in a way that won't cause any spark. The standard procedure to short circuit the capacitor terminals usually creates sparks.

v) Reassemble sealed enclosures accurately. If seals are worn, replace them.

vi) Check safety equipment before putting into service.

Repair

i) Portable equipment is to be repaired outside or in a workshop specially equipped for servicing units with FLAMMABLE REFRIGERANTS.

ii) Ensure sufficient ventilation at the repair place.

iii) Be aware that malfunction of the equipment can be caused by refrigerant loss and a refrigerant leak is possible.

iv) Discharge capacitors in a way that won't cause any spark.

v) When brazing is required, the following procedures shall be carried out in the following order:

1) Safely remove the refrigerant following local and national regulations. If the recovery is not required by national regulations, drain the refrigerant to the outside. Take care that the drained refrigerant will not cause any danger. In doubt, one person should guard the outlet. Take special care that drained refrigerant will not float back into the building.

2) Purge the refrigerant circuit with oxygen free nitrogen.

3) Evacuate the refrigerant circuit.

4) Purge the refrigerant circuit with nitrogen for 5 min (not required for A2L refrigerants).

5) Evacuate again (not required for A2L refrigerants).

6) Remove parts to be replaced by cutting or brazing.

7) Purge the braze point with nitrogen during the brazing procedure required for repair.

8) Carry out a leak test before charging with refrigerant.

vi) Reassemble sealed enclosures accurately. If seals are worn, replace them.

vii) Check safety equipment before putting into service.

Decommissioning

i) If the safety is affected when the equipment is putted out of service, the REFRIGERANT CHARGE is to be removed before decommissioning.

ii) Ensure sufficient ventilation at the equipment location.

iii) Be aware that malfunction of the equipment can be caused by refrigerant loss and a refrigerant leak is possible.

iv) Discharge capacitors in a way that will not cause any spark.

v) Remove the refrigerant. If the recovery is not required by national regulations, drain the refrigerant to the outside. Take care that the drained refrigerant will not cause any danger. In doubt, one person should guard the outlet. Take special care that drained refrigerant will not float back into the building.

vi) When FLAMMABLE REFRIGERANTS except A2L REFRIGERANTS are used,

1) Evacuate the refrigerant circuit.

2) Purge the refrigerant circuit with nitrogen for 5 min.

3) Evacuate again.

4) Fill with nitrogen up to atmospheric pressure.

5) Put a label on the equipment that the refrigerant is removed.

Disposal

i) Ensure sufficient ventilation at the working place.

ii) Remove the refrigerant. If the recovery is not required by national regulations, drain the refrigerant to the outside. Take care that the drained refrigerant will not cause any danger. In doubt, one person should guard the outlet. Take special care that drained refrigerant will not float back into the building.

iii) When FLAMMABLE REFRIGERANTS are used,

1) Evacuate the refrigerant circuit.

2) Purge the refrigerant circuit with oxygen free nitrogen.

3) Evacuate again (not required for A2L refrigerants).

4) Cut out the compressor and drain the oil.

iv) Cut out the compressor and drain the oil.

Typical Wiring Diagrams

ELECTRICAL CONNECTIONS - SINGLE EVAPORATOR

Diagram 6

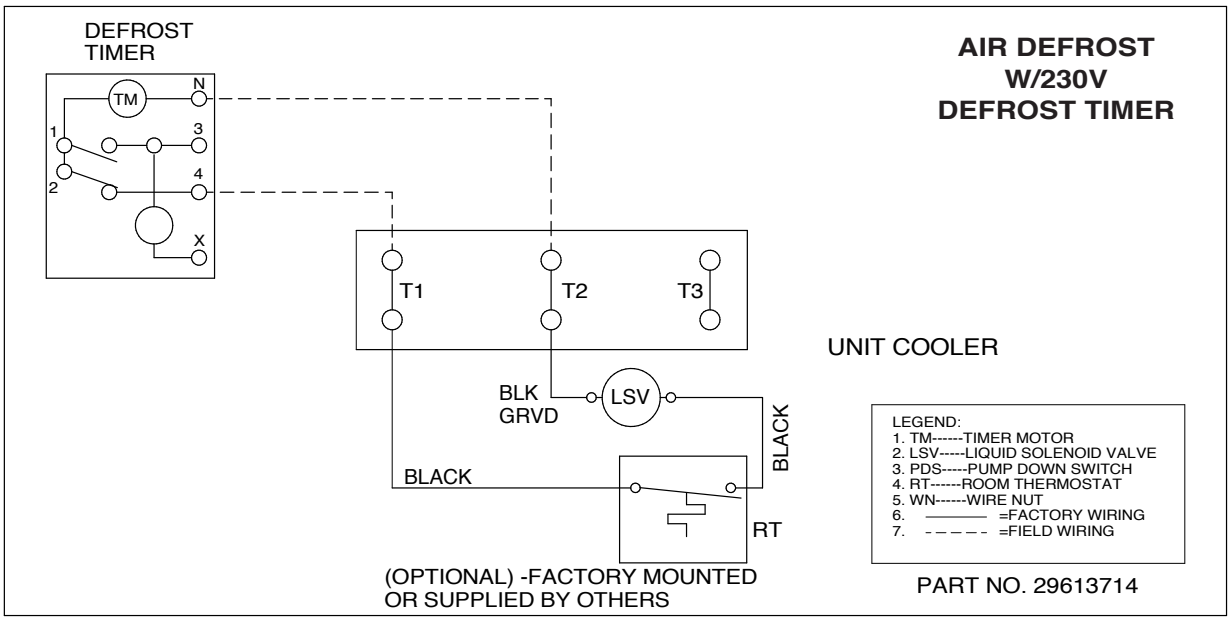


Diagram 7

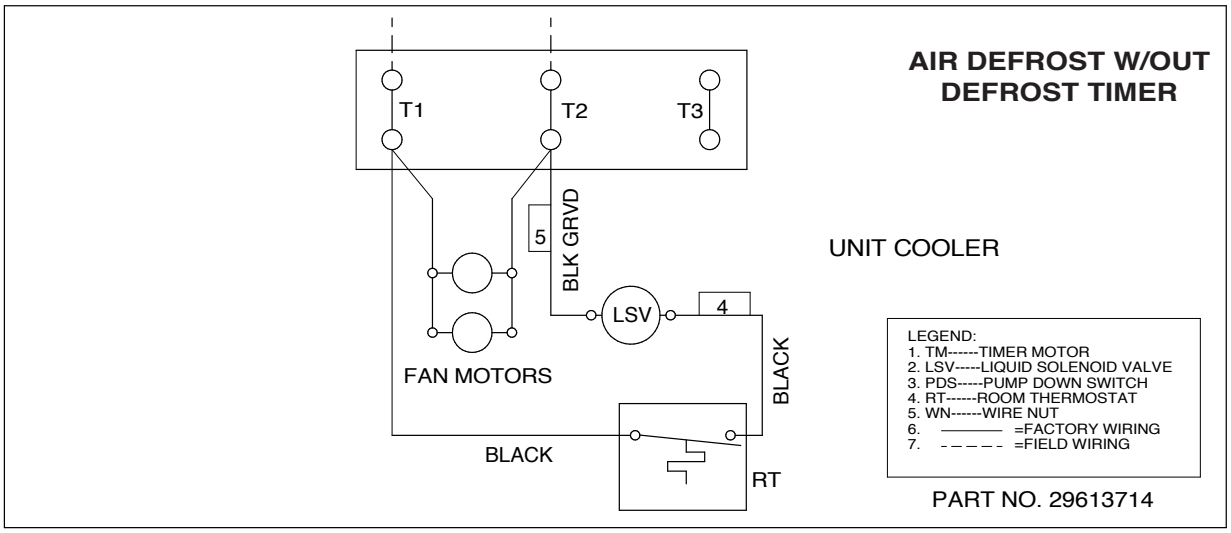
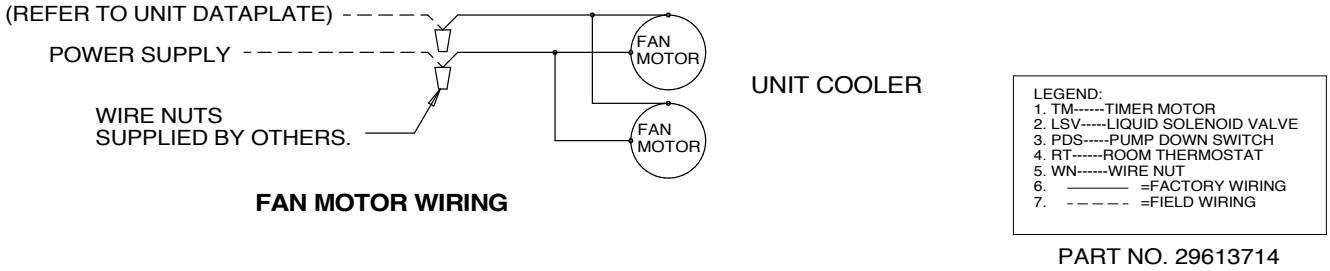


Diagram 8



FAN MOTOR WIRING

Diagram 9. Typical Wiring Diagram for Single Evaporator with and without Defrost Timer 230V Application

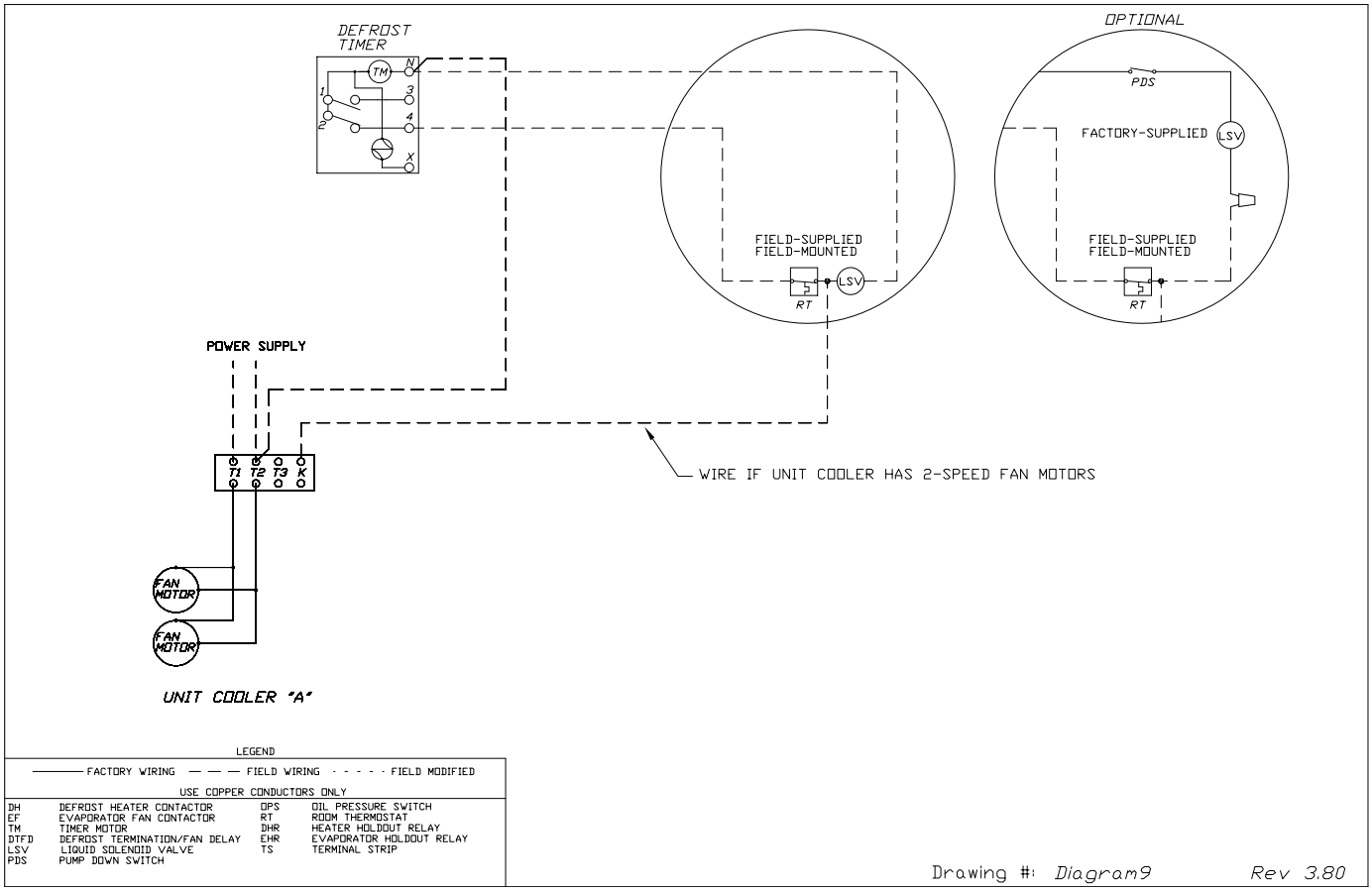


Diagram 10. Typical Wiring Diagram for Single Evaporator with Defrost Timer Only

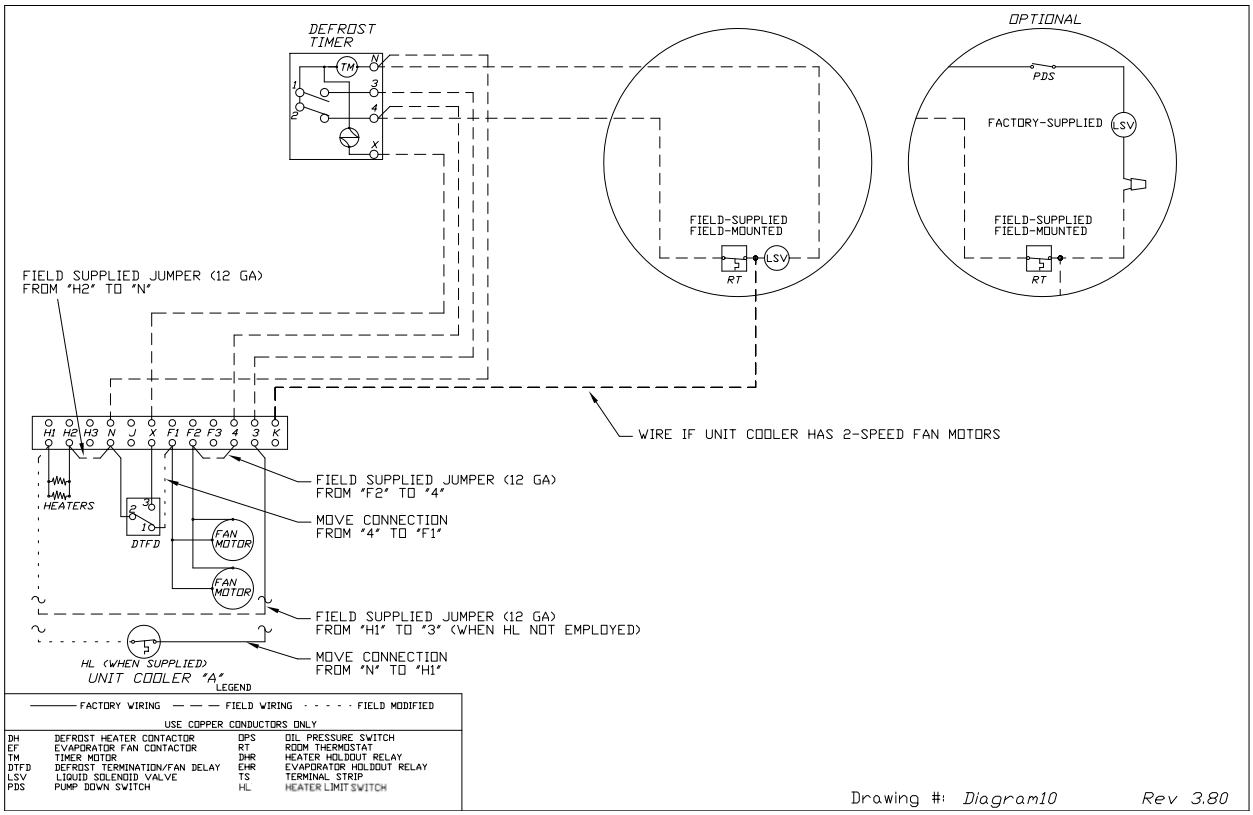


Diagram 11. Typical Wiring Diagram for Multiple Evaporators with Defrost Timer Only

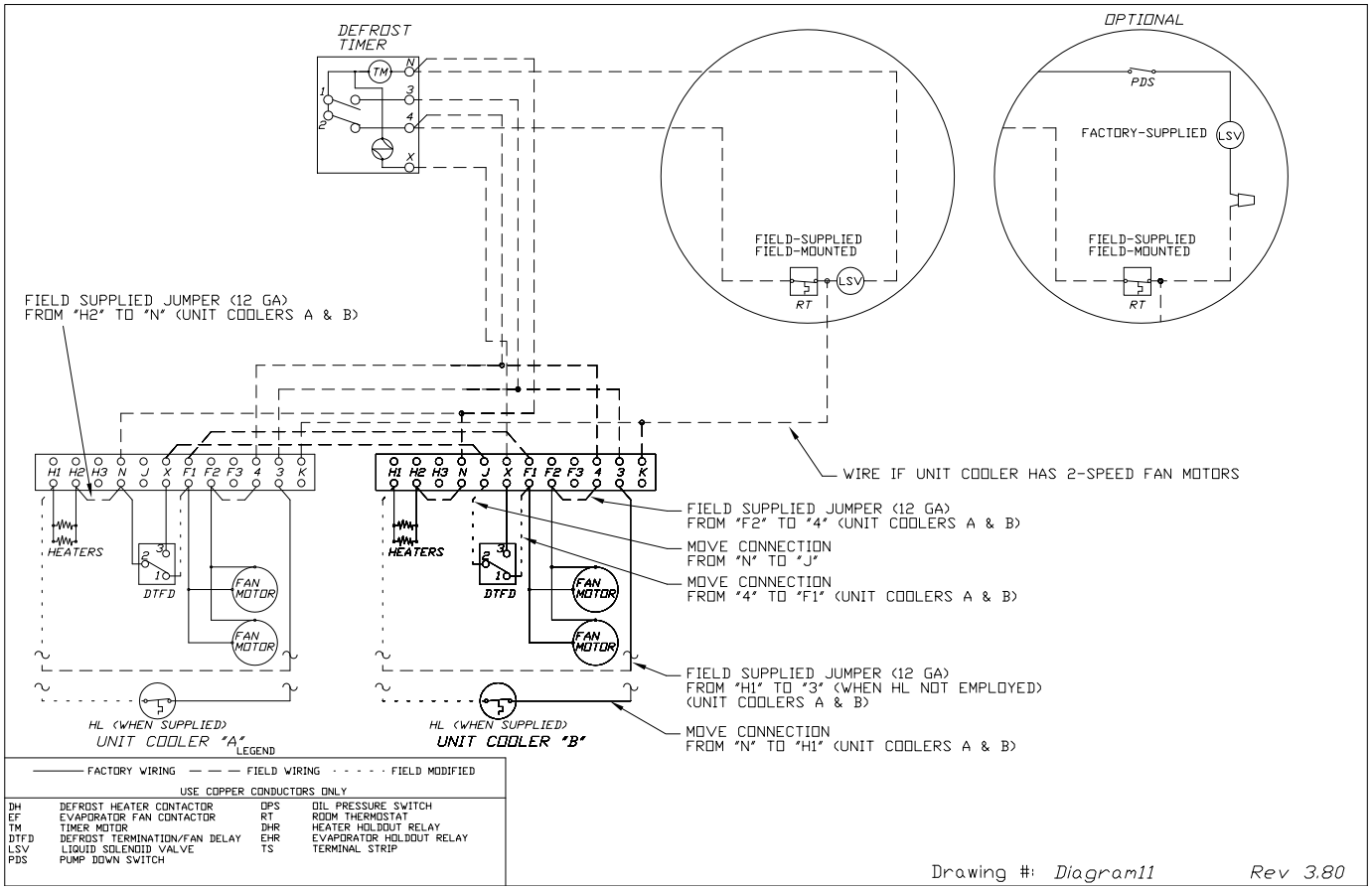


Diagram 12. Typical Wiring Diagram for Single Evaporator / Single Phase Defrost and Evaporator Fan Contactors

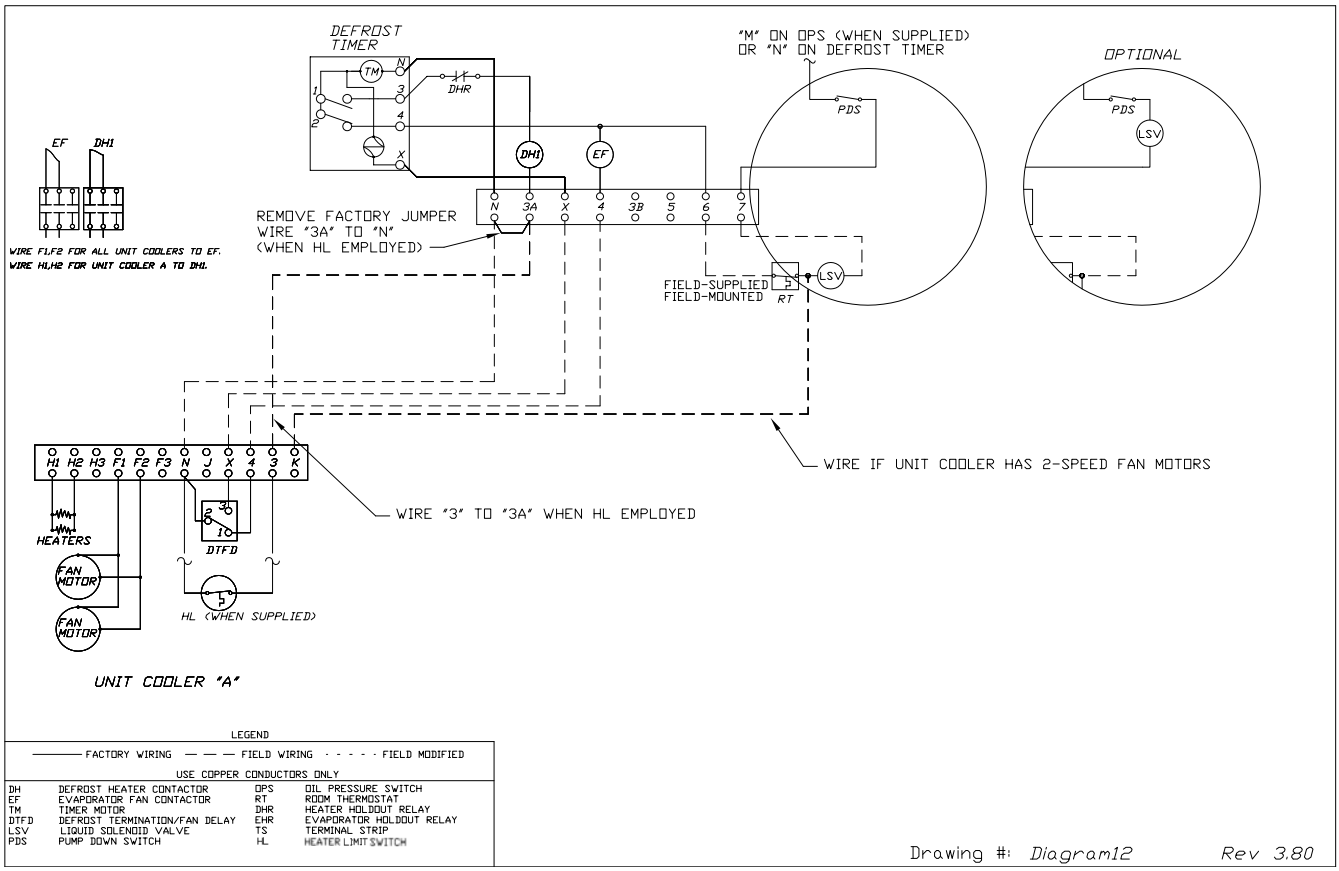


Diagram 13. Typical Wiring Diagram for Single Evaporator Defrost and Evaporator Fan Contactors

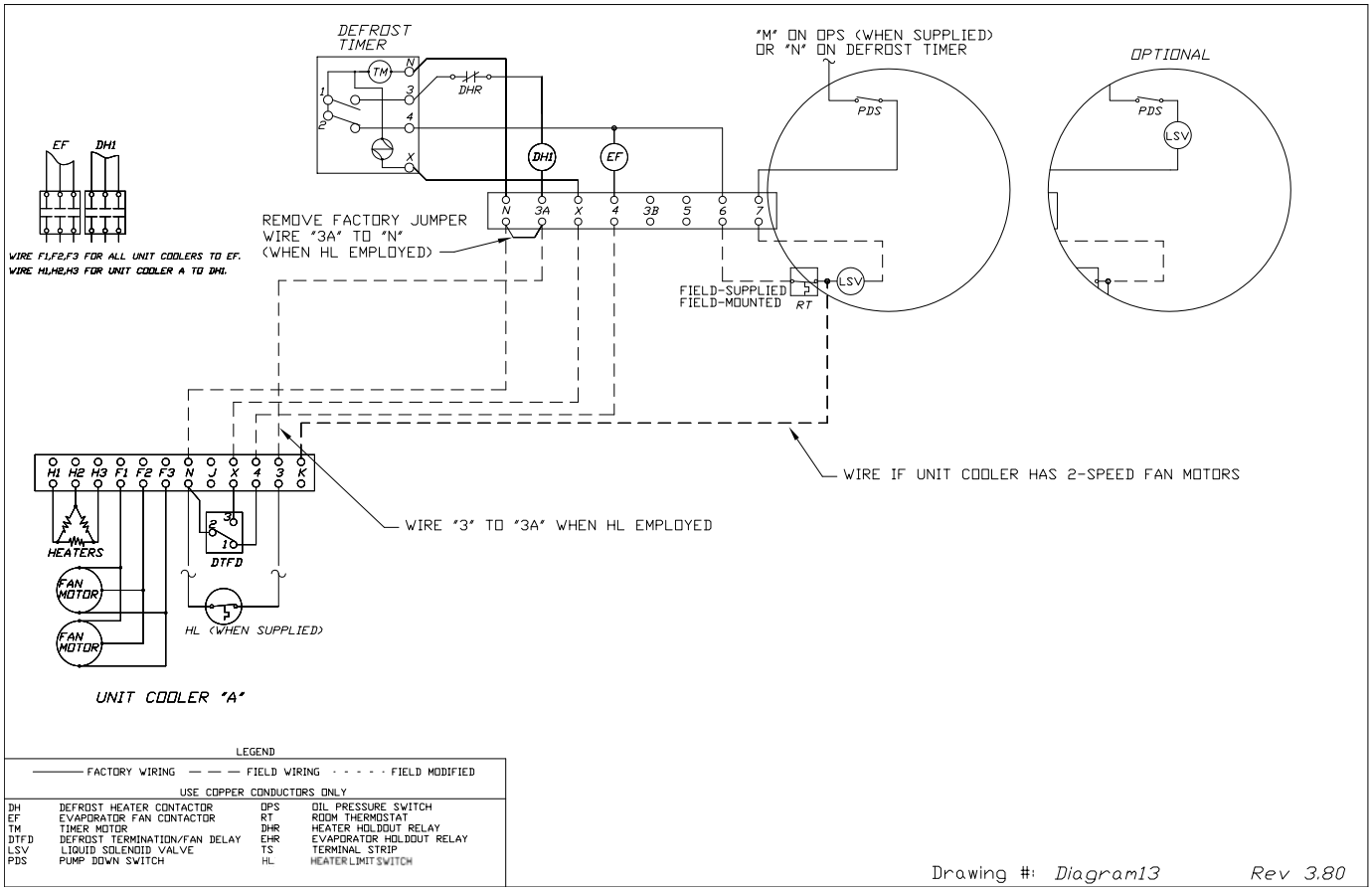


Diagram 14. Typical Wiring Diagram for Multiple Evaporators with Evaporator Fan Contactors/without Heater Limit Defrost

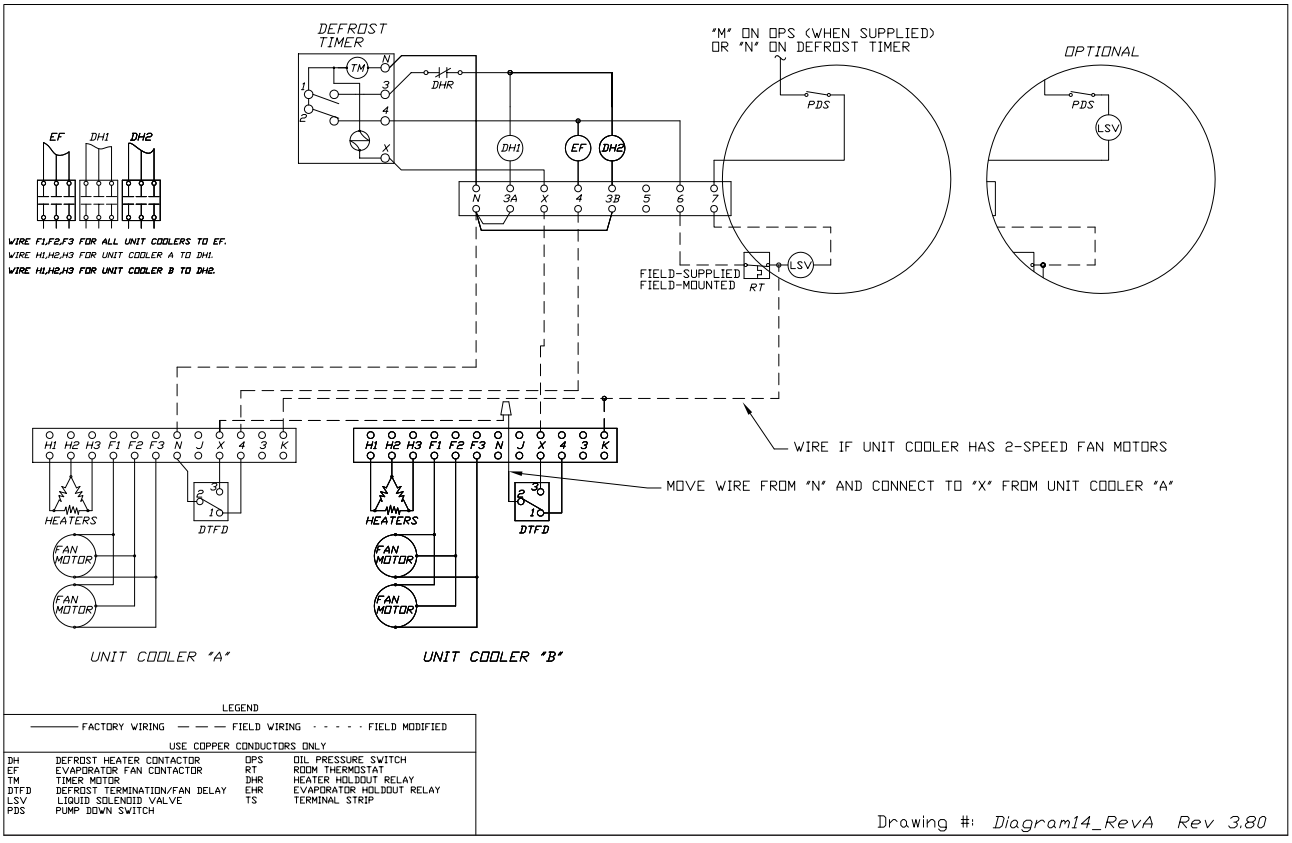


Diagram 15. Typical Wiring Diagram for Multiple Evaporators with Heater Limit Defrost and Evaporator Fan Contactors

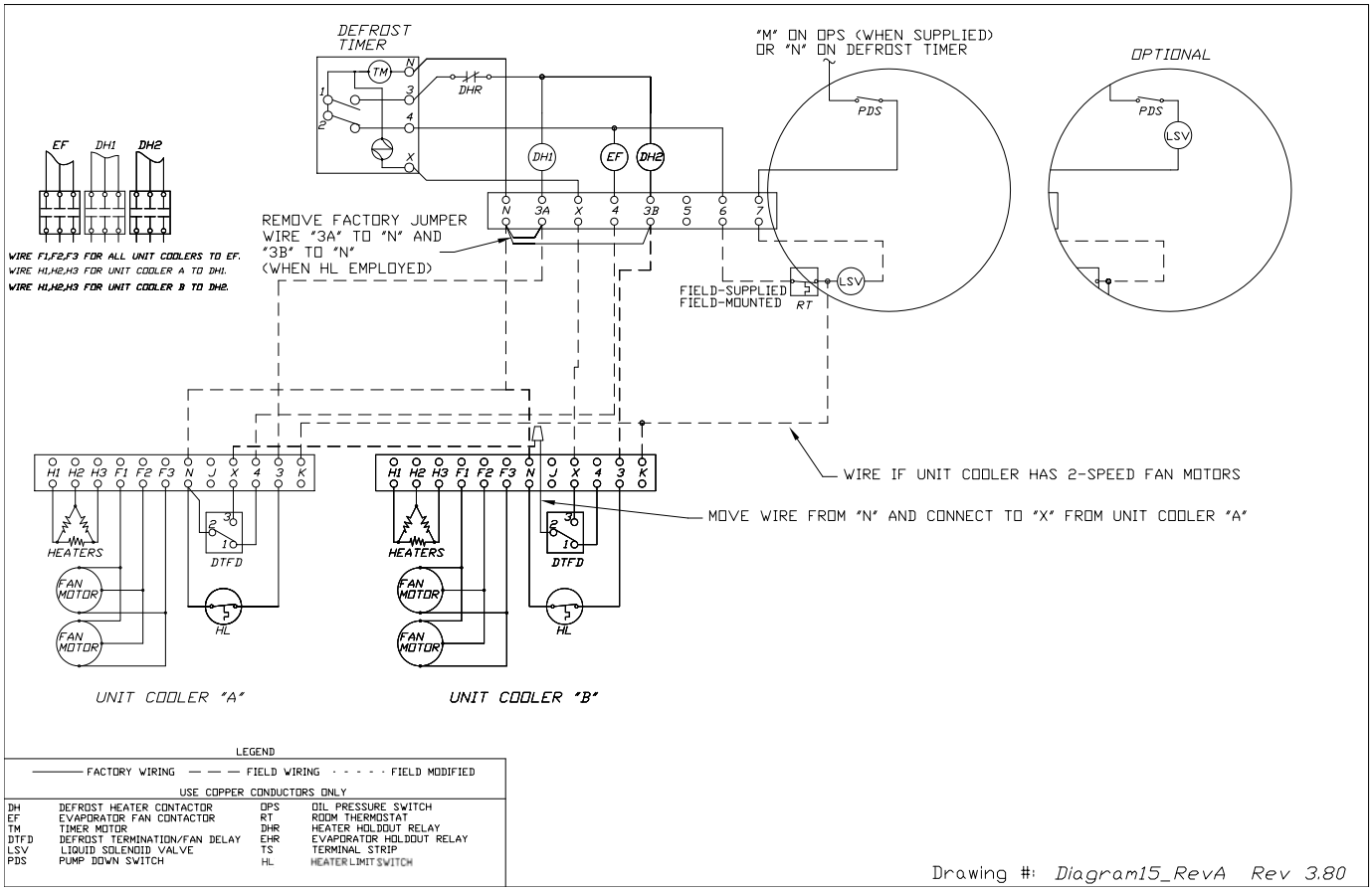


Diagram 16. Typical Wiring Diagram for Multiple Evaporators Defrost and Evaporator Fan Contactors with Unit Cooler Holdout Relay

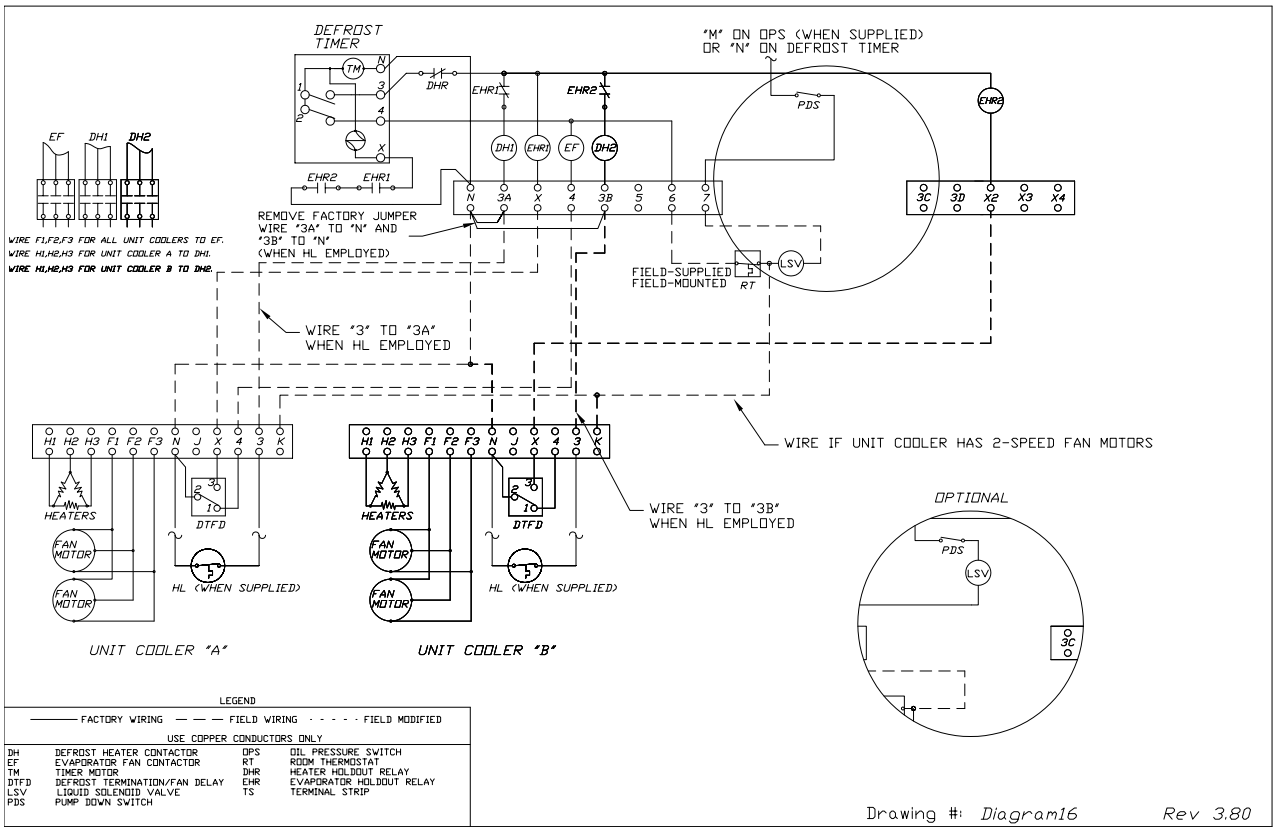
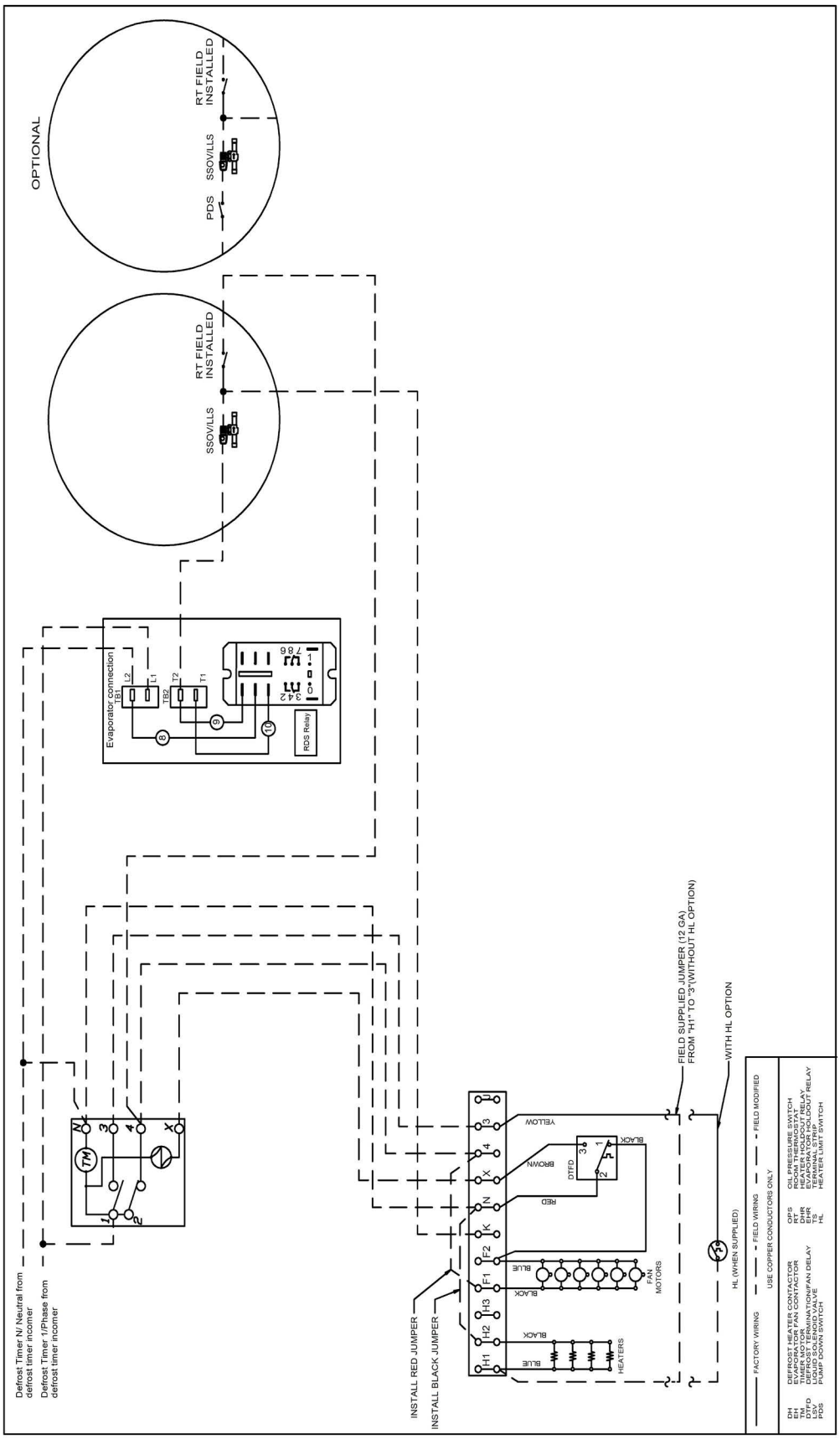
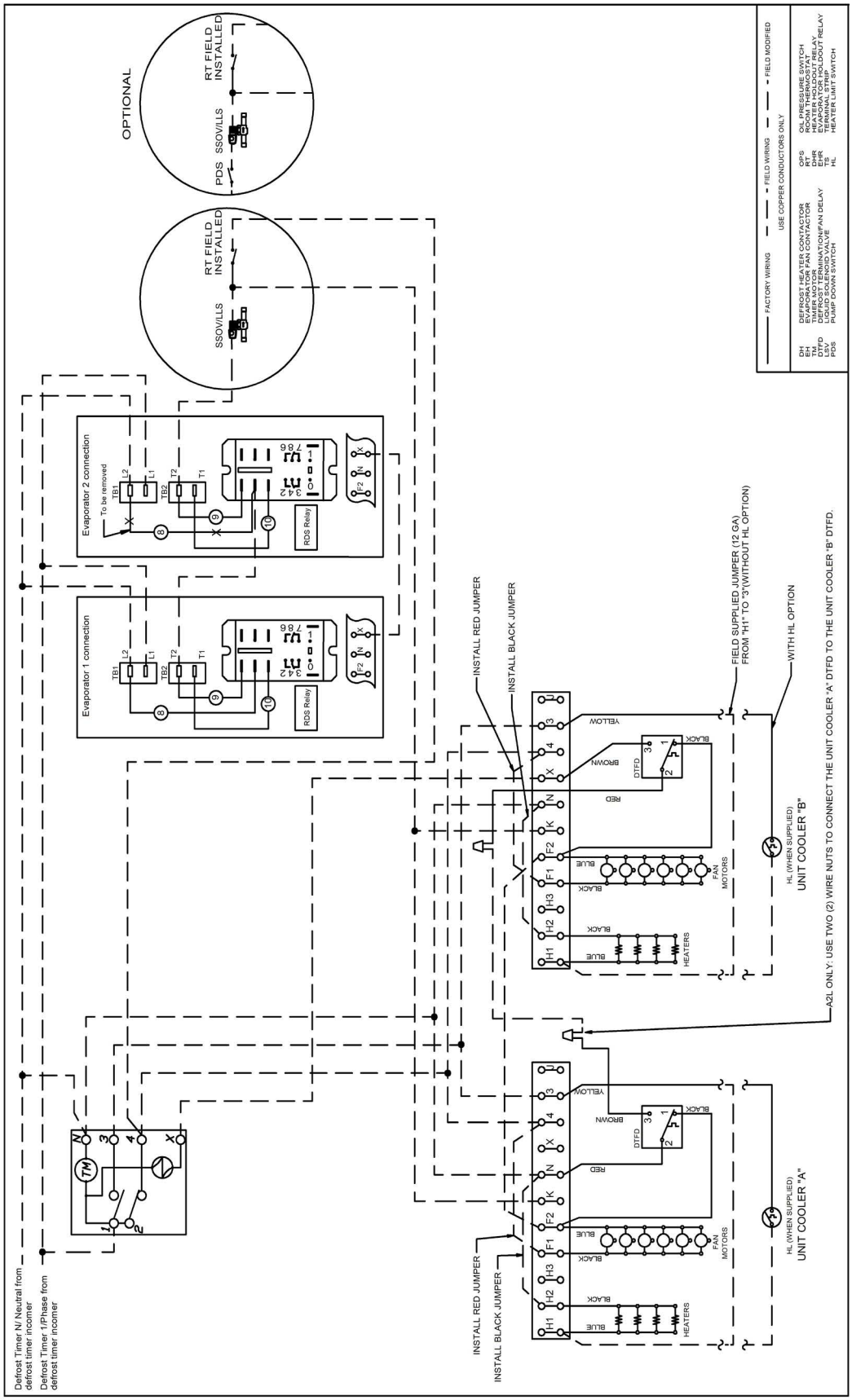


Diagram 17. Typical Wiring Diagram for A2L Single Evaporator (LOP) Electric Defrost Unit with RDS System



NOTE: This wiring diagram is an example for reference only. See the wiring diagram attached in the unit for actual wiring.

Diagram 18. Typical Wiring Diagram for A2L Multiple Evaporator (LOP) Electric Defrost Unit with RDS System



NOTE: This wiring diagram is an example for reference only. See the wiring diagram attached in the unit for actual wiring.

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Replacement Parts by InterLINK Commercial Refrigeration Parts

InterLink™ Comercial Refrigeration Parts is your link to a complete line of dependable and certified commercial refrigeration parts, accessories and innovative electronic controls for all Heatcraft Refrigeration Products (HRP) brands - including Bohn, Larkin, Climate Control and Chandler. At InterLink, we provide our wholesalers with a comprehensive selection of product solutions and innovative technologies for the installed customer base. And every product is built to ensure the same high performance standards with which all HRP brands are built — backed by a dedicated team to serve every customer need, delivering at the best lead times in the industry.

Replacement parts should be obtained from your local InterLink wholesaler. Replacement parts, which are covered under the terms of the warranty statement on page 2 of this manual, will be reimbursed for total part cost only. The original invoice from the parts supplier must accompany all warranty claims for replacement part reimbursement. Heatcraft Refrigeration Products reserves the right to adjust the compensation amount paid on any parts submitted for warranty reimbursement when a parts supplier's original invoice is not provided with a claim. **For more information, call 800-686-7278 or visit www.interlinkparts.com.**

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