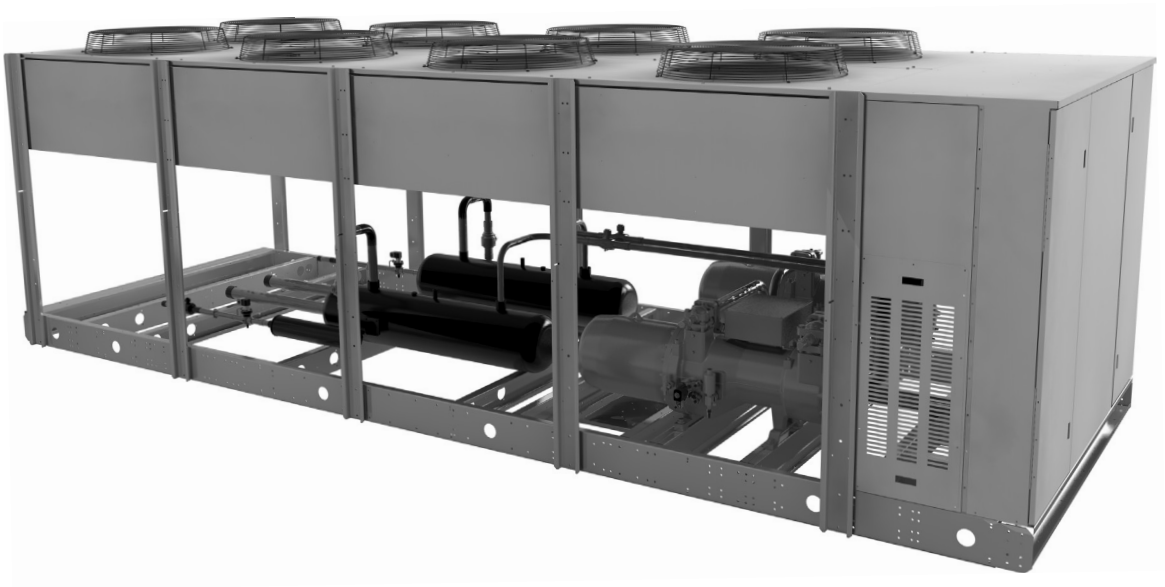
HEATCRAFT™ Worldwide Refrigeration

# Installation and Operations Manual

H-IM-SCU | October 2015 | Part No. 25008501

# Screw Compressor 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. All units are pressurized with dry air or inert gas. All units must be evacuated before charging the system with refrigerant.
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:** *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 that motor compressor replacements or exchanges shall be made through the nearest authorized wholesaler of the motor compressor manufacturer (not at SELLER's factory) and no freight shall be allowed for transportation of the motor compressor to and from the 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:

1. System piping must be in accordance with good refrigeration practices.
2. **Inert gas must be charged into the piping during brazing.**
3. The power supply to the unit must meet the following conditions:
   A. Three phase voltages must be +/- 10% of nameplate ratings.
4. B. Phase imbalance cannot exceed 2%.
5. All control and safety switch circuits must be properly connected according to the wiring diagram.
6. The factory installed wiring and piping must not be changed without written factory approval.
7. All equipment is installed in accordance with Heatcraft Refrigeration Products specified minimum clearances.

## Space and Location Requirements for Air Cooled Condensing Units

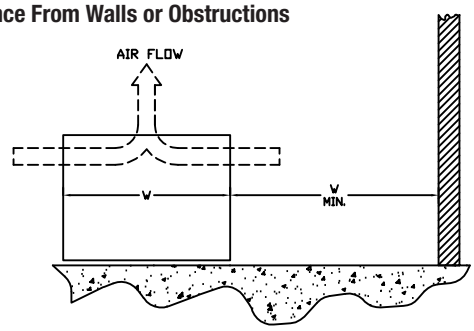
The most important consideration which must be taken into account when deciding upon the location of air-cooled equipment is the provision for a supply of ambient air to the condenser, and removal of heated air from the condensing unit or remote condenser area. Where this essential requirement is not 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.

## 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.

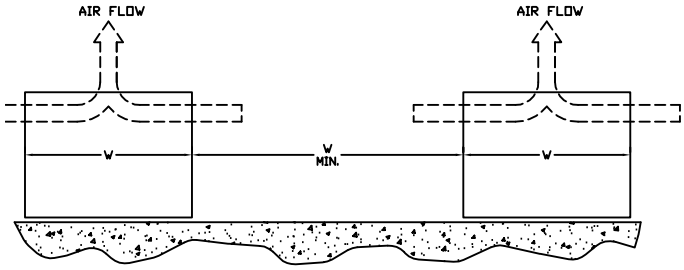
**Clearance From Walls or Obstructions**




## 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.

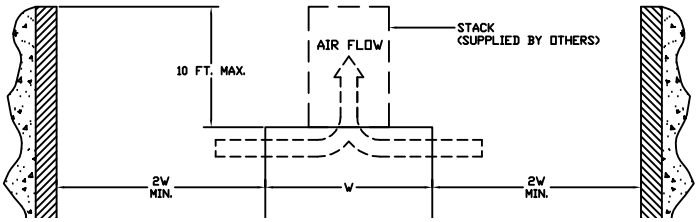
**Clearance For Multiple Units Placed Side by Side**




## 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.

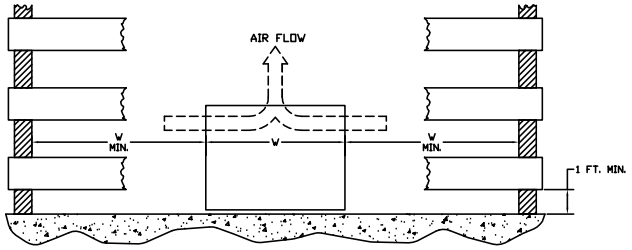
**Clearance For Units in Pits**




## Decorative Fences

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

**Clearance For Fence Enclosures**



## Condensing Unit Rigging and Mounting

Rigging holes are provided on all units. 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

Concrete slab raised six inches above ground level provides a suitable base. Raising the base above ground level provides some protection from ground water and wind blown matter. Before tightening mounting bolts, recheck level of unit. The unit should in all cases be located with a clear space in all directions that is at a minimum, equal to the height of the unit above the mounting surface. A condensing unit mounted in a corner formed by two walls, may result in discharge air recirculation with resulting loss of capacity.

## Roof Mounting

Due to the weight of the units, a structural analysis by a qualified engineer may be required before 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.

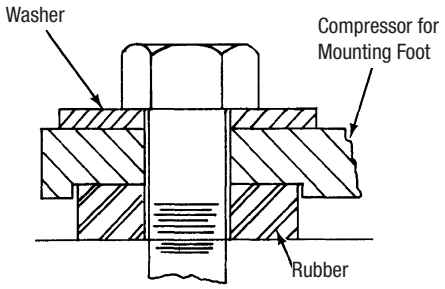
## Access

Sufficient access must provided to ensure future service of all major components is possible. The screw compressor, as well as some of the compressors removable components are heavy enough to require additional lifting equipment for service. Care must be taken during condensing unit placement to accommodate the use of service equipment for maintenance or repair.

## Pad Mounted Compressor

All units use pad mounted compressors. Check the compressor mounting bolts to insure they have not vibrated loose during shipment. See Figure 4.

**Figure 4. Pad Mount for Mobile or Deep Sump Application**

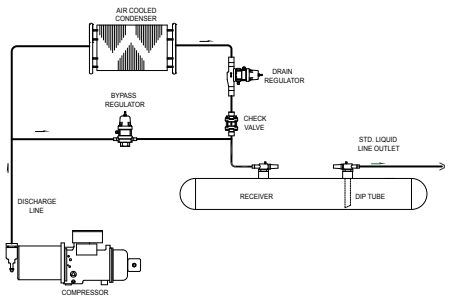



## Head Pressure Control

Head pressure control is managed by the microprocessor controller. Fan management is constantly monitored and adjusted by the controller to maintain the target head pressure.

### 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 160 to 180 PSIG."flooding" of the condenser with liquid refrigerant reduces the available condensing surface, holding the condensing pressure at the valve setting.

### b. 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 90˚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.

## 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.

## Oil Type

BITZER Compact Screws are available in both standard CSH models for medium and high temperature condensing applications. These compressors offer excellent part and full load efficiencies.

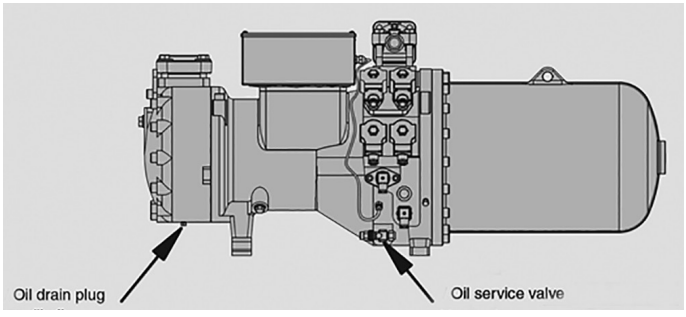
A key aspect to utilizing these compressors to their fullest potential is specifying the correct oil for your refrigerant. CSH screws may use BSE 170 oil in a variety of refrigerants (R134a, R407C, R404A and R507A).

**Table 2. Refrigeration Oils**

| Model | Refrigerant | OIL |
|---|---|---|
| CSH | R22 | B320SH |
| | R134a / R407C / R404A / R507A | BSE170 |

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.

**ISO 170 (880 SUS) POE oil**
**OIL CHANGE**

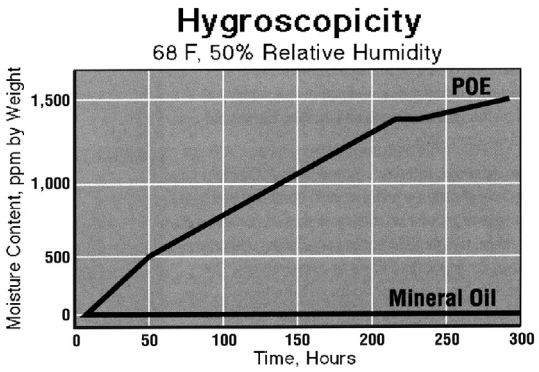


## Polyol Ester Lubricants Hygroscopicity

Ester lubricants (POE) have the characteristic of quickly absorbing moisture from the ambient surroundings. This is shown graphically in Figure 8 where it can be seen that such lubricants absorb moisture faster and in greater quantity than conventional mineral oils. 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

**Figure 8.**




## 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.

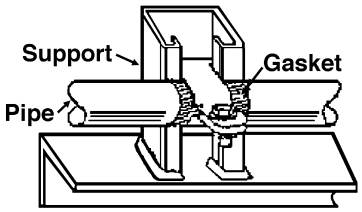
Install all refrigeration system components in accordance with applicable local and national codes and in conformance with good practice required for the proper operation of the system.

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:

1. Do not leave dehydrated compressors or filter-driers on condensing units open to the atmosphere any longer than is absolutely necessary.
2. Use only refrigeration grade copper tubing, properly sealed against contamination.
3. Suction lines should slope 1/4" per 10 feet towards the compressor.
4. Suitable P-type oil traps should be located at the base of each suction riser to enhance oil return to the compressor.
5. 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.
6. **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.**
7. Use only a suitable silver solder alloy on suction and liquid lines.
8. 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.
9. If isolation valves are installed at the evaporator, full port ball valves should be used.

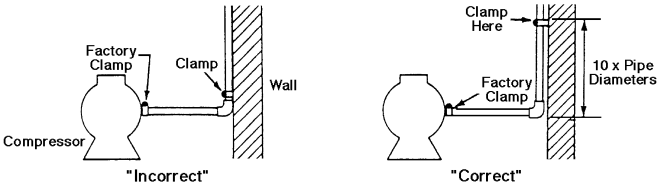
**Figure 9. Example of Pipe Support**




## 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 every 7 feet; and 1-5/8 and 2-1/8 every 9 to 10 feet.
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.
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 10. Condensing Unit / Compressor to Wall Support**



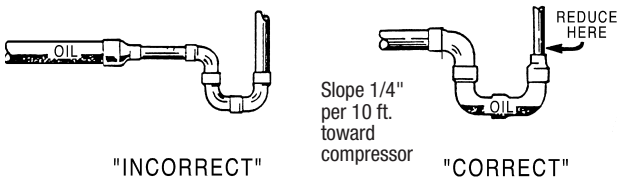
## Suction Lines

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. See the **Line Insulation** section on page 14 for more information.

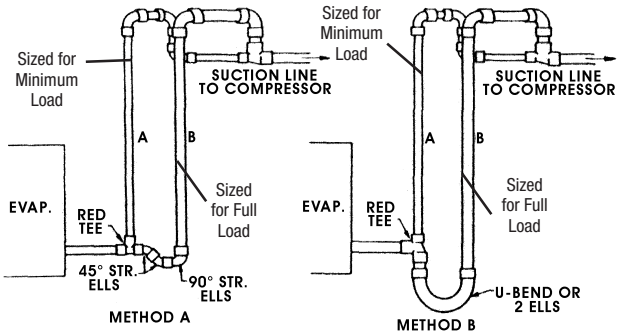
**Figure 11. Suction P-Traps**




## 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 11 for methods of constructing proper suction line P-traps.

**Figure 12. 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 on high pressure systems. The amount of subcooling will depend on the design and size of the heat exchanger and on the operating suction and discharge pressures. An additional benefit from the use of the suction to liquid type heat exchanger is that it can help raise the superheat in the suction line to prevent liquid return to the compressor via the suction line. Generally, heat exchangers are not recommended on R- low temperature systems. However, they have proved necessary on short, well insulated suction line runs to provide superheat at the compressor.

## Unit Cooler Piping

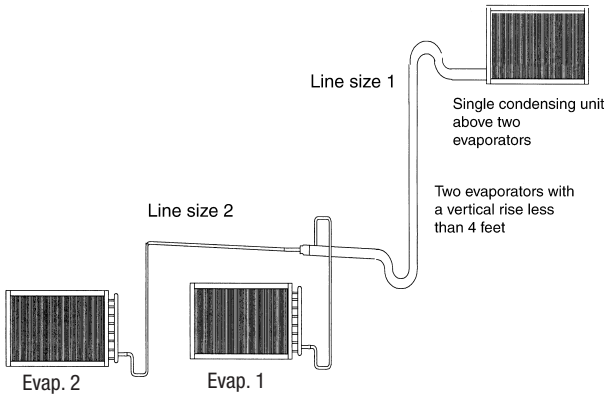
### Pipe size example:

Given: **30*F Cooler** with one system having (2) evaporators

- One condensing unit rated at 350,000 BTUH's @ 20°F SST R404A refrigerant.
- Two evaporators each rated at 175,000 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.




### Fittings in this system:

- (6) 90° elbows in main line plus a 90° turn through a tee.
- (5) additional 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 350,000 BTUH's (Table 8).
2. Refer to 350,000@100 feet at 20°F SST R404A on the chart. You will find the suction line to be 2-5/8"and 1-3/8" liquid line.
3. Refer to Table 5. For every 1-3/8" 90° elbow you must add 7 equivalent feet of pipe and 4 equivalent feet of pipe for each 1-3/8" tee.

   Therefore, total equivalent line run =

   | | |
   |---|---|
   | Actual line run | 100 feet |
   | + (6) 2-5/8" elbows @ 4' | 42 feet |
   | + (1) 2-5/8" tee @ 2.5' | 2.5 feet |
   | **Total equivalent line run** | **146 feet** |

4. Refer to Table 8. For 126.5 total equivalent feet, the suction line size should be 2-5/8" and the liquid line stays at 1-3/8" line.

**NOTE:** The gray shaded areas on Table 8. For 350,000 BTUH's, the maximum suction riser is 2-5/8"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 175,000 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. Table 8 indicates 1-5/8" suction for the first evaporator and indicates 1-5/8" suction for the second evaporator.
3. Refer to Table 5. Each 1-5/8" 90° elbow adds 4 equivalent feet of pipe. Each 90° turn through a 1-5/8" tee adds 8 equivalent feet.
4. Actual line run (evap 1)105 feet

   | | |
   |---|---|
   | + (5) 1-5/8" elbows @ 4' | 20 feet |
   | + (1) 90° turn through tee @ 8' | 6 feet |
   | **Total equivalent line run** | **133 feet** |

   Actual line run (evap 2) 120 feet

   | | |
   |---|---|
   | + (4) 1-5/8" elbows @ 3' | 16 feet |
   | **Total equivalent line run** | **136 feet** |

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

## Line Sizing

The following Tables 6 and 7 indicate liquid lines and suction lines for all condensing units for R404A, R507, and R407C.

When determining the refrigerant line length, be sure to add an allowance for fittings. See Table 5. Total equivalent length of refrigerant lines is the sum of the actual linear footage and the allowance for fittings.

**Table 3. 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 | | |
|---|---|---|---|---|---|
| | | | | +20˚F | +40˚F |
| 3/8 | R507, 404A, R407C | 3.4 | 0.31 | 0.09 | 0.13 |
| 1/2 | R507, 404A, R407C | 6.4 | 0.58 | 0.16 | 0.24 |
| 5/8 | R507, 404A, R407C | 10.3 | 0.93 | 0.25 | 0.35 |
| 7/8 | R507, 404A, R407C | 21.2 | 1.92 | 0.51 | 0.72 |
| 1-1/8 | R507, 404A, R407C | 36.1 | 3.27 | 0.86 | 1.24 |
| 1-3/8 | R507, 404A, R407C | 55.0 | 4.98 | 1.32 | 1.87 |
| 1-5/8 | R507, 404A, R407C | 78.0 | 7.07 | 1.86 | 2.64 |
| 2-1/8 | R507, 404A, R407C | 134 | 12.25 | 3.23 | 4.58 |
| 2-5/8 | R507, 404A, R407C | 209 | 18.92 | 5.00 | 7.07 |
| 3-1/8 | R507, 404A, R407C | 298 | 27.05 | 7.14 | 9.95 |
| 3-5/8 | R507, 404A, R407C | 403 | 36.50 | 19.65 | 13.67 |
| 4-1/8 | R507, 404A, R407C | 526 | 47.57 | 12.58 | 17.80 |
| 5-1/8 | R507, 404A, R407C | 812 | 73.43 | 19.42 | 27.48 |

**Table 4. 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 |
| R507, R404A, R407c | 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 |

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

**Table 5. 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 | 24 | 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 | 24 | 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 6. Recommended Suction Line Sizes for R-404A, R-407C***

| Capacity | 45 Degrees | | | | | | | 40 Degrees | | | | | | | 30 Degrees | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 25' | 50' | 75' | 100' | 150' | 200' | 250' | 25' | 50' | 75' | 100' | 150' | 200' | 250' | 25' | 50' | 75' | 100' | 150' | 200' | 250' |
| 1000 | 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 | 3/8 |
| 3000 | 3/8 | 3/8 | 3/8 | 3/8 | 3/8 | 1/2 | 1/2 | 3/8 | 3/8 | 3/8 | 3/8 | 1/2 | 1/2 | 1/2 | 3/8 | 3/8 | 3/8 | 1/2 | 1/2 | 1/2 | 1/2 |
| 4000 | 3/8 | 3/8 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 3/8 | 3/8 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 3/8 | 1/2 | 1/2 | 1/2 | 1/2 | 5/8 | 5/8 |
| 6000 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 5/8 | 5/8 | 3/8 | 1/2 | 1/2 | 1/2 | 5/8 | 5/8 | 5/8 | 1/2 | 1/2 | 1/2 | 5/8 | 5/8 | 5/8 | 5/8 |
| 9000 | 1/2 | 1/2 | 5/8 | 5/8 | 5/8 | 5/8 | 5/8 | 1/2 | 1/2 | 5/8 | 5/8 | 5/8 | 5/8 | 5/8 | 1/2 | 5/8 | 5/8 | 5/8 | 7/8 | 7/8 | 7/8 |
| 12000 | 1/2 | 5/8 | 5/8 | 5/8 | 5/8 | 7/8 | 7/8 | 1/2 | 5/8 | 5/8 | 7/8 | 7/8 | 7/8 | 7/8 | 5/8 | 5/8 | 5/8 | 7/8 | 7/8 | 7/8 | 7/8 |
| 15000 | 5/8 | 5/8 | 5/8 | 7/8 | 7/8 | 7/8 | 7/8 | 5/8 | 5/8 | 7/8 | 7/8 | 7/8 | 7/8 | 7/8 | 5/8 | 5/8 | 7/8 | 7/8 | 7/8 | 7/8 | 7/8 |
| 18000 | 5/8 | 7/8 | 7/8 | 7/8 | 7/8 | 7/8 | 7/8 | 5/8 | 7/8 | 7/8 | 7/8 | 7/8 | 7/8 | 7/8 | 5/8 | 7/8 | 7/8 | 7/8 | 7/8 | 7/8 | 7/8 |
| 24000 | 5/8 | 7/8 | 7/8 | 7/8 | 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 | 7/8 | 1 1/8 | 1 1/8 |
| 30000 | 7/8 | 7/8 | 7/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 7/8 | 7/8 | 7/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 7/8 | 7/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 1/8 |
| 36000 | 7/8 | 7/8 | 7/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 7/8 | 7/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 1/8 | 7/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 1/8 |
| 42000 | 7/8 | 7/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 1/8 | 7/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 1/8 | 7/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 1/8 |
| 48000 | 7/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 1/8 | 7/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 1/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 |
| 54000 | 7/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 1/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 3/8 |
| 60000 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 3/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 3/8 |
| 66000 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 3/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 3/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 3/8 |
| 72000 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 3/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 3/8 | 7/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 3/8 | 1 3/8 |
| 78000 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 3/8 | 7/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 3/8 | 1 3/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 3/8 | 1 3/8 | 1 3/8 |
| 84000 | 7/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 3/8 | 1 3/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 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 |
| 90000 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 3/8 | 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 | 1 1/8 | 1 3/8 | 1 3/8 | 1 3/8 | 1 5/8 | 1 5/8 | 1 5/8 |
| 120000 | 1 1/8 | 1 3/8 | 1 3/8 | 1 5/8 | 1 5/8 | 1 5/8 | 1 5/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 5/8 | 1 5/8 | 1 5/8 | 1 5/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 5/8 | 1 5/8 | 1 5/8 | 1 5/8 |
| 150000 | 1 1/8 | 1 3/8 | 1 3/8 | 1 5/8 | 1 5/8 | 1 5/8 | 2 1/8 | 1 3/8 | 1 3/8 | 1 5/8 | 1 5/8 | 1 5/8 | 2 1/8 | 2 1/8 | 1 3/8 | 1 5/8 | 1 5/8 | 1 5/8 | 2 1/8 | 2 1/8 | 2 1/8 |
| 180000 | 1 3/8 | 1 3/8 | 1 5/8 | 1 5/8 | 1 5/8 | 2 1/8 | 2 1/8 | 1 3/8 | 1 3/8 | 1 5/8 | 1 5/8 | 2 1/8 | 2 1/8 | 2 1/8 | 1 3/8 | 1 5/8 | 1 5/8 | 2 1/8 | 2 1/8 | 2 1/8 | 2 1/8 |
| 210000 | 1 3/8 | 1 5/8 | 1 5/8 | 1 5/8 | 2 1/8 | 2 1/8 | 2 1/8 | 1 3/8 | 1 5/8 | 1 5/8 | 2 1/8 | 2 1/8 | 2 1/8 | 2 1/8 | 1 3/8 | 1 5/8 | 2 1/8 | 2 1/8 | 2 1/8 | 2 1/8 | 2 1/8 |
| 240000 | 1 3/8 | 1 5/8 | 1 5/8 | 2 1/8 | 2 1/8 | 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 1/8 | 1 5/8 | 2 1/8 | 2 1/8 | 2 1/8 | 2 1/8 | 2 1/8 | 2 1/8 |
| 300000 | 1 5/8 | 2 1/8 | 2 1/8 | 2 1/8 | 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 | 1 5/8 | 2 1/8 | 2 1/8 | 2 1/8 | 2 5/8 | 2 5/8 | 2 5/8 |
| 360000 | 1 5/8 | 2 1/8 | 2 1/8 | 2 1/8 | 2 5/8 | 2 5/8 | 2 5/8 | 1 5/8 | 2 1/8 | 2 1/8 | 2 1/8 | 2 5/8 | 2 5/8 | 2 5/8 | 2 1/8 | 2 1/8 | 2 1/8 | 2 5/8 | 2 5/8 | 2 5/8 | 2 5/8 |
| 480000 | 2 1/8 | 2 1/8 | 2 1/8 | 2 5/8 | 2 5/8 | 2 5/8 | 2 5/8 | 2 1/8 | 2 1/8 | 2 1/8 | 2 5/8 | 2 5/8 | 2 5/8 | 2 5/8 | 2 1/8 | 2 5/8 | 2 5/8 | 2 5/8 | 3 1/8 | 3 1/8 | 3 1/8 |
| 600000 | 2 1/8 | 2 1/8 | 2 5/8 | 2 5/8 | 2 5/8 | 3 1/8 | 3 1/8 | 2 1/8 | 2 5/8 | 2 5/8 | 2 5/8 | 3 1/8 | 3 1/8 | 3 1/8 | 2 1/8 | 2 5/8 | 2 5/8 | 2 5/8 | 3 1/8 | 3 1/8 | 3 1/8 |
| 720000 | 2 1/8 | 2 5/8 | 2 5/8 | 2 5/8 | 3 1/8 | 3 1/8 | 3 1/8 | 2 1/8 | 2 5/8 | 2 5/8 | 3 1/8 | 3 1/8 | 3 1/8 | 3 1/8 | 2 1/8 | 2 5/8 | 2 5/8 | 3 1/8 | 3 1/8 | 3 1/8 | 3 1/8 |
| 900000 | 2 5/8 | 2 5/8 | 3 1/8 | 3 1/8 | 3 1/8 | 3 5/8 | 3 5/8 | 2 5/8 | 2 5/8 | 3 1/8 | 3 1/8 | 3 5/8 | 3 5/8 | 3 5/8 | 2 5/8 | 2 5/8 | 3 1/8 | 3 1/8 | 3 5/8 | 3 5/8 | 3 5/8 |
| 1200000 | 2 5/8 | 2 5/8 | 3 1/8 | 3 5/8 | 3 5/8 | 3 5/8 | 3 5/8 | 2 5/8 | 3 1/8 | 3 1/8 | 3 5/8 | 3 5/8 | 3 5/8 | 3 5/8 | 3 1/8 | 3 1/8 | 3 1/8 | 3 5/8 | 3 5/8 | 3 5/8 | 4 1/8 |
| 1400000 | 2 5/8 | 3 5/8 | 3 5/8 | 3 5/8 | 4 1/8 | 4 1/8 | 4 1/8 | 2 5/8 | 3 1/8 | 3 1/8 | 3 5/8 | 4 1/8 | 4 1/8 | 4 1/8 | 3 1/8 | 3 5/8 | 3 5/8 | 4 1/8 | 4 1/8 | 4 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. *If system load drops below 40% of design, consideration to installing double suction risers should be made.*

**Table 7. Recommended Line Sizes for R-404A and R-407C***

| Capacity | 20 Degrees | | | | | | | 10 Degrees | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 25' | 50' | 75' | 100' | 150' | 200' | 250' | 25' | 50' | 75' | 100' | 150' | 200' | 250' |
| 1000 | 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 |
| 3000 | 3/8 | 3/8 | 3/8 | 1/2 | 1/2 | 1/2 | 1/2 | 3/8 | 3/8 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 |
| 4000 | 3/8 | 1/2 | 1/2 | 1/2 | 5/8 | 5/8 | 5/8 | 3/8 | 1/2 | 1/2 | 5/8 | 5/8 | 5/8 | 5/8 |
| 6000 | ½ | 1/2 | 1/2 | 5/8 | 5/8 | 5/8 | 5/8 | 1/2 | 1/2 | 5/8 | 5/8 | 5/8 | 5/8 | 5/8 |
| 9000 | 1/2 | 5/8 | 5/8 | 7/8 | 7/8 | 7/8 | 7/8 | 1/2 | 5/8 | 5/8 | 7/8 | 7/8 | 7/8 | 7/8 |
| 12000 | 5/8 | 5/8 | 7/8 | 7/8 | 7/8 | 7/8 | 7/8 | 5/8 | 7/8 | 7/8 | 7/8 | 7/8 | 7/8 | 7/8 |
| 15000 | 5/8 | 7/8 | 7/8 | 7/8 | 7/8 | 7/8 | 7/8 | 5/8 | 7/8 | 7/8 | 7/8 | 7/8 | 7/8 | 7/8 |
| 18000 | 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 | 1 1/8 | 1 1/8 |
| 24000 | 7/8 | 7/8 | 7/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 7/8 | 7/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 1/8 |
| 30000 | 7/8 | 7/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 1/8 | 7/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 1/8 |
| 36000 | 7/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 1/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 |
| 42000 | 7/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 1/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 3/8 |
| 48000 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 3/8 | 7/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 3/8 |
| 54000 | 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 1/8 | 1 3/8 | 1 3/8 | 1 3/8 | 1 3/8 |
| 60000 | 1 1/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 3/8 | 1 3/8 | 1 1/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 3/8 | 1 3/8 |
| 66000 | 1 1/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 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 |
| 72000 | 1 1/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 3/8 | 1 5/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 3/8 | 1 5/8 | 1 5/8 |
| 78000 | 1 1/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 5/8 | 1 5/8 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 5/8 | 1 5/8 | 1 5/8 |
| 84000 | 1 1/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 5/8 | 1 5/8 | 1 5/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 3/8 | 1 5/8 | 1 5/8 | 1 5/8 |
| 90000 | 1 1/8 | 1 3/8 | 1 3/8 | 1 5/8 | 1 5/8 | 1 5/8 | 1 5/8 | 1 1/8 | 1 3/8 | 1 3/8 | 1 5/8 | 1 5/8 | 1 5/8 | 1 5/8 |
| 120000 | 1 3/8 | 1 3/8 | 1 5/8 | 1 5/8 | 1 5/8 | 2 1/8 | 2 1/8 | 1 3/8 | 1 5/8 | 1 5/8 | 1 5/8 | 2 1/8 | 2 1/8 | 2 1/8 |
| 150000 | 1 3/8 | 1 5/8 | 1 5/8 | 1 5/8 | 2 1/8 | 2 1/8 | 2 1/8 | 1 3/8 | 1 5/8 | 1 5/8 | 2 1/8 | 2 1/8 | 2 1/8 | 2 1/8 |
| 180000 | 1 3/8 | 1 5/8 | 1 5/8 | 2 1/8 | 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 |
| 210000 | 1 5/8 | 1 5/8 | 2 1/8 | 2 1/8 | 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 |
| 240000 | 1 5/8 | 2 1/8 | 2 1/8 | 2 1/8 | 2 1/8 | 2 5/8 | 2 5/8 | 1 5/8 | 2 1/8 | 2 1/8 | 2 1/8 | 2 5/8 | 2 5/8 | 2 5/8 |
| 300000 | 1 5/8 | 2 1/8 | 2 1/8 | 2 1/8 | 2 5/8 | 2 5/8 | 2 5/8 | 2 1/8 | 2 1/8 | 2 1/8 | 2 5/8 | 2 5/8 | 2 5/8 | 2 5/8 |
| 360000 | 2 1/8 | 2 1/8 | 2 1/8 | 2 5/8 | 2 5/8 | 2 5/8 | 2 5/8 | 2 1/8 | 2 1/8 | 2 5/8 | 2 5/8 | 2 5/8 | 2 5/8 | 2 5/8 |
| 480000 | 2 1/8 | 2 5/8 | 2 5/8 | 2 5/8 | 3 1/8 | 3 1/8 | 3 1/8 | 2 1/8 | 2 5/8 | 2 5/8 | 3 1/8 | 3 1/8 | 3 1/8 | 3 1/8 |
| 600000 | 2 5/8 | 2 5/8 | 2 5/8 | 3 1/8 | 3 1/8 | 3 1/8 | 3 1/8 | 2 1/8 | 2 5/8 | 3 1/8 | 3 1/8 | 3 1/8 | 3 5/8 | 3 5/8 |
| 720000 | 2 5/8 | 2 5/8 | 3 1/8 | 3 1/8 | 3 5/8 | 3 5/8 | 3 5/8 | 2 5/8 | 3 1/8 | 3 1/8 | 3 1/8 | 3 5/8 | 3 5/8 | 3 5/8 |
| 900000 | 2 5/8 | 3 1/8 | 3 1/8 | 3 5/8 | 3 5/8 | 3 5/8 | 3 5/8 | 2 5/8 | 3 1/8 | 3 5/8 | 3 5/8 | 3 5/8 | 4 1/8 | 4 1/8 |
| 1200000 | 3 1/8 | 3 5/8 | 3 5/8 | 3 5/8 | 4 1/8 | 4 1/8 | 4 1/8 | 3 1/8 | 3 5/8 | 3 5/8 | 3 5/8 | 4 1/8 | 4 1/8 | 4 1/8 |
| 1400000 | 3 1/8 | 3 5/8 | 3 5/8 | 4 1/8 | 5 1/8 | 5 1/8 | 5 1/8 | 3 5/8 | 3 5/8 | 4 1/8 | 5 1/8 | 5 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. *If system load drops below 40% of design, consideration to installing double suction risers should be made.*

## 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.

Manufacturer recommendation is a minimum of 500 micron evacuation. In addition, a vacuum decay test is strongly recommended to assure there is not a large pressure differential between the system and vacuum pump. Good evacuation processes include frequent vacuum pump oil changes and large diameter, short hose connections to both high and low sides of the system preferably using bronze braided hose. Leak detection can be carried out in the conventional manner. If HCFC or CFC tracer gas is used, care must be taken to completely remove all traces of the gas prior to introducing HFC's.

Electronic leak detectors are now available that will sense HFC's. This is considered preferable since it removes the possibility of chlorine remaining in the system after leak testing with HCFC's and/or CFC's. There is a view that even small quantities of chlorine may act as a catalyst encouraging copper plating and/or corrosion and should therefore be avoided.

## Leak Testing

After all lines are connected, the entire system must be leak tested. The complete system should be pressurized to not more than 150 psig with refrigerant and dry nitrogen (or dry $CO_2$). The use of an electronic type leak detector is highly recommended because of its greater sensitivity to small leaks. As a further check it is recommended that this pressure be held for a minimum of 12 hours and then rechecked. For a satisfactory installation, the system must be leak tight.

## Line Insulation

After the final leak test, refrigerant lines exposed to high ambient conditions should be insulated to reduce heat pickup and prevent the formation of flash gas in the liquid lines. Suction lines must always be insulated with 3/4" wall Armstrong "Armaflex" or equal. When required, Liquid lines should be insulated with 1/2 inch wall insulation or better. The insulation located in outdoor environments should be protected from UV exposure to prevent deterioration of insulating value.

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

## Evacuation

A good, deep vacuum pump should be connected to both the low and high side evacuation valves with copper tube or high vacuum hoses (1/4" ID minimum). If the compressor has service valves, they should remain closed. A deep vacuum gauge capable of registering pressure in microns should be attached to the system for pressure readings.

A shut off valve between the gauge connection and vacuum pump should be provided to allow the system pressure to be checked after evacuation. Do not turn off vacuum pump when connected to an evacuated system before closing shut off valve.
The vacuum pump should be operated until a pressure of 1,500 microns absolute pressure is reached — at which time the vacuum should be broken with the refrigerant to be used in the system through a drier until the system pressure rises above "0" psig.

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

**Repeat this operation a second time.**
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.

## Refrigerant Charging Instructions

1. Install a liquid line drier in the refrigerant supply line between the service gauge and the liquid service port of the receiver.
2. This extra drier will insure that all refrigerant supplied to the system is clean and dry.
3. When initially charging a system that is in a vacuum, liquid refrigerant can be added directly into the receiver tank.
4. Check equipment catalog for refrigerant capacity. System refrigerant capacity is 90% of receiver capacity. Do not add more refrigerant than the data tag indicates, unless the line run exceeds 25ft. Then, add additional refrigerant as per the chart on page 30. Weigh the refrigerant drum before charging so an accurate record can be kept of the weight of refrigerant put in the system.
5. Start the system and finish charging until the sight glass indicates a full charge and the proper amount has been weighed in. If the refrigerant must be added to the system through the suction side of the compressor, charge in vapor form only. Liquid charging must be done in the high side only or with liquid metering devices to protect the compressor.

**NOTE:** *R-407c should be introduced into the system as a liquid.*

## 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.

## Check Out and Start Up

1. After the installation has been completed, the following points should be covered before the system is placed in operation:
2. Check all electrical and refrigerant connections. Be sure they are all tight.
3. Check compressor mounting fasteners for tightness.
4. Check microprocessor for operation of high and low pressure controls, pressure regulating valves, oil pressure safety controls, and all other safety controls, and adjust if necessary.
5. Wiring diagrams, instruction bulletins, etc., attached to the condensing units should be read and filed for future reference.
6. All fan motors should be checked for proper rotation. Fan motor mounts should be carefully checked for tightness and proper alignment.
7. Electric evaporator fan motors should be temporarily wired for continuous operation until the room temperature has stabilized.
8. 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.
9. 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.
10. 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 within lower sight glass range.
11. Make sure all Schrader valve caps are in place and tight.
12. Make sure ALL service valves are properly back-seated and tighten valve packing if necessary.

**CAUTION:** Check phase rotation with phase meter prior to first start. Warranty will be denied if damage is a result of reverse rotation. 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.

## 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:

1. Check compressor discharge and suction pressures. If not within system design limits, determine why and take corrective action.
2. 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.
3. Observe oil level in compressor crankcase sight glass. Add oil as within lower sight glass range.
4. 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.
5. 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.
6. 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.
7. Check drain pan for proper drainage.
8. Check winter head pressure controls for pressure setting.
9. Check oil sump heater operation
10. 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.

Too high a suction superheat will result in excessive discharge temperatures which cause a break down of the oil and results in wear, and 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 compressor** be between 5˚F and 15˚F.

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

**NOTE:** *All adjustable controls and valves must be field adjusted to meet desired operation. There are no factory preset controls or valve adjustments. This includes low pressure, high pressure, adjustable head pressure systems and expansion valves.*

## General Sequence of Operation

1. At power up the Magnum will not start it's algorithm until Set Point.23, POWER UP DELAY, time has been satisfied.

2. At start up the MAGNUM verifies the 'NO RUN CAPACITY CONTROL STATES'.

3. If anyone of the 'NO RUN CAPACITY CONTROL STATES' is not satisfied, the following sequence occurs:
   - **a.** All compressors are not allowed to run. Any running compressor which has satisfied it's minimum run time (set point # 64) will have its liquid line solenoid turned off and the compressor turned off. (Pump down will occur if enabled).
   - **b.** The evaporator fan continues to run for 60 seconds (Set Point# 108 "PUMP DELAY") after the last compressor is turned off.

4. If all of the 'NO RUN CAPACITY CONTROL STATES' are satisfied, the capacity control logic is now allowed to run to maintain the Supply Air Temperature (or optionally Return or Zone Temperature) within the control zone defined by:
   - **a.** Set point #1 "CTL TARGET"
   - **b.** Set point #2 "CTL ZONE+"
   - **c.** Set point #3 "CTL ZONE-"

5. The Capacity control logic will increase or decrease the compressors WANTED ON versus ACTUAL ON' and maintain the compressors required. Capacity control logic for loading & unloading the chiller is as follows:
   - **a.** If the Supply Air Temperature is above the control zone and the Supply Air Temp. Rate of Change (ROC) is not indicating the supply air temperature is already decreasing at a sufficient rate, the condensing unit's capacity control logic will ask for more capacity by adding to the "Steps Wanted On" parameter. Once "Steps Wanted On" parameter has been increased the capacity control logic has a time delay before allowing the "Steps Wanted ON" to be increased again. The time delay is dependent on how far away the temperature is from target. Set Points #25 'STEP SENSIT' and Set Point #26 "STEP DELAY"
   - **b.** If the ROC indicates a sufficient decrease in Supply Air Temperature (ROC < Set Point #27 "Mac Roc-") the capacity control logic stops loading and holds the current capacity.
   - **c.** If the supply air temperature is below the control zone, special logic functions to keep the condensing unit's within the control zone.
   - **d.** If the supply air temperature is below the control zone and if the Supply Air Temp. Rate of Change (ROC) is not indicating the supply air temperature is already increasing at a sufficient rate, the condensing unit's capacity control logic ask for less capacity by subtracting from the "Steps Wanted On" parameter. Once "Step Wanted On" parameter has been decreased the capacity control logic has a time delay before allowing the "Steps Wanted On" to be decreased again. The time delay is dependant on how far away the temperature is from target, Set Points #25 "STEP SENSIT" and Set Point #26 "STEP DELAY"
   - **e.** If the ROC is indicating a sufficient increase in Supply Air Temperature (ROC < Set Point #27 "MAX ROC-" the capacity control logic stop in loading and holds the current capacity.

6. Once it has been determined that a compressor is wanted on the MAGNUM reviews the 'NO RUN CIRCUIT CONTROL STATES' to an available compressor, MAGNUM software runs its compressor control logic every second starting with the lead compressor. If a compressor is allowed to run (not locked out, tripped on a safety or disabled by pump down and /or flow switches) and the MAGNUM wants the compressor to run {"Steps Turned On is less than "Steps Wanted On") the compressor is started.

7. The condenser fan control logic runs once every second. Pumps and fans are cycled based on the compressor(s) discharge pressure and Set Point #45 to #55, depending on condenser type.

8. The Capacity State & Circuit Compressor State can be viewed via the 'STATUS' option under the 'Menu" key on the MAGNUM keypad or using PC-Connect soft ware on a Windows based computer.

**CURRENT STATE OF THE PACKAGE** *(Press 'Menu', position arrows to 'Status' Press Enter key )*

***The display show the current capacity of the package and how long we have been at this level. By pressing the PG↓ you will get an additional information on each circuit.***

**ACTUAL DISPLAY**

```
09:55      Unit      45/54
     UNIT IS UNLOADED
         025:42;33
WTD   ACT   WTD%   DLY    ROC
 0     0     40%   180    0.0
  TARGET=45.0 (ADJ +0.0)
              PG↑          PG↓
```

**DESCRIPTION**

```
HH:MM                COND. UNIT            SPLY/RTN
                CURRENT CONTROL STATE
                TIME IN CURRENT STATE
WANTED      ACTUAL      WANTED%     DELAY        SLOPE
#STEPS      #STEPS      ACTUAL%     NEXT CHG
DIRECTION
            TARGET SET POINT + TARGET RESET
                        PAGE UP              PAGE DN
```

**CURRENT STATE OF THE CIRCUIT** ***The display shows the current capacity of circuit (x) and how long we have been at this level. By pressing the F2 you will go back to the Chiller state display OR F3 you will get additional information on this circuit.***

**ACTUAL DISPLAY**

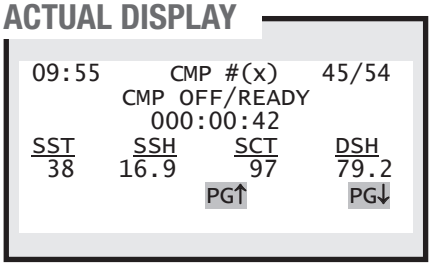
```
09:56      CMP #(x)    45/54
       CMP OFF/READY
         000:00;30
SUCT    DISC      OPD    MOTOR
 66P    190P      134P     0%
 55F    177F      ----     OK
              PG↑          PG↓
```

**DESCRIPTION**

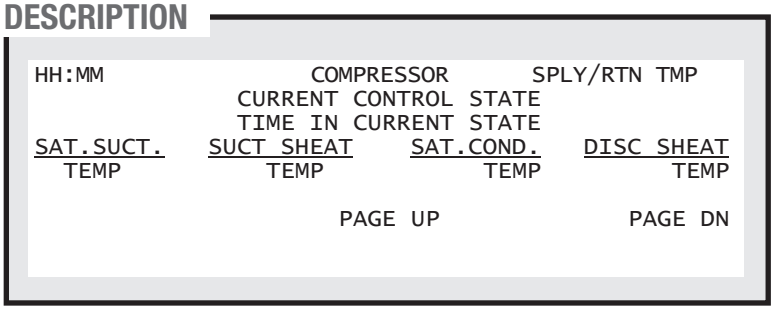
```
HH:MM                COMPRESSOR       SPLY/RTN TMP
                CURRENT CONTROL STATE
                TIME IN CURRENT STATE
  SUCTION     DISCHARGE    OIL DIFFERENTIAL    MOTOR
 PRESSURE      PRESSURE       PRESSURE           AMP
%
TEMPERATURE  TEMPERATURE        ----
STATUS
                        PAGE UP              PAGE DN
```

**CURRENT STATE OF THE CIRCUIT (cont.)**

## ACTUAL DISPLAY




## DESCRIPTION




9. The safeties (Comp no Stop, Phase Loss, Emergency Stop, High Sump Water Temperature) are checked once every second. (All of the safeties are options features). Once a safety has occurred the user is required to correct the problem and reset the unit using the 'Lckout RST' from the Menu on the MAGNUM's key pad.

10. If the compressor relay output is turned on, either by computer or manual, the compressor safeties are checked once every second. The following compressor safeties are supported:

    **a.** Low & Unsafe Suction Pressure
    **b.** Low & Unsafe Differential Oil Pressure
    **c.** Low & High Discharge Pressure
    **d.** High Discharge, Oil and Motor Temperatures
    **e.** Low & High Motor Ampere
    **f.** No Compressor Proof
    **g.** Freeze protection for split barrels units

*To reach the* **Main Menu** *press the Menu button after powering up.*

*Based on the highlighted menu option when the Enter key*  *is pressed it will bring up one fo the following screens.*

## MENU KEY

*Pressing the* **Menu Key** *shows the following:*

### ACTUAL DISPLAY

```
09:56    Main Menu
-Status        -Setpoints
-Outputs       -Serv Tools
-Inputs        -Lckout RST
-Alarms        -Lckout ALM
-Graphs        -Passwords
Help
```

### DESCRIPTION

```
HH:MM                Screen Title
-Control Status Display    -Active Setpoints Display
-Relay/Analog Display      -Service Tools Display
-Sensor Input Display      -Lockout Reset Display
-Alarm Display             -Lockout Alarm Display
-Graphing Display          -Password Display
Help
```

## STATUS

*Selecting the* **Status Menu** *option shows the following Chiller Status screen:*

### ACTUAL DISPLAY

```
09:56       Unit          23/35
        UNIT IS LOADED
           002:26:18
WTD   ACT  WTD%   DLY    ROC
 1     1   100%   300    0.0
           TARG=27.0
                 PG↑      PG↓
```

### DESCRIPTION

```
HH:MM                CHILLER UNIT                LEV/ENT
                  CURRENT CONTROL STATE
                  TIME IN CURRENT STATE
WANTED      ACTUAL      WANTED%     DELAY       SLOPE
#STEPS      #STEPS      ACTUAL%    NEXT CHG   DIRECTION
            TARGET SET POINT + TARGET RESET
                          Page Up              Page Down
```

*Pressing the* **Page Down** *button shows the following Circuit Status screen:*

### ACTUAL DISPLAY

```
09:56       CMP #1        23/35
        CMP IS HOLDING
           002:26:18
SUCT   DISC   OPD   MOTOR
 44P   222P  156P   101%
 33F   177F   OK     OK
                 PG↑      PG↓
```

### DESCRIPTION

```
HH:MM                CIRCUIT                     LEV/ENT
                  CURRENT CONTROL STATE
                  TIME IN CURRENT STATE
  SUCTION     DISCHARGE    OIL DIFFERENTIAL    MOTOR
 PRESSURE     PRESSURE        PRESSURE         AMP %
TEMPERATURE  TEMPERATURE      STATUS           STATUS
                          Page Up              Page Down
```

*Pressing the* **Page Down** *button shows the next Circuit Status screen:*

### ACTUAL DISPLAY

```
09:55       CMP #1        45/54
        CMP OFF/READY
           000:00:42
SST    SSH    SCT    DSH
 38   16.9    97    79.2

                 PG↑      PG↓
```

### DESCRIPTION

```
HH:MM                CIRCUIT                     LEV/ENT
                  CURRENT CONTROL STATE
                  TIME IN CURRENT STATE
SAT.SUCT.    SUCT SHEAT    SAT.COND.    DISC SHEAT
  TEMP          TEMP          TEMP         TEMP

                          Page Up              Page Down
```

## ACTUAL DISPLAY

```
09:55      LLS #1        45/54
         IS HOLDING
          002:43:42
        Suction Info
PRES      SST    TEMP    SSH
14.0P     60F     12F   47.0
                PG↑     PG↓
```

## DESCRIPTION

```
HH:MM          LIQUID LINE SOLENOID          LEV/ENT
                CURRENT CONTROL STATE
                TIME IN CURRENT STATE

SUCTION      SAT.SUCT.      SUCTION     SUCT.SHEAT.
PRESSURE       TEMP           TEMP          TEMP
                                Page Up          Page Down
```

## OUTPUTS

*Selecting the* **Outputs Menu** *option shows the first 4 Relay Outputs:*

## ACTUAL DISPLAY

```
09:56      Outputs          ◀ ▶
 Relays              Status
M-1 COMP           Lck Off
M-2 LOAD           Lck Off
M-3 UNLOAD         Lck Off
M-4 LLS 1          Lck Off
Anlog          PG↑         PG↓
```

## DESCRIPTION

```
HH:MM                 Screen Title        Left/Right Arrow
 RO position & names       Current status of RO

 Using the Left and Right arrow buttons allows user to view all
  data for RO's displayed (Status, Last On, Last Off, Run Time
   Today, Cycles Today, Run Time Yesterday, Cycles Yesterday,
              Total Run Hours, and Total Cycles)
Switch to AO's            Page up              Page down
```

*Pressing the* **Page Down** *button shows the next 4 Relay Outputs:*

## ACTUAL DISPLAY

```
09:56      Outputs          ◀ ▶
 Relays              Status
M-5 LIQ INJ           On
M-6 HOT GAS           On
M-7 LLS 2             On
M-8 SUBCOOLER         On
Anlog          PG↑         PG↓
```

## DESCRIPTION

```
HH:MM                 Screen Title        Left/Right Arrow
 RO position & names       Current status of RO

 Using the Left and Right arrow buttons allows user to view all
  data for RO's displayed (Status, Last On, Last Off, Run Time
   Today, Cycles Today, Run Time Yesterday, Cycles Yesterday,
              Total Run Hours, and Total Cycles)
Switch to AO's            Page up              Page down
```

*Continue pressing the* **Page Down** *or* **Page Up** *buttons to scroll through all the Output screens.*

## INPUTS

*Selecting the* **Inputs Menu** *option shows the first 4 Sensor Outputs:*

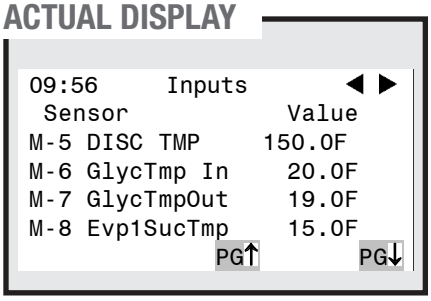
## ACTUAL DISPLAY

```
09:56      Inputs           ◀ ▶
 Sensor              Value
M-1 SUCT PSI         66.0P
M-2 DISC PSI        121.3P
M-3 SPAREM-3          ----
M-4 AMPS              52.3A
              PG↑         PG↓
```

## DESCRIPTION

```
HH:MM                 Screen Title        Left/Right Arrow
  SI position & names          Current status of SI
 Using Left/Right arrow allows user to view all data for SI's displayed
 (Value, Type, Last On, Last Off, Max Value Today, Min Value Today, Run
  Time Today, Average Value Today, Cycles Today, Run Time Yesterday, Max
 Value Yesterday, Cycles Yesterday, Min Value Yesterday, Total Run Hours,
              Average Value Yesterday, and Total Cycles)
                              Page up              Page down
```

## ACTUAL DISPLAY




## DESCRIPTION

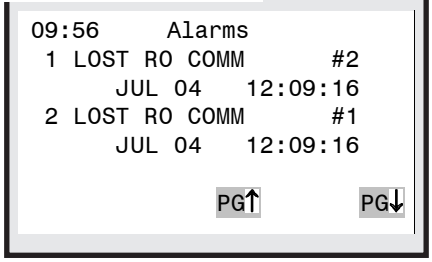
HH:MM Screen Title Left/Right Arrow
SI position & names Current status of SI
Using Left/Right arrow allows user to view all data for SI's displayed (Value, Type, Last On, Last Off, Max Value Today, Min Value Today, Run Time Today, Average Value Today, Cycles Today, Run Time Yesterday, Max Value Yesterday, Cycles Yesterday, Min Value Yesterday, Total Run Hours, Average Value Yesterday, and Total Cycles)
Page up Page down

*Continue pressing the* **Page Down** *or* **Page Up** *buttons to scroll through all the Input screens.*

## ALARMS

*Selecting the* **Alarms Menu** *option shows the first 2 Alarms:*

## ACTUAL DISPLAY




## DESCRIPTION

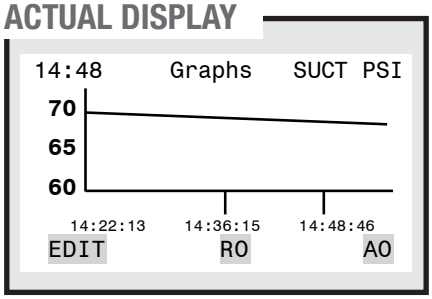
HH:MM Screen Title
1st Alarm # Alarm Title Unit Number
Alarm Date & Time of 1st alarm
2nd Alarm # Alarm Title Unit Number
Alarm Date & Time of 2nd alarm
Page up Page down

*Continue pressing the* **Page Down** *or* **Page Up** *buttons to scroll through all the Alarm screens.*

## GRAPHS

*Selecting the* **Graphs Menu** *option shows the following:*

## ACTUAL DISPLAY




## DESCRIPTION

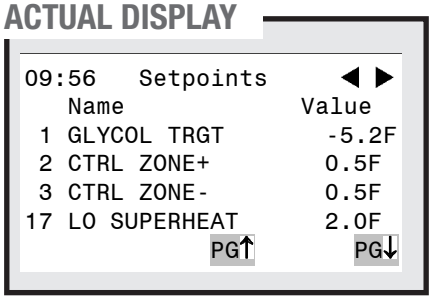
HH:MM Screen Title Sensor Name

The graph has the last 25 samples with an appropriate scale to allow it to fit on the display. Using the up/down arrows will scroll through the different Sensor Inputs, Relay outputs, or Analog Outputs.
Edit Sample Rate Switched to RO's Switches to AO's

## SETPOINTS

*Selecting the* **Setpoints Menu** *option shows the first 4 Setpoints:*

## ACTUAL DISPLAY



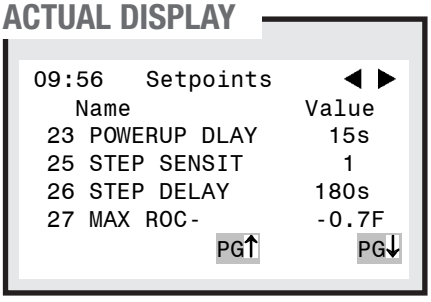

## DESCRIPTION

HH:MM Screen Title Left/Right Arrow

Using Left/Right arrow allows user to view all data for the setpoints displayed (Value, Time(sec), and Type)

Page up Page down

**ACTUAL DISPLAY**




**DESCRIPTION**

HH:MM Screen Title Left/Right Arrow

Using Left/Right arrow allows user to view all data for the setpoints displayed (Value, Time(sec), and Type)

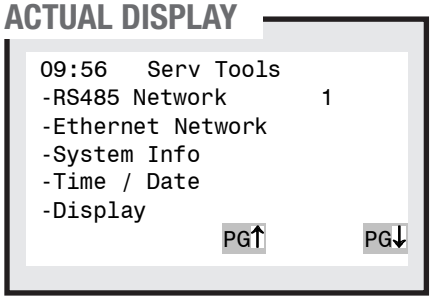
Page up Page down

*Continue pressing the* **Page Down** *or* **Page Up** *buttons to scroll through all the Setpoint screens.*

## SERVICE TOOLS

*Selecting the* **Service Tools Menu** *option shows the following submenu:*

**ACTUAL DISPLAY**

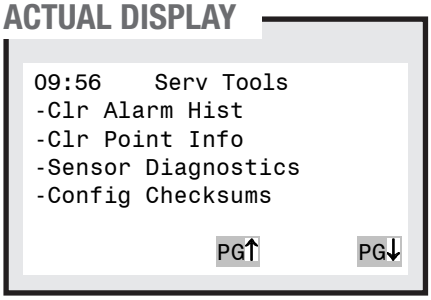



**DESCRIPTION**

HH:MM Screen Title
Highlight choice and press enter to access Sub Menu. 1.RS485 Network- View network protocol, address, and baud rate. 2.Ethernet Network- View dynaimic IP, IP address, Subnet mask, default gateway, and MCS port. 3.System Info- View Firmware version, config name, company name, model name, unit serial number, install date, config version, config date, bootloader version, hardware serial number, physical mac address, and type of I/O boards. 4.Time / Date- View and change the time or date. 5. Display View contrast, background color, and backlight.
Page up Page down

*Pressing the down arrow shows the rest of the submenu options:*

**ACTUAL DISPLAY**



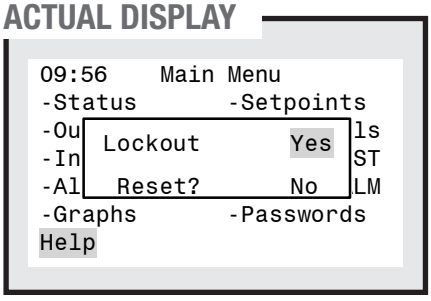

**DESCRIPTION**

HH:MM Screen Title
Highlight choice and press enter to access Sub Menu. 6.Clr Alarm Hist- Clear the alarm history. 7.Clr Point Info- Clear the point information. 8.Sensor Diagnostics- View sensor values and voltages. Page Up/Down for more sensors. 9.Config Checksums- view if a section of the configuration has been corrupted when an invalid config alarm occurs. Both the calculated checksums and storage checksums are displayed allowing the user to compare the checksums. If all checksums match, then the file is not corrupted. If a section has been corrupted the checksums will not match.
Page up Page down

## LOCKOUT RESET

*Selecting the* **Lockout RST Menu** *option shows the following:*

**ACTUAL DISPLAY**




**DESCRIPTION**

HH:MM Screen Title

Pop-up will prompt user to perform lockout reset.

## Table 10. System Troubleshooting Chart

| PROBLEM | POSSIBLE CAUSES | POSSIBLE CORRECTIVE STEPS |
|---|---|---|
| Compressor will not run | 1. Main switch open.<br>2. Fuse blown.<br>3. Thermal overloads tripped.<br>4. Defective contactor or coil.<br>5. System shut down by safety devices.<br>6. No cooling required.<br>7. Liquid line solenoid will not open.<br>8. Motor electrical trouble.<br>9. Loose wiring.<br>10. Phase loss monitor inoperative. | 1. Close switch.<br>2. Check electrical circuits and motor winding for shorts or grounds. Investigate for possible overloading. Replace fuse after fault is corrected.<br>3. Overloads are automatically reset. Check unit closely when unit comes back on line.<br>4. Repair or replace.<br>5. Determine type and cause of shutdown and correct it before resetting safety switch.<br>6. None. Wait until calls for cooling.<br>7. Repair or replace coil.<br>8. Check motor for open windings, short circuit or burn out.<br>9. Check all wire junctions. Tighten all terminal screws.<br>10. Refer to page 17. |
| Compressor noisy or vibrating | 1. Flooding of refrigerant into crankcase.<br>2. Improper piping support on suction or liquid line.<br>3. Worn compressor. | 1. Check setting of expansion valves.<br>2. Relocate, add or remove hangers.<br>3. Replace. |
| High discharge pressure | 1. Non-condensables in system.<br>2. System overcharges with refrigerant.<br>3. Discharge shutoff valve partially closed.<br>4. Fan not running.<br>5. Head pressure control setting.<br>6. Dirty condenser coil. | 1. Remove the non-condensables.<br>2. Remove excess.<br>3. Open valve.<br>4. Check electrical circuit.<br>5. Adjust.<br>6. Clean. |
| Low discharge pressure | 1. Faulty condenser temperature regulation.<br>2. Suction shutoff valve partially closed.<br>3. Insufficient refrigerant in system.<br>4. Low suction pressure.<br>5. Variable head pressure valve. | 1. Check condenser control operation.<br>2. Open valve.<br>3. Check for leaks. Repair and add charge.<br>4. See corrective steps for low suction pressure.<br>5. Check valve setting. |
| High suction pressure | 1. Excessive load.<br>2. Expansion valve overfeeding. | 1. Reduce load or add additional equipment.<br>2. Check remote bulb. Regulate superheat. |
| Low suction pressure | 1. Lack of refrigerant.<br>2. Evaporator dirty or iced.<br>3. Clogged liquid line filter drier.<br>4. Clogged suction line or compressor suction gas strainers.<br>5. Expansion valve malfunctioning.<br>6. Condensing temperature too low.<br>7. Improper TXV. | 1. Check for leaks. Repair and add charge.<br>2. Clean.<br>3. Replace cartridge(s).<br>4. Clean strainers.<br>5. Check and reset for proper superheat.<br>6. Check means for regulating condensing temperature.<br>7. Check for proper sizing. |
| Compressor loses oil | 1. Lack of refrigerant.<br>2. Excessive compression ring blow by.<br>3. Refrigerant flood back.<br>4. Improper piping or traps. | 1. Check for leaks and repair. Add refrigerant.<br>2. Maintain proper superheat at compressor.<br>3. Correct piping. |
| Compressor thermal protector switch open | 1. Operating beyond design conditions.<br>2. Dirty condenser coil.<br>3. Overcharged system. | 1. Add components to bring conditions within acceptable limits (i.e., CPR/EPR valves, additional condenser surface, liquid injection, etc.).<br>2. Open valve.<br>3. Clean coil.<br>4. Reduce charge. |

## Troubleshooting Quick Reference Sheet

| PROBLEM | POTENTIAL SOLUTION |
|---|---|
| A sensor input reads -99.9 | This indicates an open sensor input signal or 5 VDC problem.<br>• Check sensor wiring for missing wire or poor connection.<br>• Check sensor for bad sensor.<br><br>If less than 5 VDC is on the sensor 5 VDC terminal block, the problem is with probably a shorted sensor. (A poly fuse protects the board)<br>• Remove all sensor input terminals.<br>• Wait about 1 min. or until 5 VDC restored at sensor input.<br>• Connect terminals one at a time until short reappears. |
| A sensor input reads +999.9 | This indicates a shorted sensor input signal.<br>• Check sensor wiring for +5VDC shorted to signal etc.<br>• Check sensor for bad sensor. |
| A sensor is reading less then or greater than 3% off | This indicates the sensor needs to be calibrated. (You need to have a valid Authorization code to change sensor offsets)<br>• Press Service Diagnostics, press until LCD display s sensor offset option Press<br>• enter, 1st SI# and offset appears (i.e. Suction 1 = 0.0)<br>• Scroll using 'increase' (+)/decrease (-)' keys to find sensor to calibrated<br>• Press enter, use the 'increase' (+)/decrease (-)' keys to change calibration value.<br>• When value is correct press enter. |
| LCD blank or flashing. | Indicates bad connection.<br>• Check wiring to keypad<br>• Could indicate bad software transfer, retransmitting may be necessary. |
| Lost I/O | Indicates communications problem.<br>• Verify RS485 LED blinking.<br>• Verify termination jumper only on JP4 on the MCS-Magnum and the last I/O board.<br>• Verify MCS-Magnum and each I/O address is set correctly.<br>• Verify wiring from the MCS-Magnum to each I/O is correct.<br>• Check fuses/120 VAC on I/O units |
| Invalid reading on one sensor input | This indicates an input problem with 1 sensor.<br>• Verify jumper settings correct for that SI. |
| Invalid authorization | This indicates an invalid authorization number. Follow steps below for proper authorization<br>• Press SERVICE DIAGNOSTICS until the auth. option appears Press the<br>• ENTER key<br>• From the 'Display Status' menu press keys corresponding to your authorization<br>• Press ENTER |

## Magnum Alarms and Safeties

There are three types of alarms that are generated by the Magnum control logic:

- Information only alarms
- Magnum system alarms
- Chiller setpoint safety alarms

All alarms have the same format. The alarm is identified and is date/time stamped. Alarms can be viewed from the Magnum keypad by selecting the 'Alarms' from the main menu, or through MCS-Connect.

### Information Only Alarms

#### System Generated Alarms

The following alarms are generated to provide information; they will not cause a change in the control algorithm such as a lock out condition or a Relay Output being forced off.

- POWER FAILED - Generated when power to the Magnum was lost.
- POWER RETURNED - Generated when power to the Magnum returned.
- HW DATE INVALID -The date contained/read from the hardware real time clock chip is not valid. Check battery voltage, it should be > 2.0 vdc.
- HW TIME INVALID - The time contained/read from the hardware real time clock chip is not valid. Check battery voltage, it should be > 2.0 vdc.
- SW DATE INVALID - The date contained/read from the software clock is not valid.
- SW TIME INVALID - The time contained/read from the software clock is not valid.
- RAM INTEGRITY - The data contained in the battery-backed up RAM memory may be corrupted. This does not stop the Magnum from running. It means the historical data may be incorrect (run times, cycles, min/max values, and trend/graph data).
- WATCHDOG RESET - The Magnum has reset itself because of improper operator of the Magnum board. Please consult the manufacturer if this alarm has occurred.
- LOST A/D CONVTR - The Magnum microprocessor has lost communications to the Analog to Digital converter chip (chip that converts sensor voltages to a digital number). Check for a shorted sensor that may cause
- LOST DISPLAY - Generated when communication to the Keypad/Display is lost.
- CF INIT ERROR - The Compact Flash card that was installed cannot be initialized and therefore cannot be used. Replace the Compact Flash card with one that works.
- BATTERY FAILED- Generated when Magnum is not getting power from the Battery.

#### User Initiated Alarms

The following alarms indicate that an individual took action: (Most require proper authorization)

- LOCKOUT RESET - Generated when a user resets a compressor other unit from a locked condition.
- COMPUTER RESET - Generated when the manual reset button on the Magnum is pressed.
- ALARMS CLEARED –Generated when a user clears the alarm history.
- STPT CHANGED - Generated when a user makes a change to a setpoint; the number of the setpoint will also be displayed with the alarm.
- RO TO (Selected Condition) - Generated when a user manually changes the condition of a Relay Output (either AUTO, MANON, or MANOFF).
- AO TO (Selected Condition) - Generated when a user changes the condition of an Analog Output (either AUTO or MANUAL. If MANUAL, then a dialog box will appear to input the number value).
- SI TO (Selected Condition) - Generated when a user changes the condition of a Sensor Input (If a digital input, then either AUTO, MANON, or MANOFF. If an analog input, then either AUTO or MANUAL. If MANUAL, then a dialog box will appear to input the number value).
- POINT INFO CLEAR - Generated when a user clears all point information (run times, cycles, min/max values, etc.).
- CLOCK SET - Generated when a user makes a change to the Magnum real time clock.
- CFG DOWNLOADED-Generated when a user uploads a new configuration file into the Magnum. ETHERNET
- RS485 CHANGED - Generated when a user makes changes to the RS485 address through the Keypad/Display.
- CF CARD INSERTED - Generated when a user inserts a Compact Flash memory card into the Magnum
- CF CARD REMOVED - Generated when a user removes a Compact Flash memory card from the Magnum.

#### Automatic Alarms

The following alarms indicate an action that the Magnum made automatically:

- ROTATED LEAD- Generated when the Magnum automatically rotates the Lead Compressor.
- DAYLIGHT SAVINGS – Generated when the Magnum automatically changes the real time clock to adjust for Daylight Savings Time.

## Magnum System Alarms

### Configuration Alarms

These alarms indicate a problem with the configuration file in the system. The system is not operational and a new configuration must be transmitted to the unit through MCS-Connect.

- INVALID CONFIG - Checksums are incorrect.
- INVALID CFG VER - The version number of the configuration is invalid.
- INVALID CFG TYPE – The configuration type does not match the software type.

### MCS Local Network Alarms

These alarms indicate problems with the MCS local network:

- LOST SI COMM #_ / LOST RO COMM #_ - Generated when communications to a Sensor Input or Relay Output board is lost. The number of the board will be displayed with the alarm. The system can be accessed but will be in a NO RUN- I/O LOST state.
- MCS-STAT OFFLINE - The Magnum has lost communications to the MCS-STAT.
- LOST IO SHUTDOWN - Generated when Magnum is running and there are no communications to one or more of the I/O boards. The system can be accessed but will be in a NO RUN- I/O LOST state.
- LOST I/O RESTART - Generated when the Magnum does an automatic reset once I/O communications are restored.

### Key Sensors Alarms

These alarms indicate a problem with a key sensor, it is either shorted or open. The alarm will contain ALARM followed by the 10-character name of the sensor. The following sensors related to the entire system are tested:

- Leaving temperature: If failed, then Lock Out the system.
- Returning temperature: If failed, then alarm only no Lock Out.
- Ambient temperature: If failed, then alarm only no Lock Out.

The following compressor sensors are tested. If they fail, then that compressor only is locked out:

- Suction pressure and temperature
- Discharge pressure and temperature
- Oil pressure and temperature
- Motor temperature (if an analog input)

### Emergency Stop Alarm

- EMERGENCY STOP - Generated when the emergency stop switch has been turned on. The system can be accessed but is in a Lock Out state.

## Setpoint Safety Alarms

The Magnum algorithm incorporates a number of safety checks, based on setpoints, preventing unsafe conditions that could potentially cause damage to the system. When a safety trips, the circuit will be in a SAFETY TRIPPED state. The circuit will remain in this state for the time in the 'Safety Down Time (min)' cell and then move to the CMP ANTICYCLE or CMP IS OFF state where the compressor will be allowed to run again if required. If the same safety trip occurs again within the time in the'Lockout Delay Hrs' cell since the first trip, the circuit will be set to CMP LOCKED OUT state, which requires a manual reset to restart the compressor. If the lockout delay time is set to zero, the Magnum will generate a lockout condition the first time that the safety occurs.

### Sensor Inputs Used With Magnum

- Suction Pressure (Analog) Discharge
- Pressure (Analog) Discharge
- Temperature (Analog) Motor
- Temperature (Digital) Motor Amps
- (Analog)
- Motor Fault (Digital)
- Suction Temp (Analog Only) Oil Sump
- Level (Digital Only)

### Setpoint Safeties

For a safety trip to occur, both the Sensor Input and the associated setpoint must be active. If a safety trips, the alarm name will consist of the setpoint name plus additional identification such as point number, compressor number, or 30 second history leading up to the trip if applicable.

**NOTE:** ***Most safeties are checked only if the compressor is running, however if the safety is always checked it will be noted.***

The following is a list of safeties that are incorporated in the standard algorithm control. These safeties are checked every second. For a system with multiple circuits, each one is tested individually. If a safety trip occurs, only that respective compressor will be affected, the others will continue to function normally.

### Phase Loss Protection

Phase loss, as indicated by the phase loss monitor, will result in the entire system being Locked Off and a phase loss alarm will be generated. If setpoint #166 is inactive, the Magnum will wait for 2 seconds before the Lock Out occurs. The alarm will be PHASE LOSS and no restart will be attempted. If setpoint #166 is active, the name of the setpoint will be in the message. Refer to section 13 setpoint #166.

### Low Suction Pressure

If the suction pressure drops below the value of the setpoint or the digital input turns ON for the time specified in the 'Time (sec)' field, the compressor will be locked out and a LOW SUCTION alarm generated. This safety is bypassed when the compressor is in a Pump Down state. This safety can also be used as a freeze protection based upon the suction pressure. When this safety trip occurs, all compressors in the same suction group will react in the same manner. Refer to section 13 setpoint #77.

### Unsafe Suction Pressure

This safety is similar to the low suction pressure safety, except it is often set up with a lower value and a shorter safety time. If the suction pressure drops below the value of the setpoint or the digital input turns ON for the time specified in the 'Time (sec)' field of that setpoint, then the circuit will be Locked Out and a UNSAFE SUCTION alarm will be generated. This safety will always cause a Lock Out on the first trip, requiring a manual reset. This safety is bypassed when the compressor is in a Pump Down state. When this safety trip occurs, all compressors in the same suction group will react the same. Refer to section 13 setpoint #80.

### High Discharge Pressure (SAFETY IS ALWAYS CHECKED)

If the discharge pressure rises above the value of the setpoint or the digital input turns ON for the time specified in the 'Time (sec)' field of that setpoint, then the circuit will be locked out and a HIGH DISCHARGE alarm will be generated. Refer to section 13 setpoint #81.

### Low Discharge Pressure

If the discharge pressure drops below the value of the setpoint for the time specified in the 'Time (sec)' field, the compressor will be Locked Out and a LOW DISCHARGE alarm will be generated. Refer to section 13 setpoint #85.

### High Discharge Temperature (SAFETY IS ALWAYS CHECKED)

If the discharge temperature analog input rises above the value of the setpoint or the digital input turns ON for the time specified in the 'Time (sec)' field, the compressor will be Locked Out and a HIGH TEMPERATURE alarm will be generated. Refer to section 13 setpoint #87.

### High Motor Temperature or Motor Fault (SAFETY IS ALWAYS CHECKED)

If the high motor temperature input rises above the value of the setpoint or the digital input turns ON for the time specified in the 'Time (sec)' field, the circuit will be Locked Out and a HIGH MOTOR TEMPERATURE or MOTOR FAULT alarm will be generated. Refer to section 13 setpoint #95.

### High Oil Temperature

If the oil temperature rises above the value of the setpoint or the digital input turns ON for the time specified in the 'Time (sec)' field, the compressor will be locked out and a HIGH OIL TEMPERATURE alarm generated. Refer to section 13 setpoint #94.

### High Motor Amperage

If the amperage analog input rises above the value of the compressor's respective FLA setpoint #1711–90 times the value of setpoint#75 or the digital input turns ON for the time specified in the 'Time (sec)' field, then the circuit will be Locked Out and a HIGH MOTOR AMP alarm will be generated. Refer to section 13 setpoint #75.

### Low Motor Amperage

If the amperage analog input drops below the value of the compressor's respective FLA setpoint #171 – 190 times the value of setpoint #76 or the digital input turns ON for the time specified in the 'Time (sec)' field, then the circuit will be Locked Out and a LOW MOTOR AMP alarm will be generated. Refer to section 13 setpoint #76.

### Low Discharge Superheat

If the discharge superheat is below the value in setpoint for the time specified in the 'Time (sec)' field, then the circuit will be Locked Out and a LOW DISCHARGE SUPERHEAT alarm will be generated. Refer to section 13 setpoint #84.

Temperature>100 or < -20
40034 Suction Temperature>100 or < -30
40036 Discharge Temperature>110 or < -30
40046 Leaving Water Temperature>100 or < -20
40031 Suction Pressure>1200 or < -30
40033 Discharge Pressure>3500 or < -30

# Preventive Maintenance

## Unit Coolers

At every six month interval, or sooner if local conditions cause clogging or fouling of air passages through the finned surface, the following items should be checked.

### 1. Visually inspect unit

- Look for signs of corrosion on fins, cabinet, copper tubing and solder joints.
- Look for excessive or unusual vibration for fan blades or sheet metal panels when in operation. Identify fan cell(s) causing vibration and check motor and blade carefully.
- Look for oil stains on headers, return bends, and coil fins. Check any suspect areas with an electronic leak detector.
- Check drain pan to insure that drain is clear of debris, obstructions or ice buildup and is free draining.

### 2. Clean evaporator coil and blades

- Periodic cleaning can be accomplished by using a brush, pressurized water or a commercially available evaporator coil cleaner or mild detergent. Never use an acid based cleaner. Follow label directions for appropriate use. Be sure the product you use is approved for use in your particular application.
- Flush and rinse coil until no residue remains.
- Pay close attention to drain pan, drain line and trap.

### 3. Check the operation of all fans and ensure airflow is unobstructed

- Check that each fan rotates freely and quietly. Replace any fan motor that does not rotate smoothly or makes an unusual noise.
- Check all fan set screws and tighten if needed.
- Check all fan blades for signs of stress or wear. Replace any blades that are worn, cracked or bent.
- Verify that all fan motors are securely fastened to the motor rail.
- Lubricate motors if applicable.

### 4. Inspect electrical wiring and components

- Visually inspect all wiring for wear, kinks, bare areas and discoloration. Replace any wiring found to be damaged.
- Verify that all electrical and ground connections are secure, tighten if necessary.
- Check operation/calibration of all fan cycle and defrost controls when used.
- Look for abnormal accumulation of ice patterns and adjust defrost cycles accordingly
- Compare actual defrost heater amp draw against unit data plate.
- Visually inspect heaters to ensure even surface contact with the coil. If heaters have crept, decrease defrost termination temperature and be sure you have even coil frost patterns. Re-align heaters as needed.
- Check drain line heat tape for proper operation (supplied and installed by others).

### 5. Refrigeration Cycle

- Check unit cooler superheat and compare reading for your specific application
- Visually inspect coil for even distribution

## 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.

## Air-Cooled Condensing Units/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 contractors. Look for discoloration and pitting. Replace as required.
- Clean electrical cabinet. Look for signs of moisture, dirt, debris, insects and wildlife. Take corrective action as required.
- Verify operation of oil sump heater by measuring amp draw.

### 6. Check refrigeration cycle

- Check suction, discharge pressure readings. If abnormal take appropriate action.
- 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.

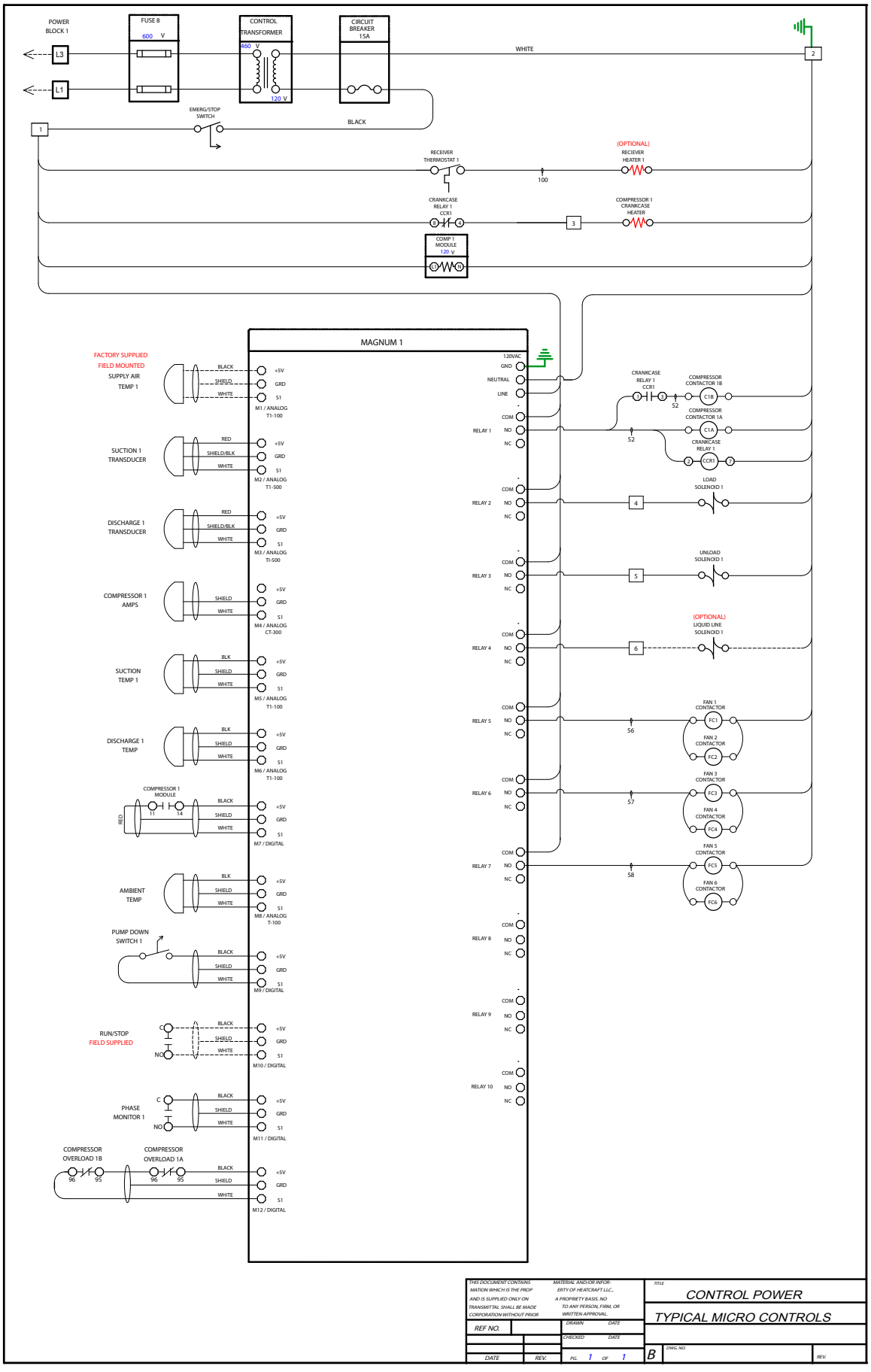
## Air-Cooled Condensing Units/Annually

### 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.



Notes:

**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.heatcraftrpd.com**

| Micro Control Parts | |
|---|---|
| MAGNUM PANEL MOUNT LCD | 28999018 |
| 16-SI BOARD | 28999904 |
| MODEM | 28908501 |
| EXP BOARD WITH 10 RO'S MCS-R10 | 28999903 |
| SENSOR 300 AMP CURRENT | 28988033 |
| TEMP SENSOR 20FT | 28908101 |
| -25TO230 T.SEN W/40FT WIR | 28908102 |
| TRANSDUCER 0-500 PSI 20FT | 28908009 |
| **Condenser Parts** | |
| Fan Motor, 1.5 HP | 25316401 |
| Fan Blade, 30” Diameter | 22900401 |
| Fan Guard, 30” Diameter | 23105701 |

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**Call 1-800-GO BITZER**
**(24/7 Support)**

**For our complete Refrigeration Systems Installation and Operations Manual (H-IM-64L), please visit www.heatcraftrpd.com**

Since product improvement is a continuing effort, we reserve the right to make changes in specifications without notice.