DRAKE
REFRIGERATION, INC.

MMAG MICRO

Installation, Operation & Maintenance Manual

Packaged Air Cooled
Split System Air Cooled
Packaged Water Cooled
Tank & Pump Skids

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NOTE

- **This equipment should only be installed and started by a certified refrigeration mechanic who is familiar with chiller equipment.**
- **Failure to follow accepted refrigeration practices during installation and start-up will void the equipment warranty.**
- **All field piping and wiring must conform to the requirements of the manufacturer as well as all applicable national and local codes.**

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Receiving

When receiving equipment from Drake, each shipment must be checked against the bill of lading . **Shortages and shipping damage is the responsibility of the shipping carrier.** Both should be noted on the shipping receipt when the equipment is first received. Hidden damage should be brought to the carrier's attention as soon as it is discovered. In both cases, claims should be filed promptly with the carrier. Do not return damaged equipment to the manufacturer without prior approval .

Uncrating

The shipping skid can be used to aid moving equipment, such as to lift via forklift . The shipping skid should not be removed until the equipment is at the point of installation .

Rigging

Fork lifts or dollies are required for moving this equipment. When lifting from above, always use sufficiently long spreader bars to avoid lifting damage. On larger units, where lifting eyes are provided in the base frame, be sure to lift only from the base and use all eyes provided.

Unit Location

Units must be positioned with sufficient clearance on all sides for proper inspection, maintenance and airflow.

Allow at least 3 ft. for access into the compressor compartment. National Electric Code requires a minimum of 3 ft. in front of control panels rated 600V or less. More may be required depending on the peculiarities of the installation such as proximity to other live electrical parts. Local codes may require greater clearance.

Units with Air-cooled Condensers:

- Care must be taken to ensure an ample supply of fresh, clean air.
- Installing Indoors:
  - When installing indoors, an intake and exhaust air system capable of handling 1000 CFM per compressor horsepower must be supplied at zero static pressure.
  - In all cases, caution must be taken to avoid locating units in restricted spaces where heat build up at the condenser can occur.
  - Avoid locating multiple units such that the air discharge from one blows into the air intake of another.
- Installing Outdoors
  - For air-cooled units located outdoors AND intended for year-round operation, special attention must be paid to prevailing wind direction during colder weather.
  - If wind is blowing through the condenser, cycling or reducing the speed of the condenser fan may no longer be an effective means of head pressure control . This is normally not a problem with flooding types of head pressure control.

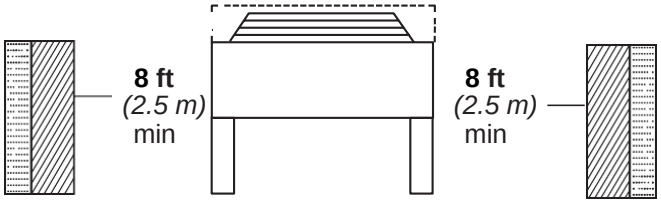
Avoid ALL overhangs and allow 5ft. of vertical clearance from fan discharge.
Failure may cause discharge air to be re-circulated through the condenser!

Units with any vertical-face condensers:

- One condenser height is the minimum distance that the condenser face may be located from a wall or obstruction.
- When placing (2) of these units side by side so that the condensers face one another, use twice the tallest condenser height as the minimum distance between units .

Units with any horizontal-face condensers:

- Allow at least (1) condenser width between the condenser and a single wall.
- If the unit is located with solid walls on more than one side, allow at least (1) condenser width.
- If two or more units are placed side by side, allow at least (2) condenser widths between units.
- For units in pits, the top of the condenser must be level with, or above the top of the pit . In addition, a minimum of **8 feet** (2.5m) is required between the unit and the pit walls.



Failure to follow these instructions will cause the unit to run inefficiently and may cause nuisance trips on various safety controls.

Mounting

Units must be installed in a level position, on a firm support. **Never use a wooden shipping skid as a permanent base.**

- For ground mounting, a suitably designed concrete slab is recommended. Raising the slab 4 to 6 inches above grade provides some protection from ground water.
- For roof mounting, a structural analysis by a qualified engineer may be required.

The unit should be mounted on suitably sized steel channels or beams . Vibration-absorbing pads or springs between the unit and mounting frame are recommended for vibration elimination .

Compressors that are spring-mounted are rigidly secured from the factory to prevent shipping damage . After mounting the unit and prior to startup, the following steps should be taken:

1 . Loosen and remove the (4) nuts and washers used to hold the compressor firmly in place.
2 . Remove and discard the (4) shipping spacers between the compressor and its mounting base .
3 . Install the (4) rubber spacers, provided as loose items, over the compressor mounting stud
4 . Reinstall the (4) nuts and washers removed in step 1 above leaving approximately 1/16" space between the nut and washer. This will allow the compressor to "float" on the mounting springs.

Piping – General

All field piping must conform to the requirements of the equipment, as well as all applicable national and local codes. Care has been taken to insure that factory piping is properly brazed, and all fittings and gasketed joints are tight. These may loosen or break during shipment & must be checked prior to start-up. All joints, especially threaded and gasketed joints, should be checked again after one to two weeks of operation. Take corrective action as necessary.

All lines must be supported . The distance between supports will vary with the diameter and wall thickness of the pipe or tubing used, the weight of the fluid being carried, as well as the number of valves and fittings in the line. Supports should be provided near changes in direction, at branch lines and particularly near valves. The weight of the tubing must not be carried through the valve body, since this may distort the valve and cause it to not function properly. Horizontal supports must be close enough to prevent sag, which would impose excessive stress on the pipes . Vertical supports must be close enough to adequately support the weight of the tube as well as to prevent sway caused by blowing wind. As a guide, the following table may be used:

Table 1. Pipe / Tube Support

Tube OD (in)	3/8 – 7/8	1-1/8	1 3/8 – 1 5/8	2-1/8	2-5/8	3-1/8
Nom. Pipe Size (in)	1/4 – 5/8	1	1-1/4	1-1/2	2	3
Max. Span (ft)	5	6	7	9	10	12

Chilled Fluid Piping

Various types of pipe may be used, but care must be taken to ensure that the material is compatible with the service for which it is intended . Line sizes should be based on the curves shown in Fig . 1, 2, and 3 on Page 21, and not on connection sizes at the chiller .

- **Chilled Fluid Lines** (See Line Size curves shown in Fig. 1, 2, and 3 on Page 26) 1 . Fluid lines should be kept as short and direct as possible .
  2 . Lines should be sized for low pressure drop in order to minimize pump requirements . 3 . Lines must be insulated .
  4 . Use insulation of sufficient thickness to prevent sweating, which can damage property or present a hazard to personnel .
  5 . Piping must be a continuous loop with purge valves at high points .
  6 . Expansion tanks are normally not required and their use is dependent on the peculiarities of the job.
  7 . A continuous and steady fluid flow through the chiller's heat exchanger is necessary for proper system operation. If the fluid is being used to cool more than (1) process or machine, 3-way valves or bypass circuits may be required .
  8 . Field supplied flow controls, meters or gauges may be required for proper operation.
  9. Field supplied strainer or filter is required in the return fluid line at the chiller. The fineness of the strainer mesh, or the filtering medium, used is dependent on local conditions. If no mesh fineness is defined, a mesh fineness of U.S. Mesh 14 to 35 is recommended to protect the chiller. **Failure to provide a strainer or filter will void all warranties.**

Refrigeration Piping

Packaged Chillers:

- All Packaged chillers leave the factory with the refrigeration side fully piped & charged.

Water-Cooled Chillers:

- Water-regulating valves for water-cooled condensers are shipped loose with the chiller, and **must be installed in the field.**
- Install on the condenser Leaving Fluid side or on the condenser Return to Fluid Source side.

Split-Systems:

- Split-System chillers require interconnecting refrigeration piping between the compressor/evaporator section & the condenser section.
- **Both sections leave the factory charged with refrigerant. Their combined charge is indicated on the compressor/evaporator data tag**. Additional refrigerant will have to be added in the field due to the interconnecting piping (see "System Refrigerant Charging") .
- The discharge and liquid lines in both sections have shutoff valves with capped leads. **Never uncap these leads without checking the shutoff valves to be sure that they are fully closed and the units are ready for piping.**
- To prevent moisture in the air from condensing inside the tubes, **never leave refrigerant lines open when they are not being worked on, especially overnight.** This is especially important with units that have compressors using polyolester (POE) oils, due to the hygroscopic nature of the oil. Copper tubing must be refrigeration grade (ACR).
- When using high temperature solders, always pass dry nitrogen through the lines to prevent scaling.
- Interconnecting line size should never be based on the lead sizes at the compressor/evaporator section and the condenser section. For proper system operation, they must be sized in accordance with the remote condenser line size table, as shown in Fig. 4 on Page 24. The interconnecting lines must be evacuated. Be sure to install appropriate fittings.

Refrigeration Liquid Line – **Split-Systems only** (See Line Size tables in Fig . 4 on Page 26)

1. Liquid lines should be kept as short and direct as possible .
2. Lines should be sized for low pressure drop to prevent liquid flashing. The height of liquid risers must be taken into account .
3. **Do not run liquid lines through heated spaces.** At best, this will result in a loss of subcooling . At worst,
4. the liquid refrigerant may flash.
5. **Do not insulate liquid lines.** Liquid refrigerant moving through the line will normally be warmer than the surrounding air . Uninsulated lines will allow for some heat exchange between the refrigerant and ambient air. This increased subcooling will result in slightly increased capacities.
6. **Brace liquid lines securely to prevent damage to the line from liquid hammer.** Liquid lines are prone to substantial motion when valves are suddenly opened or closed. The bigger and longer the line, the more pronounced the problem. This is caused by the shock of the liquid column impinging on the next closed valve, or on the first bend in the line that it encounters, and is a major cause of joint failure.

Refrigeration Discharge Line – **Split-Systems only** (See Line Size tables in Fig . 4 on Page 26)

1. Discharge lines should be kept as short and direct as possible .
2. Lines should be sized for low-pressure drop in order to minimize the effect of pressure drop on system capacity.
3. These lines should not be insulated *except* to prevent injury to personnel who may come in contact.
4. Horizontal lines should be pitched downward in the direction of flow to prevent oil from flowing back to the compressor during a off cycle .
5. Vertical lines require a trap at the base of the riser as well as an inverted trap at the top . The inverted trap should be the highest point in the discharge line and should have a access valve installed to allow for purging of non-condensables from the system . For vertical runs greater than 10-12 ft, additional traps should be used at 10-ft. intervals.
6. Systems using unloading compressors may require the use of double risers .
7. Line pulsation is an inherent characteristic in systems utilizing reciprocating compressors . Additional line support may be required to prevent transmission of vibration & movement in the line .
8. An inverted trap of sufficient height or a check valve may be required to prevent liquid migration back to the compressor during off cycles. This can be especially important on units using flooding head pressure controls, due to their larger refrigerant charge.

Wiring

All field wiring must conform to the requirements of the equipment and to all applicable national and local codes.

Main power wires must be kept a minimum of 12 inches away from all low voltage wiring and controls, such as the microprocessor, temperature sensors, and transducer cables. Power wires can create "noise" that will interfere with the operation of the microprocessor and sensors, such as false readings and nuisance trips.

****All Equipment needs to have its own dedicated power supply**

- Use only copper conductors that are properly sized to handle the load. Always consult the unit's electrical nameplate . Since equipment is continuously being updated, do not rely on catalog information unless it has been verified.
- Always refer to the unit electrical nameplate for sizing conductors, disconnects, and fusing. Units are factory wired so that a single power source can be brought to the unit. However, this may not always be the case with non-standard units. Consult the wiring diagram affixed to the inside of the control panel lid. Additional wiring diagrams are supplied as a separate loose item in the envelope that contained these instructions .
- Electrical connections have been securely tightened at the factory. They may loosen during shipment and again during initial periods of operation . All connections should be checked and tightened as necessary prior to startup and again after the system has been operating for 1 to 2 weeks. To avoid personnel injury, always disconnect power before conducting tightness checks .
- Disconnect switches (fused or non-fused) are optional items when the system is purchased and normally are not factory supplied. They must be field-supplied and field-installed as required by applicable national and local electric codes .

Compressor Oil Charge

- All compressors intended for use with R-134A, R-404A, R-407C, & R-507 are shipped with POE oil.
- For all compressors with an oil sight glass, the proper oil level is between 1/2 to 3/4 up the sightglass.
  - For 8-cylinder compressors, the level should be 1/4 to 1/3 up the sightglass.
- Oil levels should be observed at start-up and when the system is operating. Add or remove oil from the system as necessary to maintain these levels.
- Always remember: *Too much oil is just as detrimental to a system as not enough oil.*

Low Oil Level

In the absence of a visible oil leak, a low oil level generally indicates one or more of the following problems:

1. Oil was not at the proper level to begin with .
2. Refrigerant lines are not properly pitched . This rarely is a problem with factory piping and is usually encountered with field piping on Split-Systems. The usual causes are:
   a. Failure to pitch piping in direction of flow.
   b. Excessively large lines which allow refrigerant velocities to drop below the point where oil remains entrained .
   c. Failure to provide traps in vertical risers
3. Low refrigerant mass flow.
4. A system component such as the suction accumulator having a blocked oil return
5. Compressor short-cycling

High Oil Level

Excessively high oil levels are generally caused by one or more of the following:

1. Oil was not at the proper level to begin with .
2. Oil was simply added to the system due to a low sightglass without looking for the cause .
3. A compressor changeout using a compressor with a full oil charge . Replacement compressors generally contain no oil or have a reduced charge .
4. During long off cycles, liquid refrigerant may migrate to the compressor where it can lay in the crankcase . This gives the impression of high oil levels when the compressor is not running. On starting the compressor, this refrigerant will rapidly boil off as evidenced by violent foaming in the sightglass. This in turn may cause tripping of the oil pressure safety switch . A properly working crankcase heater will normally eliminate this problem.

The following oils have been approved by Copeland & Bitzer for use with their compressors:

Polyolester (POE) Oils: Mobile, Emkarate RL 32CF, EAL ARCTIC 22CC, ICI

Leak Testing

Refrigeration Side

Prior to startup, the entire system must be leak tested . Due to their greater sensitivity, electronic leak detectors are recommended. Carefully leak test both factory and field made joints including condenser coils. Although each unit is factory leak tested, joints can loosen and sometimes break during shipment.

As with electrical connections, gasketed and flared joints may loosen after a short running time. After 1 to 2 weeks after placing a system into operation, return and again leak check the various joints. Tighten or repair as necessary.

Chilled Fluid Side

After initially filling the system with water or a water/glycol solution, turn on all pumps and allow the fluid to circulate. The entire system should be checked for leaks, paying special attention to joints and seals. Approximately 1 to 2 weeks after placing a system into operation, return and again leak check the various joints. Tighten or repair as necessary.

Evacuation – Refrigeration Side

Evacuating a system to remove moisture and non-condensable gases is necessary if it has been opened to the atmosphere. With Split-Systems, provisions should be made to evacuate the interconnecting discharge and liquid lines prior to opening the shutoff valves provided in each section.

Non-condensables trapped in the system will increase condensing pressures above what would be normal for a particular operating condition. This causes the system to run inefficiently and may cause nuisance trips on high pressure. Moisture will chemically react with refrigerant and oil in the system, creating acids and sludge, which in turn will corrode the system internally. This problem can be especially severe with POE oils. Proper evacuation will eliminate these problems.

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

Evacuation:

- Connect a deep vacuum pump to both the high side and low side of the system with copper tube or vacuum hoses.
    - The larger the tube or hose diameter, the better . In no case should the inside diameter of the tube or hose be smaller than the vacuum pumps service port.
    - A vacuum gauge capable of showing pressure in microns must be attached. Ordinary charging manifold gauges are not satisfactory!
    - This gauge should be attached to the system as far from the vacuum pump connections as possible . Some gauges of this type may be damaged if exposed to pressures greater than atmospheric.
    - Be sure that the system pressure is below one atmosphere before exposing the gauge to system pressure.
- Manually open all service valves and solenoids as required. Operate the vacuum pump until a pressure of 500 microns is attained.
- Close the vacuum pump service valves so as to isolate the pump from the refrigeration lines being evacuated and turn it off .
- Perform a vacuum decay test by monitoring system pressure for approximately 1/2 hour. It should not rise more than 250 microns.
    - Rising pressure indicates either a small leak, which was not found during leak testing, or moisture in the system.

Troubleshooting:

If a leak is suspected, it must be found and corrected as indicated under the Leak Testing section above, before proceeding any further. Ultrasonic leak detectors are available which “listen” for the high frequency sound of gas rushing into or out of a system. For small leaks, it is not necessary to repressurize the system with refrigerant.

If moisture in the system is the issue, continued evacuation is necessary. Due to the low boiling point of water at very low pressures, the moisture in the system may freeze, especially when using a pump of excessive capacity . An oversized pump can reduce the system pressure so rapidly that freezing will occur, unless special precautions are taken, such as introducing dry nitrogen into the system to maintain pressure or using sun lamps to maintain temperatures above freezing. Attempting to run the vacuum pump after moisture has frozen will greatly prolong the evacuation process, and can possibly damage the pump.

Refrigerant Charging

Once leak testing and evacuation are complete, refrigerant charging may commence. Always refer to the unit nameplate for the type and amount of refrigerant required.

- *Always use a charging manifold with gauges along with a scale to charge refrigerant into a system.*
- When initially charging a system that is in a vacuum, liquid refrigerant can be added directly into the high side while the compressor is off.
    - As much refrigerant as possible should be charged in this manner, since it is the fastest method available.
    - **Never liquid-charge into the low side without taking special precautions as indicated further in this section.**
- Maximize the amount of refrigerant charged by chilling the receiver (when provided) and warming the refrigerant cylinder:
    - Chill receivers by using either liquid or dry ice packed into an insulating blanket which has been wrapped around the receiver.
    - Warm refrigerant cylinders using sun lamps or a warm water bath. *Do not use a torch or heat gun, since these can cause cylinder pressures to increase significantly in a very short time span.*

CAUTION: Cylinder pressures must be closely monitored whenever a refrigerant cylinder is being heated in ANY manner . Allowing pressures to exceed the cylinder pressure rating may result in the cylinder rupturing, with related injury and/or property damage.

- Once system and tank pressures have equalized, other slower methods must be employed to finish charging the system . The method chosen depends on the refrigerant involved .

"Pure Fluid" Refrigerants & Azeotropic Blends

- Refrigerants that are pure fluids (such as **R-134A**) as well as Azeotropic blends (such as **R-507**) can be vapor- charged into the low side of the system.
- **Never attempt to vapor-charge into the system high side**. This will result in the refrigerant cylinder becoming charged by the system, rather than the other way around . Cylinders can quickly become over-pressurized, causing them to rupture with resultant injury and property damage.

Zeotropic Blends & Near Azeotropic Blends

- Zeotropic blends such as **R-404A** and **R-407C**, and Near-Azeotropic blends (such as **R-502**) should generally not be vapor-charged due to *fractionation* (see below).

What is fractionation? Fractionation is the process where the most volatile component(s) in the blend begin to boil first, thereby leaving higher concentrations of the least volatile component(s) behind . Fractionated blends have a ***reduced capacity*** and become ***less effective*** when returned to the system . This does not present a problem if the entire contents of the refrigerant cylinder are to be used, since it allows all of the refrigerant to boil off and return the mixture to its original proportions . **If all the refrigerant in a cylinder is to be used, vapor-charging is permissible,** but it is generally not a good habit for regular unit servicing and proper operation of chiller.

When in doubt as to the type of blend being used, refer to a current pressure-temperature chart. If the saturated temperature column for a particular refrigerant shows distinctly different bubble and dew points, it is either a Zeotrope or Near-Azeotrope.

To avoid the problem of fractionation, Zeotrope or Near-Azeotrope refrigerants should be liquid-charged.
Suggested Method:

1. Liquid-charge into the high side .
2. Start compressor .
3. Using a throttle valve, then begin liquid charging into the low side. This ensures that the liquid flashes to vapor before entering the compressor, preventing liquid slug .

**Pure fluid refrigerants and Azeotropes may also be charged in this manner.*

Fractionation is also a concern with system leaks. The problem is negligible in areas of the system where the refrigerant is in a totally liquid or vapor phase. **However, if the leak occurs in a heat exchanger where phase changes are normally encountered, the problem can be more significant.** As the blend becomes increasingly fractionated, the system performance can be affected to the point where the outlet water (or glycol) temperature cannot be maintained. **Additionally, the effects of fractionation also become more significant with increased refrigerant glide, meaning these problems become more pronounced with Zeotropes than with Near-Azeotropes.** If leaks are small and corrected early, simply topping off the system with refrigerant is acceptable. **On the other hand, with systems having repeated or large leakages, it may be necessary to completely evacuate and recharge.**

Amount of Refrigerant Required

The amount of refrigerant required to charge a system depends on the specific components used in the chiller and the type and combination of head pressure control(s) used. Refer to the engineering documents packaged with your chiller for the capacity and sizes of the components in your chiller.

A head pressure control or condenser fan control alone does not require any additional refrigerant. However, flooding type head pressure controls may require a significant amount of additional refrigerant. The exact amount is dependent on the condenser coil design, as well as the minimum head pressures required for proper thermal expansion valve (TXV) operation. Using both fan controls and flooding type controls in the same system can significantly reduce the amount of additional refrigerant required.

For Split-Systems, the size and length of the liquid line between the (2) sections must be considered. The lbs. of refrigerant contained in liquid lines can be estimated from the following table, which is based on 100 lineal feet of Type “L” copper tube and refrigerant densities corresponding to 90°F saturated liquid.

Table 2. Weight Liquid Refrigerant in Copper Tube

Tube O.D. (in)	3/8	1/2	5/8	7/8	1-1/8	1-3/8	1-5/8
R-134A / R-407C (lbs)	3 .9	7 .4	11 .8	24 .4	41 .6	63 .5	90
R-404A / R-507 (lbs)	3 .4	6 .4	10 .3	21 .2	36 .1	55	78

Pre Start-Up Checklist

Once installation is complete, ***prior to startup*** check the following:

1. Inspect chiller location is **free from overhangs and at least 3 feet from any wall or fence**
2. Verify power supply on site and check that incoming voltage matches nameplate voltage and chiller disconnect per national & local codes
3. Inspect all electrical connections in the control panel, microprocessor, and other controls are wired in accordance with the attached diagram. **Tighten any terminal connections loosened during shipping**.
4. Shipping spacers on spring mounted compressors have been removed, the neoprene washers used to properly center the compressor foot on its mounting spring and stud have been properly installed, and the mounting nut and washer is reinstalled so as to allow the compressor to "float."
5. The compressor oil is at the proper level in the oil sightglass (when provided) --- See **"Compressor Oil Charge"**
6. Confirm the **Pump Overload** settings in the electrical box match the SFA rating on the pump labels (if applicable)
7. Inspect chilled fluid line(s) and tank are full, bled, and free of trapped air.
8. Check glycol freeze point and log into **Warranty Activation Form** at end of manual.
9. Tighten all Schrader valve cores and liquid line solenoid bodies
10. **Confirm all PROPER refrigerant ball valves are open** to release the refrigerant into the system and the packing nuts are tight (if applicable).
11. Leak check the refrigerant circuit with an electronic leak detector.
12. **Check Warranty Activation Form at end of the manual**

Compressor Pre Start-Up

Care must be taken when initially starting a system or when the system has been off for an extended period. At this time, the compressor may contain liquid refrigerant. Simply starting the system and walking away may result in irreparable compressor damage not covered under warranty. To prevent compressor damage, **one or more of the following steps** may be used:

1. All compressors are supplied with a **crankcase heater. It must be activated for 24 hours prior to starting the compressor.** Be sure to check that the heater is functional. This can be done by simply touching the compressor in the area of the heater. It should feel warm to the touch. This check should be performed shortly after energizing the heater and again prior to starting the compressor. **If the compressor is cold, do not attempt to start it.** Locate the source of the problem, correct it, and wait 24 hours before starting the compressor.
2. Use a "safe" heat source such as a heat lamp on the compressor crankcase for approximately 1/2 hour before start-up. **Never use a torch or heat gun.** They can raise system pressures to dangerous levels in a very short time, resulting in injury to personnel as well as property damage.
3. After following steps 1 and 2 above, you can be relatively certain that no liquid refrigerant is left in the compressor. However, this does not mean that liquid refrigerant is not present elsewhere in the low side. **To avoid compressor damage on start-up:**
    a. **Hook up refrigerant pressure gauges (see nameplate for refrigerant type).**
    b. **Deactivate the liquid solenoid valve.**
    c. **"Bump" the compressor with the following procedure:**
        i. **Before running the compressor, ensure that the compressor is not in a vacuum.** Running the compressor in a vacuum can quickly cause it to be overworked and burn out the motor.
        ii. *Using a flathead screwdriver with an insulated handle,* "bump" the compressor by pressing the contactor switch for 2 seconds. **Do not repeat**.

This process will rapidly reduce low side pressure, causing any remaining liquid to boil off quickly. After this process is complete, it is usually safe to allow the compressor to run.

After starting the compressor, listen for unusual sounds such as knocking, shaking, or rattling. **Should these noises be heard, immediately stop the compressor.** Do not restart until the problem is resolved.

- **Rotational direction is very important with three-phase scroll compressors. Running these compressors with reversed rotation will result in damage not covered by warranty.**
- When starting a three-phase scroll compressor, refrigerant pressure gauges ***must*** be attached to both the high and low-pressure ports provided on the system. *With the compressor rotating in the proper direction, system suction pressure should drop and discharge pressure should rise to appropriate levels within a few seconds after the compressor is started.* If this is not the case, the compressor is probably running in reversed rotation. Each chiller is computer tested before it leaves the factory, and all three-phase motors (i.e. pumps and compressors) have been set in the proper phase.
- **Turn off the power at the main disconnect, reverse any two of the three main power leads, and restart.** Observe the suction and discharge pressure gauges to verify that the compressor is rotating correctly. If pressures are still not appropriate, some other problem has developed which must be found and corrected prior to running the system.

Drake MicroMag Controller Start-Up (MCS Standard Microprocessor)

****Chillers with MCS Controls can be started via Keypad or Laptop****
****For a Laptop, call Drake Tech Support 215-638-5515****

Chiller Controls (Via Keypad)

1. Refer to **MicroMag - Keypad Only Manual** on www.drakechillers.com under **Tech Support** for full display features and menu navigation
    a. To confirm any change on the keypad --- press **UP/DOWN** to the correct setting --- press **ENTER**
2. From the start up screen, hit **MENU** on the keypad to arrive at the **Main Menu** from any screen

3. Scroll **DOWN** --- hit **ENTER** to **Enter Password** --- use the **UP/DOWN** key to scroll through digits 1 to 9 --- use the **LEFT/RIGHT** keys to move through digits 1 to 4 -- enter **2112** for Supervisor level access

4. Go to the **Inputs SI** menu --- scroll **DOWN** to **RUN/STOP** (usually M-9) --- hit **ENTER** to set to **'DI MANOFF'**

5. Return to the **Main Menu** --- scroll **DOWN** to **Lckout RST** --- hit **ENTER** to perform a **'Lockout Reset'**

6. Return to the **Main Menu** --- scroll **DOWN** to **Outputs RO** – hit **ENTER** to open the **Outputs RO** tab
7. Test all component relay(s) following steps a.) to f.) below

CAUTION WHEN TESTING CHILLER COMPONENTS:

NEVER **'MANON'** A COMPRESSOR. THIS BYPASSES ALL SAFETY LOGIC AND CAN RUIN THE CHILLER AND/OR COMPRESSOR. ONLY EVER **'BUMP'** A COMPRESSOR CONTACT **ONCE** AS LISTED ON PG. 11

a. Scroll **DOWN** to pump relay(s) --- hit **ENTER** to set to **'MANON'**.
b. Confirm phase and proper rotation (Zip-tie use is recommended)
c. Return to the **Main Menu** --- go to **Inputs SI** --- scroll **DOWN** to **EVAP FLOW** (M-10) --- this should be reading **'YES'** signaling there is fluid circulating through the chiller

d. Return to **Outputs RO** --- turn the pump relay(s) to **'AUTO'**
e. Continue testing individual components --- scroll **DOWN** to component name --- change status from **'AUTO'** to **'MANON'** to test the components (solenoids, receiver heaters, **EXCEPT COMPRESSORS**) manually.
f. Ensure the components are operating correctly --- return component relay(s) to **'AUTO'** setting when finished. (For solenoids, use of a magnetic solenoid rotation tester is recommended)

NOTE: If any Chiller components are not energizing during testing, confirm that when turned to **'MANON'** there is a +24VAC reading between the **NO** relay connection and **GND** source on the control board. If not, test to see if there is +24VAC reading between the **COM** relay connection and **GND** source on the control board. If so, the 5A on-board relay fuse has blown and needs replacing.

See Wiring diagram for component relay locations & ground source
See MCS manual for fuse locations

Before testing Chiller Operation, confirm that the process source is able to provide a load to the chiller

****Any questions at this point call Drake Tech Support 215-638-5515****

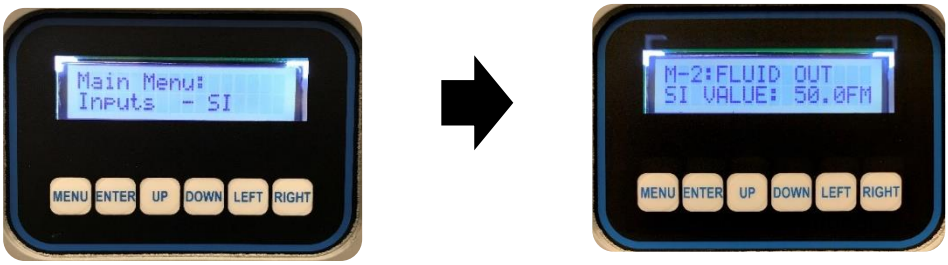
Full Start-Up & Refrigeration Circuit Testing

Ensure the liquid line solenoids (LLS), condenser fan motor (COND), pumps, and other Outputs RO are set to 'AUTO'

Ensure that COMP 1, 2, 3, 4, etc. are set to 'MANOFF'

1. Go to **Setpoints** tab --- press **ENTER** and scroll through to confirm all setpoints match attached form and sign

2. Go to **Inputs SI** --- scroll **DOWN** to **RUN/STOP** (M-9) --- hit **ENTER** to set to **'DI MANON'**
3. Pumps should begin to run and circulate fluid through the chiller
    a. Confirm previously checked 3-Phase rotation and fluid circuit flow
4. Allow the heat load to bring **'FLUID OUT'** (M-2) up to 10ºF above **Setpoint #1** --- monitor via **Inputs SI** tab



5. Go to **Outputs RO** --- set **COMP 1** to **'AUTO'** --- Compressor #1 should begin to run

6. **Confirm** compressor and condenser fan rotation (Pg. 11 for 3-Phase if applicable) --- fan should discharge out the top of the unit
7. Return to the **Main Menu** --- go to **Inputs SI** --- scroll **UP** and **DOWN** monitor chiller pressures and temperatures as the system continues to run
8. Verify sensor accuracy by confirming pressures displayed on **Inputs SI** match readings from refrigerant pressure gauges

****Any questions at this point call Drake Tech Support 215-638-5515****

9. Continue completing **Warranty Activation Form**
10. **Fill out Log Sheets – Motor/Elements/Etc. & Pressure/Temperature Chart at this time**
11. Inspect pressure fan speed control settings to maintain min-designed head pressure of 230-250 psi
12. If Chiller has receivers --- set OROA or ORD/ORI valves to maintain a minimum operating discharge pressure (235-240 psi – R407C and 250 psi – R404A) with all fans running
    See Piping diagram(s) for refrigerant and fluid circuit components

    For Dual Compressor Testing (if applicable)
    a. Once CIRCUIT #1 testing is complete, disable the **RUN/STOP** (M-9) --- set it to **'DI MANOFF'**
    b. Wait for **COMP** 1 to pump-down and turn off
    c. Go to **Outputs** --- set **COMP 1** to **'MANOFF'** --- this will disable **COMP 1** from starting with CIRCUIT #2
    d. Ensure components for CIRCUIT #2 are set to **'AUTO'** and **COMP 2** is set to **'MANOFF'**
    e. Enable the **RUN/STOP** (M-9) by using the same procedure as above to set the **Input** to **'DI MANON'**
    f. Pumps should begin to run and allow the heat load to bring **'FLUID OUT'** to 10ºF above '**ChwOut'** setpoint
    g. Go to **Outputs** --- set **COMP 2** to **'AUTO'** --- Compressor #2 should begin to run
    h. Continue Testing Circuit #2 as listed in Steps (6-12)

13. Finish completing attached **Warranty Activation Form**
14. Confirm that **RUN/STOP** (M-9) is set to **'DI MANON'**
    a. This input acts as the Chillers On/Off switch. It is a wet contact on the control board that can be field wired to an eternal toggle switch
    b. **If installing a switch**, the **RUN/STOP** (M-9) will instead be set to **'AUTO'**
15. Confirm everything else is in **'AUTO'** --- **Including Compressors** --- when done with the unit.

With the chiller now running, continue through the Operational Check to finalize start-up and adjust for normal operation conditions

For electrical and mechanical component information, see following sections

OPERATIONAL CHECK
AFTER INSTALLATION, CHECK ALL OF THESE STEPS

1. **CAUTION (When pumps are provided): The chilled fluid side of the system must contain either water or a water/glycol solution before turning on any pump.** Pumps should not be allowed to "**deadhead**," and those using three-phase motors must be checked for proper rotation . Allowing a pump to run dry, deadheaded, or in reverse rotation may all cause damage not covered by warranty.

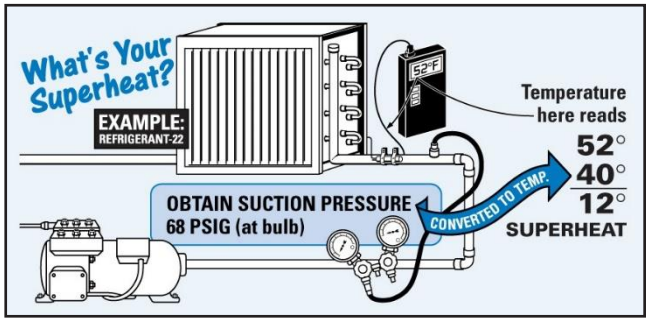
2. **With the pumps running & all valves open, check the chilled fluid circuit.** Note that the ball valve on the discharge side of the tank recirculation pump has been factory set for the proper evaporator flow rate & the handle removed. **Do not readjust unless otherwise specified by Drake Tech Support or Engineering**.
    1. **First**, bleed the tank using the boiler drain provided (closed-vented tanks only).
    2. **Second**, bleed the chilled fluid lines at their high points.
    3. **Third**, bleed the system's water flow switch located in the compressor compartment.
        i. **Air trapped in the flow switch lines will trip the switch and prevent the chiller from operating. This will trip the "Low Flow" alarm on the Drake Chiller Controller.**

3. **Attach thermocouples to the evaporators Entering & Leaving water lines**, and to the suction line, as close to the expansion valve bulb as possible . **Always disconnect electrical power before replacing fuses.** The refrigeration circuit may now be turned on, by replacing the compressor fuses, if they had been removed . Refer to "System Controls, Electrical" for details concerning thermostat adjustments. Be sure that the Compressor Precautions from above have been followed.

4. **Allow the system to operate for 1 – 2 minutes.** Check refrigerant pressures, water temperatures, etc. to ensure that all readings are in line with what could be expected at present water temperatures, ambient temperatures, etc.
    i) **Keep in mind that pressure-limiting expansion valves are used to limit low side pressures for most chillers, regardless of water temperature.**
    ii) ***Typical Standard Chiller* -- Low Side Pressure Limit**: Equivalent of 55°F
    iii) ***Low Temp Operation Chiller*** – **Low Side Pressure Range**: Equivalent of -5° to 0°F.

5. For the evaporator to operate at maximum efficiency, **a superheat of 8-20°F at the compressor is required to be verified by the start-up technician, and adjusted if necessary.**

6. To ensure that liquid refrigerant does not return to the compressor during the running cycle, maintaining proper superheat at the compressor suction inlet is critical . Drake recommends a maximum of 20°F superheat at the compressor suction inlet, to prevent liquid refrigerant flood-back; this must be verified by the start-up technician and adjusted if necessary.



Adjustment Method:

1. **Measure** the **temperature** and **pressure** 6 inches from the compressor suction valve .
2. **Convert** the temperature using a **P-T chart**.
3. **Subtract** this conversion from the measured temperature. 4 . The resulting number is the **superheat** at the compressor .

5 . Check Compressor oil level and stability . If milky or bouncy increase superheat . If clear and stable leave alone or decrease slowly to desired superheat .

- **Check the liquid line sight glass to make sure it is clear with steady liquid.**

1. **NOTE: A slightly bubbling sightglass does not necessarily mean the system is undercharged.** Take this into account when installing/servicing the unit .

2 . Small amounts of bubbling may result from the following:

3 . Cool weather operation without head pressure controls 4 . Locating the sightglass close to the condenser outlet .

- **Check status of moisture indicator:**
  - **GREEN** – Normal Operation
  - **Light Red** – Small amount of moisture in the system. This can usually be removed by the filter drier & does not necessarily indicate a serious problem. The indicator should be monitored over the next few days & corrective action taken as required.
  - **Bright Yellow** – Large amounts of moisture in the system . Can be indicative of a serious problem . Do not rely on the filter drier under these circumstances & do not run the refrigeration equipment until the problem is resolved.

- **Ensure that the system recirculation pump has proper flow.** All systems require a system circulation pump to move the chilled fluid between the chiller & whatever machinery, process etc. is being cooled. Care must be taken to ensure that fluid flow rates are in line with the requirements of the system being cooled. Flow meters and/or regulators may be required.
  - **Flow rates can be adjusted using ball valves on the discharge side of the pump. Never adjust flow from the intake side of a pump.** *Always remember that if the machinery, process etc. is not being properly cooled, the problem is normally flow rates that are either too high or too low.*
  - **Do NOT attempt to solve the problem by simply lowering the thermostat setting.** This is normally not a solution & may damage the system.

- **Chillers using integral recirculation tanks**: The ball valve installed on the discharge side of the tank recirculation pump is factory-set to maintain an approximate 5°F TD across the evaporator . The handle is then removed & wrapped to the valve with zip ties. Under most circumstances, no readjustment is necessary.

- **Systems using a chilled fluid recirculation tank**: It may be necessary to leave the system pump off until the fluid inside the tank reaches the desired temperature .

Check with Gauge or Thermometer

The following adjustable controls & valves must be checked with an appropriate gauge and/or thermometer. Many are optional items, which may not be included in your system . *Refer to System Controls -- Electrical & System Controls – Mechanical for description & settings.*

1. **Condenser Fan Control**
2. **Evaporator Heat Tape Freeze Protection Thermostat**
3. **Discharge Bypass Valve**
4. **Head Pressure Control Valve**
5. **Thermostatic Expansion Valve**
6. **Water Regulating Valve**
7. **Compressor Unloading Pressure Switch**

- **Do not leave the system unattended until normal operating conditions have been reached & the compressor oil level has been adjusted to maintain the proper level.**

- **Once the system has operated for 2 or 3 hours without any sign of problems, it may be left operating overnight. The following day, recheck the system as follows:**

1. **Check** both **high & low side pressures** . If they are not within appropriate ranges, determine the cause & correct.
2. **Check sightglass** for signs that additional refrigerant is required. Before adding any refrigerant, leak check the entire system correcting any leaks that may be found.
3. **Check compressor oil level** where appropriate. Add or remove oil as necessary.
4. **Check evaporator superheat** and readjust expansion valve as required.
5. **Check voltage** & **amperage** at the compressor power terminals . **Voltage must be within ±10% of the nominal as indicated on the unit nameplate.** If it is outside of this limit, contact the local power company. If amperage is excessive, the cause must be determined & corrective action taken . With a three-phase line, the load must be balanced at each phase.
6. **Check** all **safety & operating controller** settings in the review mode for proper settings & operation.
7. **Check** all **head pressure controls** for proper operation. This may not be possible during warm weather & it will be necessary to wait until the ambient temperature falls below 70°F.

System Controls, Electrical

One or more wiring diagrams are supplied on the inside of the control panel lid, as well as in the envelope that contained these instructions. These should be referred to while reading these instructions .

Catalog-listed chillers can be built for operation on the following electric services . Not all models however are available for every electric service shown below .

Designation	Electric Service (V/Phase/Hz)	Designation	Electric Service (V/Phase/Hz)
S2	208-230/1/60	S6	220/1/50
T3	208-230/3/60	T7	200/3/50
T4	460/3/60	T9	380/3/50
T5	575/3/60		

- **Regardless of which electric service is ordered, the system control circuit operates on 24 VAC** . This is accomplished through a “step-down” transformer located in the control panel.

- All parts mounted in the control panel are clearly labeled. Unless otherwise shown on the wiring diagram, **all control panels contain a main terminal block intended for single point electrical connection.**

- **Compressor Unloading Pressure Switch:** Optional component, normally mounted in the compressor compartment.
  - Senses compressor suction pressure & will deactivate banks of compressor cylinders in response to a drop in suction pressure, due to low load conditions.

- **Condenser Fan Control, Ambient Temperature Switch:** Optional component, normally mounted on the back of the control panel in the compressor compartment.
  - Senses ambient temperature and will de-energize fan motor(s) when the temperature drops below the control setting. Motor(s) will be re-energized when ambient temperature rises to a predetermined level.

- **Condenser Fan Control, Variable Speed:** Optional component normally mounted on the back of the control panel in the compressor compartment. The feeler bulb is connected to the liquid line piping at the outlet of the condenser coil . It will begin to modulate fan speed when the sensed temperature drops to 100°F & will proportionally reduce fan speed until the temperature reaches 70°F at which point power to the motor is cut off. As the temperature rises, the motor will restart at full speed and than modulate to the appropriate RPM . Caution – the power wiring to the fan motor(s) must be derived from the same two-phase lines as those, which are wired to the primary side of the control circuit transformer .

- **Fusing:** Condenser fan motor(s), as well as the control circuit, are fused using **class-“R” dual-element time delay cartridge fuses** . Replacing these with non-time-delay fuses of the same amperage rating may result in nuisance trips . Non-time-delay fuses with higher amperage ratings may not fit in the fuse block provided.

- **Heat Tape Freeze Protection:** Optional item, consisting of low wattage (5 Watts/ft) heat tape wrapped around the heat exchanger below the insulation, and operated by a thermostat wired to close on temperature drop. The thermostat bulb is strapped to the bottom of the water line leaving the heat exchanger. Typical setting for the thermostat: 35°F.

- **Indicator lights (with or without dry contacts**): Optional component(s). Indicator lights are externally visible and normally mounted adjacent to the control panel.
  - **GREEN** – Normal Operation
  - **RED** – Indicates Problem!
  - Wiring for the indicators varies depending on their use. Refer to wiring diagrams.
  - If dry contacts are ordered with any indicator, a DPDT relay is included in the control panel. The relay coil is wired in parallel with it corresponding indicator. The controller has relay terminals that can be connected to a remote audible or visual alarm, should the controller fault and shut down the chiller. Reference the wiring diagram for the location of these terminals for field connection.

- ***Switch, Disconnect**: (Optional Component)*
  - **This is a safety device and should not be used as an on/off switch.** Throwing this switch to the off position will remove all power from the system, including the compressor crankcase heater . *This may result in irreparable damage to the compressor when restarting.* See "Start-Up."
  - *It is generally the responsibility of the installer to provide and mount a fused or non-fused disconnect switch, as per national and local electric codes.*

- **Switch, Oil Pressure:**
  - A safety device that senses compressor crankcase pressure . It is used with all compressors which have a positive displacement oil pump and is located in the compressor compartment. These switches contain a non- adjustable timing circuit, which allows the crankcase pressure to come up to a predetermined minimum before shutting down the compressor. The length of the time delay is dependent on the particular compressor .

- **Microprocessor controller:**
  - Temperature controller mounted on the chiller panel, which senses the temperature of the chilled fluid returning to the chiller. Its range is -30° to +220°F, with an adjustable differential of 1° to 30°F.
    - **When using plain water, never set the thermostat lower than +42°F unless the chiller has been specifically built to operate at a lower temperature.** Failure to do this may result in heat exchanger freeze-up and rupture, which in turn will destroy the refrigeration circuit. **This type of failure will void any warranty on the equipment.**
    - When colder temperatures are required, a glycol/water solution can be used . The thermostat can then be lowered below +42°F. The lowest setting is dependent on the type and concentration of glycol used.

- **Transformer(s):**
  - The control circuit transformer is used to step down the system voltage to 24 VAC used to power the control circuit.
    - Additional transformers may be used to power selected components as shown on the wiring diagram . On systems intended for use on 208-230V electric service, the transformer leaves the factory wired for 230V on the Primary side .
    - Some transformers must be rewired when used on a 208V network. Always check the wiring of the transformer primary circuit before energizing .

- **Water Flow Switch**:
  - A safety device used to sense flow through the evaporator. It is a heat dissipation flow sensor typically mounted to the water inlet of the evaporator and wired to the electrical control box .
  - **If flow rates drop for any reason, the flow switch will shut down the unit completely until flow is restored.**

System Controls -- Mechanical

One or more piping diagrams are supplied in the envelope that contained these instructions. These should be referred to while reading these instructions.

- **Discharge Bypass Valve**: A modulating control valve which opens on a decrease in suction pressure, and can be set to automatically maintain a desired minimum evaporating pressure regardless of the evaporator load.
  - **Valves typically used have an adjustment range of 0 – 80 PSIG** . Other ranges are available and may be used depending on application . The valve is factory-set to maintain a minimum evaporating temperature of 34°F for most applications . **Do not reset to a lower pressure when chilling ordinary water unless specially designed heat exchangers are employed.**
  - For applications using glycol solutions, this valve can be safely reset to maintain a lower minimum pressure. The exact setting will be dependent on the type and concentration of glycol used . To reset the valve, the following procedure should be followed:
    1 . Remove the cap and insert a 5/16" allen wrench into the adjusting screw. Turning this screw clockwise will increase the setting and counter-clockwise will lower the setting .
    2 . A high evaporator load is initially required to raise the evaporator pressure above the desired setting .
    3 . Slowly decrease the load until the regulating valve begins to open . This will be indicated by a hissing sound and/or an accompanying temperature rise at the outlet .
    4. Note the evaporator pressure when the valve opens. This is the current pressure setting of the valve. 5 . Turn the adjusting screw as required and repeat steps 2 through 4 to determine the new valve setting. 6 . Repeat this procedure until the valve is set at the proper pressure for the service required .

- **Head Pressure Control Valve – Adjustable:** Systems with these valve(s) use a combination of Sporlan ORD/ORI valves.
  - The ORI valve is adjustable over a range and is located in the liquid line between the condenser and receiver. Due to its wide adjusting range, it can be used with most commonly used refrigerants. The valve will throttle and restrict the flow of liquid refrigerant from the condenser. Adjusting the valve is done by removing the cover over the adjusting screw and turning it clockwise to raise pressure and counter-clockwise to reduce pressure.
  - The ORD valve is a non-adjustable pressure differential check valve located in a bypass line between the systems discharge line and the receiver inlet. As the ORI valve restricts flow from the condenser, it creates a pressure differential across the ORD valve . This allows the ORD valve to bypass hot gas directly into the receiver, warming the liquid refrigerant and thereby maintaining a constant pressure at the expansion valve .

- **Head Pressure Control Valve – Non-adjustable:** Systems with these valve(s) use a Sporlan OROA valve, which is factory set to maintain a set discharge pressure depending on the refrigerant.
  - R-404A, R-407C, R-507: 225 PSIG discharge pressure
  - R-134: 100 PSIG discharge pressure.

- **Solenoid, Liquid:** Electrically operated (energize to open) valve used to control the flow of **liquid refrigerant to the expansion valve.**

- **Solenoid, Hot Gas:** Electrically operated (energize to open) valve used to control the flow of **discharge gas to the discharge bypass valve.**

- **Thermostatic Expansion Valve:** A modulating valve used to meter refrigerant into the evaporator in response to the imposed load. It does this by maintaining a constant superheat of the refrigerant vapor at the suction outlet of the evaporator. The lower the superheat, the more efficiently the evaporator is operating. **From a practical standpoint, Drake recommends a superheat of 8° - 10°F at the evaporator.**
  - To adjust superheat, remove nut covering the adjusting stem. Turning the stem clockwise will increase superheat and slightly decrease the valve capacity . Turning the stem counter-clockwise will decrease superheat and slightly increase the valve capacity . Keep in mind that superheat cannot be adjusted when the system is operating well above setpoint.

- **Water Regulating Valve:** An optional modulating type valve used with water-cooled condensers to maintain a constant head pressure.
  - The valve senses discharge pressure and modulates the flow of water through the condenser in response to this pressure. Turning the adjusting stem on top of the valve will increase or decrease the systems discharge pressure.
- **All water regulating valves should be installed on the leaving fluid condenser outlet.**

Warranty Repairs

All in-warranty repairs must be performed by competent refrigeration mechanics that are familiar with this type of equipment. Prior to the commencement of the work, factory authorization is required. Billing for parts and labor will not be considered without this authorization.

See Terms and Conditions of Sales on next page.

TERMS AND CONDITIONS OF SALE

ORDER PROCEDURES- All equipment-requiring options are manufactured to order after receipt of customer purchase order. Some of the standard units are stocked and available for shipping generally within three working days.

DELIVERY REQUIREMENTS-Indicate at time order is placed.
STANDARD DELIVERY-Manufactured to order, approximately in 2-3 weeks (Weeks to ship will vary due to workload,) Shipping inquiries will be estimated to the "week ending."
EXTENDED DELIVERY- manufactured to order and shipped as per requested, when applicable, within the weeks required.
PRIORITY DELIVERY- Manufactured to order in 3-10 working days. Must have factory authorization in advance.
QUOTATIONS-All quotations in writing automatically expire thirty (30) days from the date of quotation and may be terminated by notice within that period. All oral quotations automatically expire five (5) days from date of quotation and are subject to change without notice. All orders are subject to approval at the factory by and authorized employee of the Seller. Orders are accepted under the Seller's terms, conditions, and price information as of the date of the Seller's factory acknowledgment of the order. Orders, originally entered, and then "held" for future release will be subjected to the Seller's terms, conditions, and price information as of the date Buyer's release is accepted by the Seller.

CANCELLATIONS- The buyer may not cancel an order except upon a verbal notice followed by a written notice and on payment of a reasonable and proper sum to compensate for expenses incurred in the engineering and manufacturing of said order to the date of cancellation.

TERMS OF PAYMENT- Credit is a privilege and all orders will be shipped C.O.D. unless prior arrangements have been made with the credit department. Direct all inquires for information to the credit manager. All goods are sold FOB factory suitably packed or crated for domestic shipment. Export shipments are subject to additional packing charge.

Terms to buyers of satisfactory credit are-NET 30 DAYS FROM DATE OF INVOICE. NO CASH DISCOUNT ALLOWED. No shipments for accounts 45 days outstanding. Shipments made only after receipt of payment on all outstanding invoices. For special orders, a down payment or deposit may be required.

SALES TAXES- Sales or use taxes required by law to be collected or paid by seller be in addition to prices quoted unless appropriate tax exemption certificate is furnished.

SHIPPING- All shipments will be forwarded FOB, PHILADELPHIA, PA.

1.) Prepaid only when open accounts terms are applicable to shipment.
2.) Collect on all other accounts.
3.) Insurance will be automatically added to UPS shipped valued in excess of $100.00
4.) All COD shipment will include the appropriate COD charges, when applicable.

DAMAGED FREIGHT- The consignee (buyer) is responsible for filing a freight claim with the delivering carrier should freight damages occur. Damages in shipment are not considered the responsibility of the factory. An inspection should be made at the time of delivery for any visible sign of mishandling by the carrier. Damages MUST be noted on the delivery receipt and a request for an inspection should be made immediately by the freight company adjuster. All packaging MUST be retained for the INSPECTION of the carrier or claim may be denied.

RETURNED GOODS- All returned goods must be authorized in advance. Only new and unused equipment will be considered for return. All items must be sent freight prepaid and include a packing slip. Equipment built to order is not subject to return for credit. Items returned that are inspected and found to be "OK" will be subject to a 25% restocking charge. Goods must be securely packed to arrive at the factory without damage. Any cost incurred by the factory to put equipment in first class condition will be charged to the buyer.

IN WARRANTY SERVICE PARTS- In warranty service parts will be invoiced pending receipt of the replaced parts previously authorized for return. After inspection of the replaced part at the factory, credit will be issued against the replacement parts providing the part was returned freight prepaid and that the part was free from abuse or misuse.

EQUIPMENT PARTS WARRANTY-DRAKE REFRIGERATION, INC. WARRANTS TO THE ORIGINAL OWNER OF THE UNIT THAT THE EQUIPMENT WILL BE FREE FROM DEFECTS IN MATERIAL AND WORKMANSHIP FOR A PERIOD OF ONE YEAR FROM THE EFFECTIVE DATE OF THE WARRANTY.
The effective date of this warranty is thirty days after shipment from the factory. The company's obligation under this warranty is limited to the repair or replacement, at its factory, of any part that shows evidence of being defective in material and workmanship and are deemed so by Drake Refrigeration, Inc., during the one year period. No obligation for labor required to replace the defective parts not for freight or Drake Refrigeration, Inc assumes mailing costs to return or to secure the part.
THE COMPRESSOR ONLY WILL BE WARRANTED FOR AN ADDITIONAL FOUR YEARS (TOTAL FIVE YEARS) FROM THE EFFECTIVE DATE OF THE WARRANTY PROVIDED THE EXTENDED WARRANTY IS PURCHASED
WITHIN THIRTY DAYS FROM THE EFFECTIVE DATE. The compressor warranty obligates Drake Refrigeration, Inc., to replace FOB the factory, the compressor with a comparable compressor with equal capacity, free of charge. Drake Refrigeration, Inc. assumes no responsibility for refrigerant accessories, labor, or freight to or from the factory. Defective parts will be replaced provided notice of such defect was given by the original owner within the warranty period. Drake Refrigeration, Inc. reserves the right to replace in warranty defective parts from its factory. The warranty does not cover the cost to parts substituted by field service for original equipment parts not authorized by Drake Refrigeration, Inc. Any unauthorized substitution voids the warranty.
THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES. IN NO CASE WILL ANY CLAIM FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES BE APPROVED. THIS WARRANTY DOES NOT APPLY TO THE UNIT OR ANY PART THEREOF WHICH HAS BEEN SUBJECT TO DAMAGE DUE TO TRANSPORTATION,

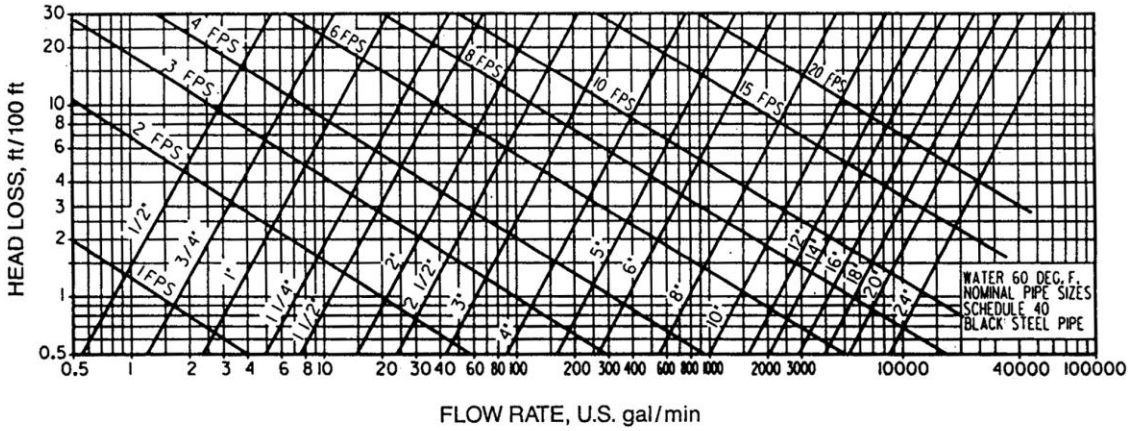


Fig. 1 Friction Loss for Water in Copper Steel Pipe (Schedule 40)

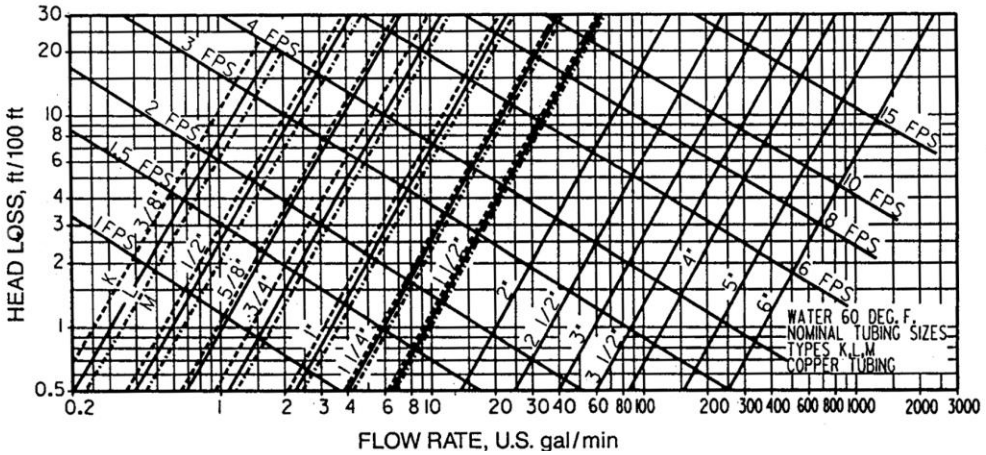


Fig. 2 Friction Loss for Water in Copper Tubing (Types K, L, M)

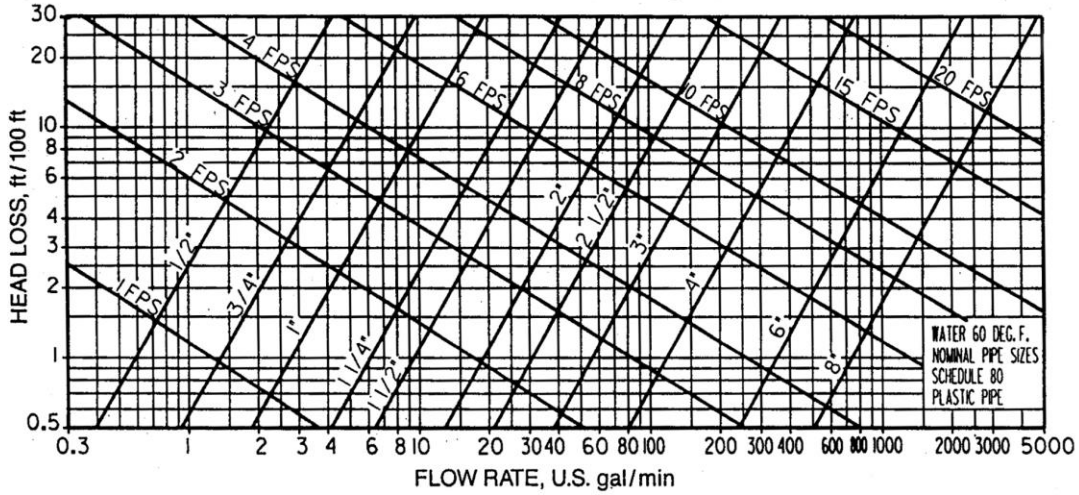


Fig. 3 Friction Loss for Water in Plastic Pipe (Schedule 80)

RECOMMENDED REMOTE CONDENSER LINE SIZES

Net Evaporator Capacity BTUs	Total Equivalent Length FEET	R-134a		R-407		R507 & R-404A	
		Discharge Line (O.D.)	Liquid Line (O.D.)	Discharge Line (O.D.)	Liquid Line (O.D.)	Discharge Line (O.D.)	Liquid Line (O.D.)
3000	50	3/8	3/8	3/8	3/8	3/8	3/8
	100	1/2	3/8	3/8	3/8	3/8	3/8
6000	50	1/2	3/8	3/8	3/8	1/2	3/8
	100	1/2	3/8	1/2	3/8	1/2	3/8
9000	50	5/8	3/8	1/2	3/8	1/2	3/8
	100	5/8	3/8	1/2	3/8	5/8	3/8
12000	50	5/8	3/8	1/2	3/8	1/2	3/8
	100	7/8	3/8	5/8	3/8	5/8	3/8
18000	50	7/8	3/8	1/2	3/8	5/8	3/8
	100	7/8	1/2	5/8	3/8	5/8	1/2
24000	50	7/8	1/2	5/8	3/8	7/8	3/8
	100	7/8	1/2	5/8	1/2	7/8	1/2
36000	50	7/8	1/2	7/8	1/2	7/8	1/2
	100	1 1/8	5/8	7/8	1/2	7/8	1/2
48000	50	1 1/8	1/2	7/8	1/2	7/8	1/2
	100	1 1/8	5/8	7/8	1/2	1 1/8	5/8
60000	50	1 1/8	1/2	7/8	1/2	7/8	1/2
	100	1 3/8	5/8	7/8	5/8	1 1/8	5/8
72000	50	1 1/8	5/8	7/8	1/2	1 1/8	5/8
	100	1 3/8	7/8	1 1/8	5/8	1 1/8	5/8
90000	50	1 3/8	5/8	7/8	5/8	1 1/8	5/8
	100	1 3/8	7/8	1 1/8	5/8	1 3/8	7/8
120000	50	1 3/8	7/8	1 1/8	5/8	1 1/8	5/8
	100	1 5/8	7/8	1 1/8	7/8	1 3/8	7/8
180000	50	1 5/8	7/8	1 3/8	7/8	1 3/8	7/8
	100	2 1/8	1 1/8	1 3/8	7/8	1 5/8	7/8
240000	50	1 5/8	7/8	1 5/8	7/8	1 5/8	7/8
	100	2 1/8	1 1/8	1 5/8	7/8	1 5/8	1 1/8
300000	50	2 1/8	1 1/8	1 5/8	7/8	1 5/8	1 1/8
	100	2 1/8	1 1/8	1 5/8	1 1/8	2 1/8	1 1/8
360000	50	2 1/8	1 1/8	1 5/8	7/8	2 1/8	1 1/8
	100	2 5/8	1 3/8	2 1/8	1 1/8	2 1/8	1 3/8
480000	50	2 1/8	1 1/8	2 1/8	1 1/8	2 1/8	1 1/8
	100	2 5/8	1 3/8	2 1/8	1 1/8	2 1/8	1 3/8
600000	50	2 5/8	1 3/8	2 1/8	1 1/8	2 1/8	1 3/8
	100	3 1/8	1 5/8	2 1/8	1 3/8	2 5/8	1 5/8
720000	50	2 5/8	1 3/8	2 1/8	1 3/8	2 1/8	1 5/8
	100	3 1/8	1 5/8	2 5/8	1 3/8	2 5/8	1 5/8
840000	50	2 5/8	1 3/8	2 1/8	1 3/8	2 5/8	1 5/8
	100	3 1/8	1 5/8	2 5/8	1 5/8	2 5/8	2 1/8
960000	50	3 1/8	1 3/8	2 5/8	1 3/8	2 5/8	1 5/8
	100	3 1/8	2 1/8	2 5/8	1 5/8	3 1/8	2 1/8
1080000	50	3 1/8	1 5/8	2 5/8	1 3/8	2 5/8	2 1/8
	100	3 5/8	2 1/8	2 5/8	1 5/8	3 1/8	2 1/8
1200000	50	3 1/8	1 5/8	2 5/8	1 5/8	2 5/8	2 1/8
	100	3 5/8	2 1/8	3 1/8	1 5/8	3 1/8	2 1/8
1440000	50	3 1/8	1 5/8	2 5/8	1 5/8	3 1/8	2 1/8
	100	3 5/8	2 1/8	3 1/8	2 1/8	3 5/8	2 5/8
1680000	50	3 5/8	2 1/8	2 5/8	1 5/8	3 1/8	2 1/8
	100	4 1/8	2 1/8	3 1/8	2 1/8	3 5/8	2 5/8

Fig. 4 Remote Condenser Line Sizes

Drake Refrigeration Chiller Preventative Maintenance Schedule

Type of PM: Quarterly:_____ Annual:_____

Site or Building Name:_____

Technician Name:_____ Date:_____

Chiller Model #:_____ Chiller Serial #:_____

	Initial	Quarterly	Annually
1 . Review Chiller Logs		x	
2 . Clean Condenser Coils-Fin			x
3 . Flush Evaporator			x
4 . Flush Condenser-Coaxial			x
5 .Test Compressor Oil			x
6a . Change Compressor Oil, Recips			x
6b . Change Compressor Oil, Scroll			x
6c . Change Compressor Oil, Screw			x
7 . Check Oil Filters		x	
8 . Change Oil Filters			x
9 . Check Y-Strainers		x	
10 . Check Pump Gaskets/Seals		x	
11 . Check For Leaks		x	
12 . Tighten All Electric		x	
13 . Check Overloads		x	
14 . Check Contactors		x	
15. Check VFD'S		x	
16 . Check Chiller Operation		x	
17 . Complete PM Checklist		x	

# Drake Refrigeration Inc. # MCS Warranty Activation Form	**Issue Date** 3-21-12 **Supersedes** 8-1-00	**File Name** **3T. ACTIVATION. FORM**
Schedule Type: Drake Chiller start-up & pm checklist		**Page: 1 of 6**

Start Up/PM Date:				
Site Name:			Site Contact:	
Address:			Phone Number:	
City:	State:	Zip:	Email Address:	
Manufacturer:	**Drake Refrigeration Inc**		Service Company Name:	
Model #:			Service Company Phone:	
Serial #:			Startup Technician:	
Seg. # .				

Pre Start-Up Checklist

- ☐ Inspect incoming voltage matches nameplate voltage, and chiller disconnect per national and local codes.
- ☐ Confirm that chiller has power supplied for 24 hours and the disconnect switch is turned ON. Inspect
- ☐ installation of equipment mounting, piping, and wiring for completion.
- ☐ Inspect chiller location is **free from overhangs and at least 3 feet from any wall or fence**.
- ☐ Inspect chiller fluid level is full and free of air.
- ☐ Inspect distilled water loop is full of fluid. **If Applicable**. **N/A if not**
- ☐ On indoor heat exchanger inspect disconnect is in OFF position. **If Applicable**. **N/A if not**
- ☐ Inspect chiller piping and pump housing for any fluid leaks.
  (Slight seal leak may occur until pump seal burn in time is complete.)
- ☐ Inspect pump overload settings. (This should match the SFA rating on the pump labels)
- ☐ Tighten all Schrader valve cores and liquid line solenoid bodies.
- ☐ Open receiver ball valves to release the refrigerant into the system. **If Applicable**. **N/A if not.**
- ☐ Tighten receiver valve packing nut **If Applicable. N/A if not.**
- ☐ Leak check the refrigerant circuit with an electronic leak detector.
- ☐ Tighten all electrical connections in the control panel, microprocessor and other controls. Measure
- ☐ the glycol freeze point and log into the chart below.

****The Chiller can be started via Keypad or Laptop. If using Laptop proceed to next section****

Chiller Operation (Via Keypad)

- ☐ Refer to detailed start-up procedures in IO&M Manual for full walk through and keypad navigation
- ☐ Go to the Password tab and enter the 2112 password for Supervisor level access
- ☐ Confirm that the RUN/STOP is set to 'MAN OFF'
- ☐ Perform a 'Lockout Reset' from the display Main Menu
- ☐ From Outputs RO tab, verify pump(s) are running properly and circulating fluid to the evaporator
- ☐ From Outputs RO tab, test the function of:
  - Liquid line solenoid(s) (LLS 1&2),
  - Condenser fan motor(s) (COND 1-4),
  - Receiver heater(s) (REC HTR 1&2)
- ☐ Return all Outputs RO **- EXCEPT COMP(s) -** to 'AUTO'

Any questions at this point call Drake Tech Support 215-638-5515

Completion Date:	Service Provider: (1)	Material/tool reference

- ☐ Turn the RUN/STOP to 'MAN ON'
- ☐ Allow the pumps to run and bring the 'FLUID OUT' up to 10ºF above desired setpoint
- ☐ Set COMP 1 to 'AUTO'
- ☐ Confirm 3-phase compressor and fan rotation (if applicable)
- ☐ Monitor pressure and temperature readings and verify pressure readings with refrigerant pressure gauges
- ☐ Measure amperage and voltage readings while the unit is running
- ☐ **Fill out Log Sheets – Motor/Elements/Etc. & Pressure/Temperature Chart**
- ☐ Inspect pressure fan speed control settings to maintain min-designed head pressure of 230-250 psi
- ☐ If Chiller has receivers --- set OROA or ORD/ORI valves to maintain a minimum operating discharge pressure (235-240 psi – R407C and 250 psi – R404A) with all fans running
- ☐ Disable Circuit #1 and test chiller Circuit #2 (if applicable) by repeating steps for Circuit #1
- ☐ After testing all chiller circuits, confirm the RUN/STOP is set to 'MAN ON'
  - If an external switch has been wired to this input, instead set to 'AUTO'
- ☐ Confirm every Output RO is set to 'AUTO' **– INCLUDING COMP(s) –** when done testing

Chiller Operation (Via Laptop)

- ☐ Refer to detailed star-up procedures in IO&M Manual for full walk through
- ☐ Bring Windows based computer with the latest version of MCS Connect downloaded https://mcscontrols.com/ - Download AUTH CODE version to enable program changes
- ☐ Bring one of two cables for laptop to MCS connection
  - RS-485 to USB cable included with chiller --- MicroMag & Magnum Controller
  - Cross-over Ethernet cable --- Magnum Controller only
- ☐ Through MCS Connect, choose ***Local Serial*** is using RS-485 cable and ***Ethernet*** if using Cross-over cable
- ☐ Once connected, the chiller model number will show up on laptop
  - If chiller is not displaying on laptop, refer to www.drakechillers.com for a more complete walkthrough on using MCS Connect
- ☐ Click on the VIEW ONLY tab and enter the 2112 password for Supervisor level access
- ☐ Confirm that the RUN/STOP is set to 'MAN OFF'
- ☐ Perform a 'Lockout Reset' from the display Main Menu
- ☐ From Outputs RO tab, verify pump(s) are running properly and circulating fluid to the evaporator
- ☐ From Outputs RO tab, test the function of: liquid line solenoid(s) (LLS 1&2), condenser fan motor(s) (COND 1-4), receiver heater(s) (REC HTR 1&2)
- ☐ Return all Outputs RO **- EXCEPT COMP(s) -** to 'AUTO'

Any questions at this point call Drake Tech Support 215-638-5515

- ☐ Turn the RUN/STOP to 'MAN ON'
- ☐ Allow the pumps to run and bring the 'FLUID OUT' up to 10ºF above desired setpoint
- ☐ Set COMP 1 to 'AUTO'
- ☐ Confirm 3-phase compressor and fan rotation (if applicable)
- ☐ Monitor pressure and temperature readings and verify pressure readings with refrigerant pressure gauges

- ☐ Measure amperage and voltage readings while the unit is running
- ☐ **Fill out Log Sheets – Motor/Elements/Etc. & Pressure/Temperature Chart**
- ☐ Inspect pressure fan speed control settings to maintain min-designed head pressure of 230-250 psi
- ☐ If Chiller has receivers --- set OROA or ORD/ORI valves to maintain a minimum operating discharge pressure (235-240 psi – R407C and 250 psi – R404A) with all fans running
- ☐ Disable Circuit #1 and test chiller Circuit #2 (if applicable) by repeating steps for Circuit #1
- ☐ After testing all chiller circuits, confirm the RUN/STOP is set to 'MAN ON'
  - If an external switch has been wired to this input, instead set to 'AUTO'
- ☐ Confirm every Output RO is set to 'AUTO' **– INCLUDING COMP(s) –** when done testing

Motors, Elements

- ☐ Confirm log sheets have been completely filled out

Final Checklist

- ☐ Remove all tools and debris from the equipment.
- ☐ Replace all service caps and tighten.
- ☐ Replace receiver valve stem caps and tighten. (If applicable)
- ☐ Replace all chiller manuals and documentation into the electrical panel.
- ☐ Install & secure all access panels and hardware.
- ☐ Review start up documents with the customer
- ☐ Give a copy of the start-up documents to the customer
- ☐ Fax or email a copy of the start-up documents to Drake: **(215) 638-5518** or drakeservice@drakechillers.com

Completion Date:	Service Provider: (1)	Material/tool reference

Glycol Freeze Point :

Log Sheet: MOTORS, ELEMENTS, ECT.

ID Information		Amp Readings				Voltage Readings			
Motor/Element Name	**% Load**	**L1**	**L2**	**L3**	***NP**	**L1-L2**	**L1-L3**	**L2-L3**	***NP**
Digital Compressor									
Compressor 2									
Condenser Fan 1									
Condenser Fan 2									
Condenser Fan 3									
Condenser Fan 4									
Chiller Recirc Pump									
Process Fluid Pump									
Receiver Heater 1									
Receiver Heater 2									
Liquid Solenoid 1									
Liquid Solenoid 2									

*NP=Name Plate

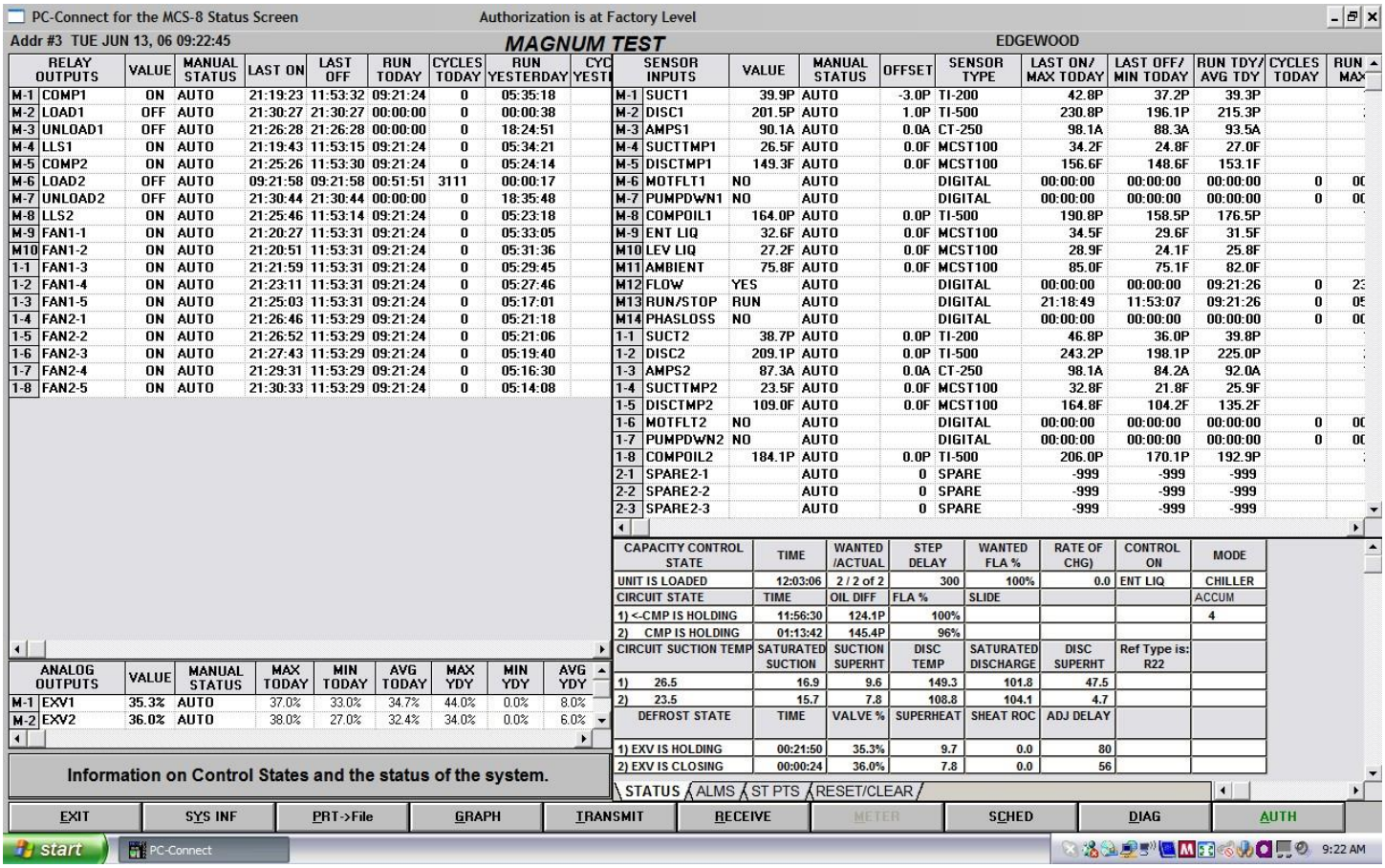
Log Sheet: PRESSURES AND TEMPERATURES

INPUTS	**VALUES* 1**	**VALUES* 2**	**VALUES* 3**	**VALUES* 4**	**VALUES* 5**	**VALUES* 6**	**VALUES* 7**	**VALUES* 8**
SUCT1								
DISCH1								
SUCT2								
DISCH2								
FLUID IN								
FLUID OUT								
AMBIENT								

*Values - taken

Completion Date:	Service Provider: (1)	Material/tool reference

MCS STATUS SCREEN



Completion Date:	Service Provider: (1)	Material/tool reference

Notes:

Completion Date:	Service Provider: (1)	Material/tool reference

WARRANTY LABOR ALLOWANCES

MUST BE APPROVED TO RECEIVE COMPENSATION

Service Category	Task Description	Man Hours
Electrical	Replace HOST micro-processor controller	1 .00
	Replace REMOTE micro-processor controller	1 .00
	Replace High or Low pressure controller transducer with cable	1 .00
	Replace compressor or fan contactor	1 .00
	Replace pump motor contactor/overload and calibrate to SF amps	1 .00
	Replace differential flow safety	1 .00
	Replace compressor crank case heater (insert or band)	1 .00
	Replace receiver heater Scroll system	2 .50
	Replace receiver heater Semi-Hermetic system	3 .50
	Replace evaporator heater (Brazed Plate)	2 .00
	Replace evaporator heater (Shell and Tube)	2 .50
	Replace condenser fan motor	1 .00
	Replace refrigerant solenoid coil	1 .00
	Replace flooded condenser heater controller	1 .00
Refrigeration	Replace compressor (Scroll)	6 .00
	Replace compressor semi-hermetic	8 .00
	Replace TXV standard	3 .00
	Replace liquid line solenoid valve standard	5 .00
	Replace liquid line solenoid flooded condenser	2 .00
	Replace head master valve	5 .00
Fluid Systems	Replace Recirculation pump	3 .00
	Replace System pump	3 .00
	Replace Pump Seal on Recirc or System	2 .00
	Replace tank level sight glass lenses	1 .00
Leak Repairs	Refrigeration piping braze joint (15% silfos)	4 .00
	Fluid piping braze joint (95/5 solder)	2 .00
	Pipe to fitting joint repair (Refrigeration or Fluid)	2 .00
	Fluid pipe to Braze Plate evaporator	3 .00
	Fluid pipe to shell and tube evaporator	3 .00

Notes

Notes

Notes

2900 Samuel Drive | Bensalem, PA 19020 888-289-7299 | 215-638-5515

www.drakechillers.com

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