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INSTRUCTIONS FOR INSTALLATION & OPERATION

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CONDENSING UNIT

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WARNING

TO INSURE THE SAFETY OF INSTALLING AND OPERATING PERSONNEL, THE FOLLOWING PRECAUTIONS MUST BE OBSERVED:

1. Prior to lifting units to above-grade machine rooms, all lifting slings, hooks, hoists, etc. must be inspected to make sure they are in good condition and adequately sized for the load they will handle.

2. All electrical work must be done in accordance with the National Electrical Code and existing local codes.

3. Equipment must be properly grounded by connecting marked ground terminal in control panel to an adequate ground.

4. An adequate electrical power supply - the same as specified on the data plate of the motor compressors - must be provided.

5. Control panels (regardless of compressor motor voltage requirements) must be provided with a 208/240 volt, single phase, 60 hertz electrical supply for pilot circuitry.

6. Disconnect all electrical power before servicing. On some units, more than one disconnect switch must be turned off to completely deenergize the equipment for servicing.

7. Refrigerant discharge lines (and suction lines on hot gas defrost systems) can become very hot. Avoid touching them when equipment is operating.

8. Do not operate units with any protective grilles or access covers removed. Be sure to replace all protective covers removed during servicing.

Any suction lines which drip condensate water during equipment operation should be insulated to prevent the hazard of slippery floors in the machine room. Avoid moisture collection on electrical components.

9. Only low pressure nitrogen or dry CO_2 should be allowed to flow through lines as an oxidation inhibitor when brazing connections. Use a pressure regulator on the supply tank.

11. Do not purge nitrogen or CO_2 in confined, unventilated areas where there is a possibility of displacing normal oxygen supply. Purged refrigerant should be returned to an approved pressure tank rather than vented to the atmosphere.

12. Pressure tests should be conducted using only inert gases such as refrigerant/nitrogen or refrigerant/carbon dioxide mixtures. Oxygen should never be used as a back-up gas since it may mix with oil in a system and cause an explosion. An accurate pressure regulator must be used on test gas cylinders.

INTRODUCTION

A refrigeration condensing unit is a highly sophisticated apparatus. It is installed with the anticipation that it will give many years of trouble-free operation with a minimum of maintenance. To a great extent, the length of service life realized from a particular condensing unit is directly proportional to the care with which the original installation was performed.

Cleanliness is absolutely mandatory when installing a condensing unit. Utmost care has been taken at the factory to insure that the unit is free of all contamination. The factory-applied seals must not be removed until the unit is ready to be installed. All tubing, valves and fittings must be carefully inspected to insure cleanliness. Only refrigeration grade tubing and fittings should be used and the entire system must be evacuated as described under the installation instructions.

The correct electrical supply must be provided to each condensing unit. The voltage at the motor-compressor terminals should be checked with the unit operating under full load and also during start-up to insure that it is within plus or minus 10 per cent of the nameplate rating.

Condenser requirements should be carefully determined at installation. The condensing unit must be located where an adequate supply of cooling air or water is available at all times of the year. Condensing temperatures must not be so low as to cause short cycling of the condensing unit due to extremely low head pressures, however.

The lubrication recommendations for the motor-compressor and fan motors (where applicable) must be carefully adhered to. The crankcase oil is a good indicator of correct motor-compressor operation and it should be carefully observed through the sight glass during the initial start-up and during the operational checkout.

INSTALLATION

RECEIPT AND INSPECTION OF EQUIPMENT

Inspect the condensing unit and all accessories shipped with it for any damages or shortages. Any damage or shortage should be reported immediately to the delivering carrier. Damaged material becomes the delivering carrier's responsibility and it should not be returned to the manufacturer unless prior approval is given to do so.

Do not remove the condensing unit from its shipping skid until it has been placed as close as possible to its permanent location. When lifting with a crane, protect the control panel, wiring and piping from any lifting stress by spacing the lifting cables away from the unit with appropriate spreaders. Do not exert any twisting force on the base frame.

When the unit has been placed in its permanent location, remove the steel straps and other shipping material. Back off and remove the motor-compressor mounting nuts. Install the rubber grommets supplied in each of the motor-compressor mounting feet. Reinstall the motor-compressor mounting nuts and tighten them only enough to insure that the motor-compressor rides freely on its mounting springs (there should be $\frac{3}{8}$" to $\frac{1}{2}$" clearance between the motor-compressor mounting feet and the shipping pads).

LOCATION AND VENTILATION

The condensing unit should be located in an area which provides for ease of installation and service of all electrical lines, refrigeration and water piping and any accessory equipment. The unit must be level to insure proper lubrication.

The machine room must be so designed as to protect the condensing unit from extremes of both high and low temperatures. Adequate ventilation must be provided even with remote-condenser units since the motor-compressor body and discharge lines give off heat. If air-cooled condensers must be located out doors or in locations where the ambient temperature dips below 60°F or 65°F for at least a few days at a time, some provision must be made to insure that the correct motor-compressor head pressures are maintained during the cool weather season. This may be accomplished by various methods at the user's option as follows:

1. Fan cycling controls which turn off the condenser fans when the motor-compressor head pressure reaches a pre-determined minimum value.

2. Power-operated louvers on the condensing unit air-cooled condenser which are opened and closed by a pressure-operated actuator connected directly to the motor-compressor.

3. Power-operated louvers on the machine room walls which are opened and closed by motor actuators controlled by thermostats.

4. Head pressure control valves which sense the motor-compressor head pressure and allow all or a portion of the refrigerant to bypass the condenser at times when the condenser ambient is unusually low.

Air-cooled condensers must be located to insure adequate air for condensing purposes. Specifically, the air-cooled and remote air-cooled condensing unit capacity ratings are based on 90°F (nominal) air entering the entire condenser face area. Care must be taken to prevent the re-circulation of air both from one condensing unit to another and from the air outlet back to the air inlet of any one condensing unit.

NOTE

The exact air temperature necessary to maintain the correct condensed refrigerant temperature will vary slightly from that above depending on the various operating suction pressures.

ELECTRICAL

The voltage, phase and frequency of the electrical supply must coincide with the specifications indicated on the condensing unit motor-compressor nameplate. The voltage as checked under starting and running conditions must not be higher or lower than 10 per cent of the nameplate rating. If the supply voltage exceeds this limitation, consult the power company immediately for corrective action since long term operation at excessive or reduced voltage invites motor failure.

Wiring MUST be sized to the maximum load to be served. All wiring must comply with the National Electrical Code and all applicable local codes.

Before starting the condensing unit, check that all fuses and motor protective devices are in place and that all wiring is secure. A complete wiring diagram for trouble-shooting the condensing unit will be found inside the control panel cover.

INSTALLING WATER-COOLED SYSTEMS

If the condensing unit is water-cooled, the water pipe sizes and the circulating pump and cooling tower capacities must be selected to provide an adequate supply of water to maintain desired condensing temperatures. Specifically, water-cooled condensing unit capacities are based on a clean water supply of approximately 3.0 gallons per minute per ton (12,000 BTU) at a nominal temperature of 80°F.

NOTE

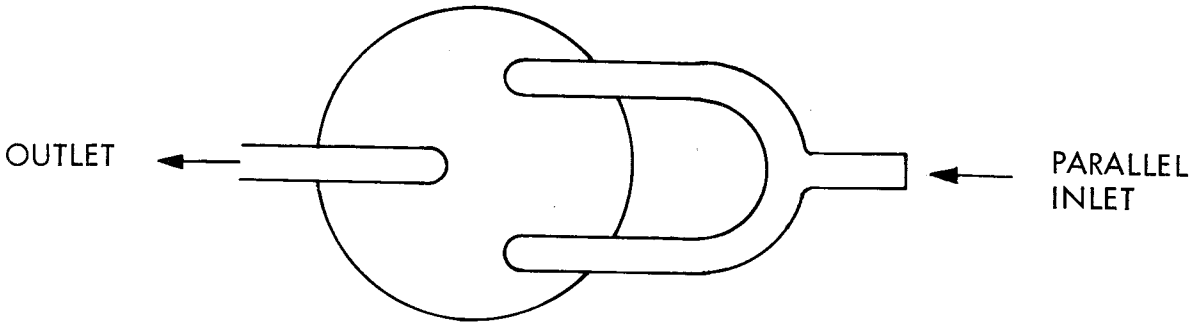
The exact water temperature necessary to maintain the correct condensed refrigerant temperature will vary slightly from that above depending on the various operating suction pressures.

In open water systems, such as those employing cooling towers and evaporative water coolers, the cooling water exposed to the atmosphere should be constantly replenished with fresh water to avoid concentrations of impurities, fungus and scaling in cooling towers and evaporative coolers. A continuous waste bleed is recommended so that continuous addition of fresh make-up water will be required. The exact amount of water bled off to stabilize the accumulation of impurities

will vary with the amount of impurities present in the atmosphere and the bleed-off rate should be adjusted during the periodically scheduled maintenance calls to achieve optimum conditions.

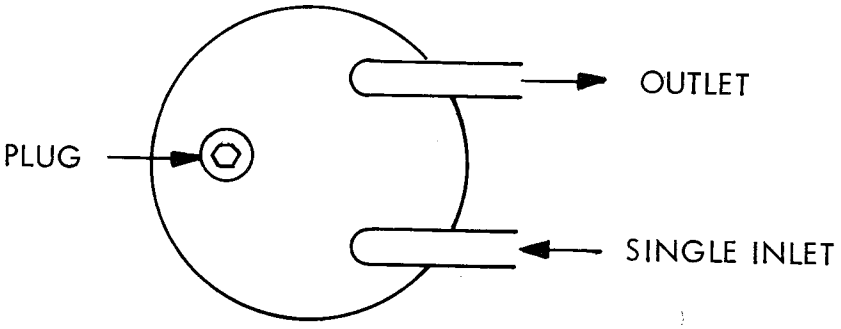
All water piping should be protected from freezing.

The standard condenser piping arrangement with parallel water inlet is as shown below. This is supplied for all cooling tower applications.



COOLING TOWER HOOK-UP

On special order, a water-cooled condensing unit may be factory-piped with a single water inlet for use with city water (once through to waste) as shown below. Water inlet is through a regulating valve.



CITY WATER HOOK-UP

Closed water systems are generally part of an engineered design. Therefore, the design plans should specify the use of parallel or single condenser inlets and whether or not water regulating valves will be supplied.

A water regulating valve is supplied on all water-cooled condensing units. It may be left off by special request. If supplied, the water regulating valve should be temporarily adjusted during the initial pulldown to obtain reasonable head pressures. After the system has stabilized and reached the design operating conditions, the water regulating valve should be readjusted to obtain the following head pressures:

REFRIGERANT	HEAD PRESSURE PSIG
R-12	118
R-22	196
R-502	214

Upon completion of the water piping installation, check to see that the water pump operates and that the rotation of the pump is correct. A careful inspection of all the piping and pump seals should be made while the system is operating to check for leaks.

The presence of non-condensibles in the refrigerant of a water-cooled system may be detected as follows:

1. Strap thermometers on the inlet and outlet water lines at the condenser and install an accurate pressure gauge on the liquid port of the receiver valve.
2. Stop the machine.
3. Adjust the water valve to feed fully with the machine off and wait 10 minutes or until the inlet and outlet water temperatures are equal.
4. Check the relationship of temperature and pressure on the pressure-temperature chart for the refrigerant used in the system. Pressure on the gauge higher than that indicated on the chart for the observed water temperature indicates non-condensibles.

Purging to remove non-condensibles in the system should be done only after the condensing unit has been turned off and rested for a few minutes.

SPECIAL NOTE FOR WATER-COOLED UNITS

The importance of observing proper precautions when installing cooling systems for water-cooled condensing units cannot be overemphasized. If piping systems were constructed of materials that were absolutely clean and free of all foreign matter it would be possible to fill the cooling systems with average city water, start them up and run them with no trouble whatsoever. However, in practice, the coatings used as rust preventatives on pipe, the cutting oils used in threading pipe, the resulting metal chips, the flux used in sweating copper fittings, sand and dirt of all types are typical of the foreign matter which may be present in a newly completed piping system. This material may combine with the water and piping materials to cause harmful corrosion and/or clogging in the system.

The use of system strainers such as the Henry Valve Company series 895 or 896 is strongly recommended.

Every cooling system, whether large or small, should be thoroughly cleaned and flushed at least once before it is put into operation. This is done by circulating a solution of water and tri-sodium phosphate or other commercial detergent through the entire system by operating the pump for several hours. After this is done, the system should be completely drained and all strainers carefully cleaned.

For permanent safe operation, the water in the cooling system should test out slightly on the alkaline side at all times. In closed cooling systems, the small amount of cleaning compound that adheres to the pipe after a system is drained is often enough to establish the correct pH level when the system is filled with fresh water. In areas where water supplies are exceptionally corrosive, a small amount of appropriate

chemical may be necessary to raise the pH level to the correct range. Tightly closed cooling systems require no further attention to maintain the correct pH value after the initial installation. Open systems, however, which require periodic addition of make-up water, must be checked for the correct pH value each time more water is added. A local water treatment specialist should be consulted whenever water treatment is necessary. Only experienced personnel using the correct chemicals should be trusted with the care of a cooling system since incorrect additives may do more harm than good.

A properly designed and installed cooling system will give many years of dependable performance with a minimum of attention. The small amount of extra time and money spent to insure that the entire cooling system is free of contaminants of all kinds will pay dividends in long-term trouble-free operation.

REFRIGERANT PIPING

Only refrigerant grade copper tubing, properly sealed against contamination should be used for refrigerant piping. Water tubing often contains wax and other troublesome contaminants. Permanent suction line filters and liquid line filter-driers are recommended in all field installed systems. Suitable P-type oil traps should be located at the base of each suction riser to enhance oil return to the compressor and suction lines should slope $\frac{1}{2}$" for every 10 feet of run towards the motor-compressor.

Two evacuation valves with $\frac{1}{2}$" connections are necessary. One should be in the suction line and one in the liquid line at or near the receiver.

Observe the following precautions when brazing the refrigeration lines:

1. An inert gas such as dry nitrogen should be allowed to flow through the lines under low pressure to reduce scaling and oxidation.

2. Only a suitable silver solder alloy or 95/5 solder should be used on suction and liquid lines to fixtures. The discharge line connections near the motor-compressor must be made with a high temperature silver solder alloy only.

3. In order to avoid damage to the internal "Silfos" joints in vibration eliminators, the connections to the vibration eliminators should be made with a silver solder alloy such as "Easy-Flo" which has a melting temperature of 900°F to 1200°F (well below the 1300°F melting point of "Silfos").

4. Limit the amount of soldering paste or flux used to the minimum to prevent contamination of the brazed joint internally. Apply flux to only the male portion of each connection, never the female.

If vibration absorbers are installed in suction or discharge lines they must be applied according to the manufacturer's recommendations. With "Copelametic" motor-compressors, the preferred position is parallel to the crankshaft, as close to the motor-compressor as possible. Vibration eliminators may also be installed in a vertical

position if joints are sealed against the trapping of condensation which might damage the vibration absorber bellows when it freezes. (Filling of the joints with soft solder as a means of sealing is recommended.)

Installation of vibration absorbers in a horizontal plane at right angles to the crank shaft is not acceptable since the resultant stress from motor-compressor movement may cause failure of the absorber bellows or refrigerant line.

The suction line just upstream from the suction vibration eliminator and the discharge line just downstream from the discharge vibration eliminator should be securely fastened to rigid supports to prevent any movement of the lines.

After all retrigerant lines are connected, the entire system must be leak tested. The complete system should be pressurized to 175 psig with refrigerant and dry nitrogen (or dry carbon dioxide). 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 prior to charging the system be evacuated to a pressure of 1 PSIA (27.9" mercury vacuum) or less and sealed for 12 hours. Any leakage of air into the system will cause the vacuum reading to decrease. If an air leak is indicated, the system should again be charged with the nitrogen-refrigerant mixture, leak tested and the leaks repaired. For a satisfactory installation the system must be leak tight.

After the final leak test, liquid lines exposed to high ambient temperatures should be insulated to reduce heat pick-up and prevent the formation of flash gas in the lines. Suction lines located in areas where condensation may be a problem should also be insulated.

EVACUATION

Design performance and trouble-free operation can best be insured by a system that is both clean and dry. A triple evacuation procedure is recommended as follows:

1. Blow out all refrigerant lines with dry nitrogen or carbon dioxide to eliminate the possibility of dirt, scale, etc. remaining inside. Pressure should be kept under 250 lbs. (Scaling can be reduced during brazing operations by allowing dry nitrogen or carbon dioxide to flow through the lines under very low pressures.)

2. Connect all lines and leak test all connections.

3. Connect a good high vacuum pump to both the low and high side evacuation valves. Connections between the pump and evacuation valves should be made with copper tubing or high vacuum hose having a diameter of at least 3/8".

4. Operate the pump until a vacuum of 1500 microns (0.06 inches of mercury) absolute pressure is obtained. At this point, the vacuum should be broken by the introduction of refrigerant into the system. The refrigerant should be released through a drier until the pressure is brought up to 0 pounds gauge.

Repeat this procedure two more times. During the third and final evacuation, a vacuum of 500 microns (0.02 inches mercury) absolute pressure should be obtained. After this vacuum is reached, the system can be fully charged with refrigerant and put into operation.

IMPORTANT

Use only a high vacuum gauge capable of registering pressure in microns. A thermocouple vacuum gauge is recommended.

IDENTIFICATION

Each refrigerated case and cooler should be identified with numerals at least ½" high placed in some inconspicuous location on the case or cooler which is readily accessible to the serviceman. The condensing units serving these fixtures should be marked with the numbers (at least 1" high) of the cases and coils served.

INSTALLING AND PURGING AUXILIARY RECEIVERS

WHEN SUPPLEMENTAL RECEIVERS ARE NECESSARY

Auxiliary receivers may be necessary when refrigerant pumpdown capacity is less than the amount of refrigerant in the system. This condition sometimes occurs in water-cooled systems where the condenser-receivers have limited capacity and it can also occur in any system where large evaporators or long liquid lines are used or where the pumpdown liquid solenoid valve cannot be located close to the expansion valve. To correct this condition, an additional receiver with the necessary holding capacity should be installed in series with and close to the outlet of the main receiver on the condensing unit.

INSTALLATION

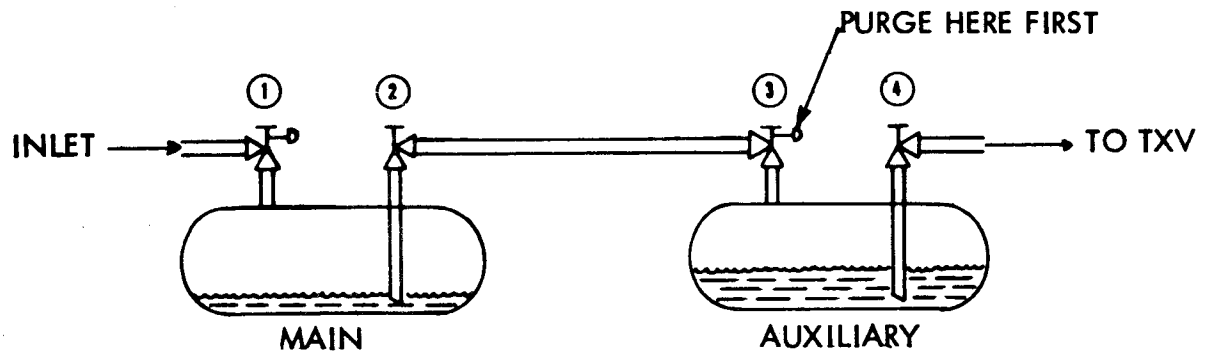
The auxiliary receiver should be installed on the same level or below the main receiver on the condensing unit. Both the main and auxiliary receiver must have their own purge valve and fusible plug or relief valve. The liquid line sightglass, drier and the liquid line to the evaporators should then be connected in the normal manner to the angle valve which is installed on the outlet fitting of the auxiliary receiver.

PURGING

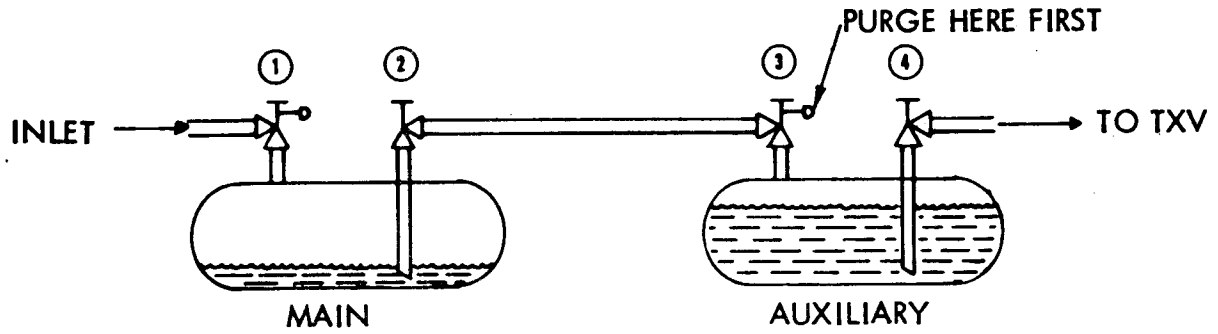
Purging the receivers may be done to check the liquid level in the receivers and to remove the non-condensibles from the system. Purging off non-condensibles should be done after the condensing unit is shut off and the system is allowed to stabilize for a few minutes. Purging to check liquid level may be done with the condensing unit shut off or running.

The illustrations on the next page indicate four conditions of liquid refrigerant level which can exist and can be identified by systematic purging.

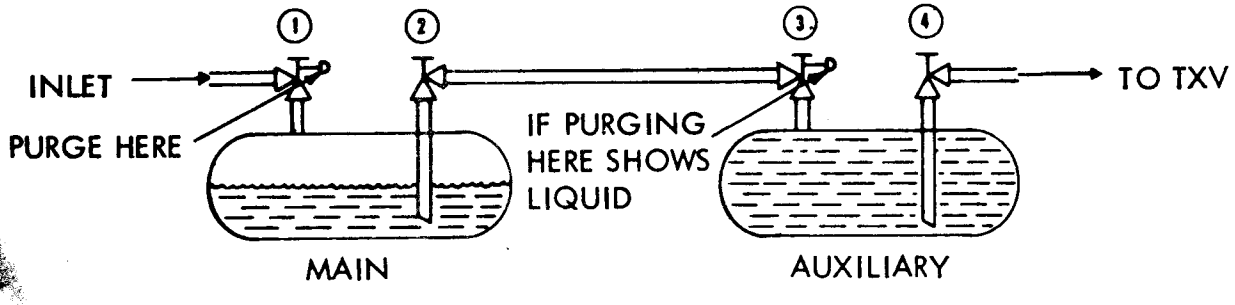
To check the liquid level in the receivers with valves 1, 3 and 4 open, close valve 2 and purge at the valve 3 port. If liquid appears at this point, indicating the auxiliary receiver is full, valve 2 should be opened and a purge check made at the valve 1 port. Liquid here indicates that both receivers are full and the system is overcharged.



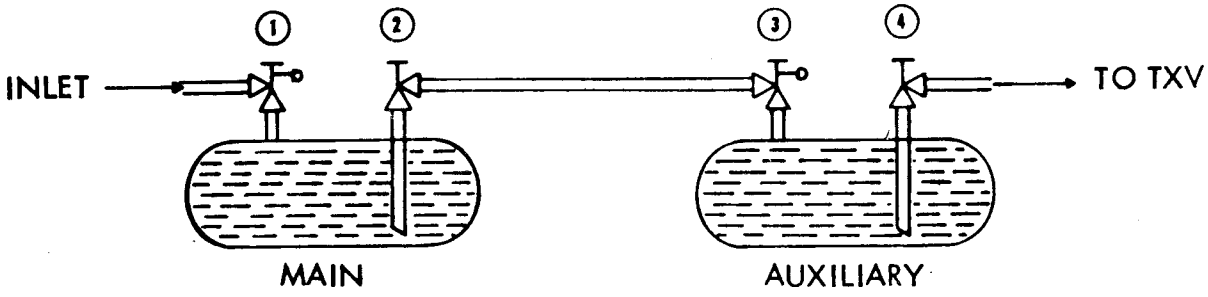
MINIMUM LIQUID IN RECEIVERS



ADDITIONAL LIQUID IN RECEIVERS



AUXILIARY RECEIVER FULL



BOTH RECEIVERS FULL

PRELIMINARY CHECK-OUT AND START-UP

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

1. Check electrical connections. Be sure they are all tight.

2. Observe the motor-compressor oil level before start-up. The oil level should be at or slightly above the center of the sight glass. Use only Suniso 3G compressor oil.

3. Insure that the rubber grommets supplied are installed under the motor-compressor mounting nuts and that the motor-compressor rides freely on its mounting springs.

4. Check the high and low pressure controls, water valves, pressure regulating valves, oil pressure safety controls and all other safety controls and adjust if necessary.

5. Check the fixture thermostat for correct operation.

6. Suitable tags or other means should be provided to indicate the refrigerant used in the system.

7. The instruction manual, bulletins, tags, etc. attached to the condensing unit should be placed inside the plastic bag supplied for this purpose and filed for future reference.

8. Make the proper refrigerant connections and weigh the refrigerant drum before charging so an accurate record can be kept of the weight of refrigerant put into the system. Charge the system with the refrigerant to be used. If refrigerant must be added to the system through the suction side of the compressor, charge in vapor form only. Liquid charging must be done on the high pressure side only.

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

10. Continue charging until the 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.

11. Do not leave the unit unattended until the system has reached normal operating conditions and the oil charge has been properly adjusted to maintain the oil level at the center of the sight glass.

OPERATIONAL CHECK-OUT

When the system has been charged and has operated for at least 2 hours at normal operating conditions without any indication of malfunction, it should be allowed to operate overnight on automatic controls. Then a thorough re-check of the entire system operation should be made as follows:

1. Check the motor-compressor head and suction pressures. If the pressures are not within the system design limits, determine why and take corrective action.

2. Check the 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 the oil level in the motor-compressor crankcase sight glass and add oil as necessary to bring the level to the center of the sight glass.

4. Thermostatic expansion valves must be checked for proper superheat settings. Feeler bulbs must be in positive thermal contact with the suction line. Valves with high superheat settings produce little refrigeration and poor oil return. Too little superheat causes low refrigeration capacity and promotes liquid slugging and compressor bearing wash-out. Liquid refrigerant must be prevented from reaching the crankcase. If proper control cannot be achieved with the system in normal operation, a suction accumulator must be installed in the suction line just ahead of the motor-compressor to prevent liquid refrigerant from reaching the motor-compressor.

5. Using suitable instruments, carefully check line voltage and amperage at the compressor terminals. Voltage must be within 10 per cent of that indicated on the compressor nameplate. If high or low voltage is indicated, notify the power company. The current normally should not exceed 120 per cent of the nameplate rating. 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. Check all fan motors on air-cooled condensers and in fixture evaporator coils for correct rotation. Fan motor mounts should be carefully checked for tightness and proper alignment. If belt drives are used, check the belt tension. All motors requiring lubrication should be oiled or greased as necessary.

7. In machine rooms equipped with more than one air-cooled condensing unit, check to see if the condenser fan of a non-operating unit rotates in reverse when the other machine(s) are operating. Reverse rotation of a fan (usually caused by a restricted air intake opening in the machine room wall) will cause the fan motor of a non-operating machine to draw an excessive amount of starting current and will eventually burn out the motor. If this condition occurs, the intake opening must be enlarged to achieve a balanced pressure on either side of the condenser.

8. High pressure controls on condensing units should be set to cut-out as follows:

	R-12	R-22 and R-502
Air cooled	230 psig	350 psig
Water cooled	230 psig	350 psig

A check of the cut-out point of these controls should be made by stopping the condenser air flow on air-cooled units or shutting off the water supply on water-cooled units and at the same time carefully monitoring the head pressure with an accurate gauge.

9. Re-check all safety controls and operating controls for proper operation and adjust if necessary.

10. Check the defrost time clock (if applicable) for initiation, termination and length of defrost period as described in the fixture instruction book.

11. Check fan cycling or head pressure controls (if applicable) for correct pressure setting.

12. Check crankcase pressure regulating valves (if applicable) for proper settings.

13. Adjust water valves on water-cooled systems to maintain desired condensing temperatures. Check water pumps for proper rotation.

MAINTENANCE

AIR-COOLED CONDENSERS

All air-cooled condensers should be cleaned with a brush and vacuum cleaner every 4 to 6 months to remove all accumulations of dust, dirt, leaves and other debris. Where air-cooled condensers must operate in unusually dusty locations, cleaning should be scheduled as often as conditions dictate.

WARNING

Be sure that the main disconnect switch is in the OFF position before any cleaning of the condensers is attempted.

Fan motors and fan bearings (on belt-driven units) should be lubricated with a few drops of oil every 3 to 6 months. The belt tension and the condition of the belt on belt-driven remote condensers should be checked whenever the unit is lubricated.

WATER-COOLED CONDENSERS

On tightly closed water cooling systems, very little maintenance to the condenser is usually necessary since the initial water treatment at installation serves to protect the system from corrosion and clogging. On open systems, however, where fresh water is continuously added, there will be a build-up of deposits inside the condenser which should be cleaned out on a regularly scheduled basis to prevent continuous operation at excessive head pressures. This scaling and liming is best removed by flushing the condenser with an "inhibited acid" type cleaner as directed by the condenser manufacturer. Cleaning should be carried out in such a way that the life of the condenser is not shortened.

ELECTRICAL AND PIPING CONNECTIONS

All electrical connections should be periodically checked to be sure they are tight. Loose connections contribute to low voltage conditions which can cause motor failure.

Refrigerant and water connections (on water-cooled units) should be inspected to insure that they have not loosened. Whenever it is necessary to add refrigerant, a careful leak check of all refrigerant connections should be made.

CRANKCASE LUBRICATION

As indicated under the operational check-out procedures, the oil level in the motor-compressor crankcase should be at the center of the sight glass at all times. If the oil level is low, more oil should be added to bring the level up to center of the sight glass and the cause of oil migration corrected (check expansion valve adjustment and the size of risers and traps).

Dirty, discolored oil probably indicates one of three things:

1. Contaminants such as moisture, air, etc. trapped in the system.
2. Excessive system pressure drop or improper control settings allowing motor-compressors not so designed to operate in a vacuum with the result that the motor-compressor overheats due to lack of suction cooling and the oil discolors.
3. Insufficient air cooling or restricted air blast on a suction cooled motor-compressor operating below 0°F saturated suction temperature. If sufficient air blast on the body of these motor-compressors is not provided as described in Copeland Application Bulletin AE-1135, they will overheat since the refrigerant vapor does not provide enough cooling.

If the first situation is encountered and the discoloration is not severe, usually installation of a new liquid line filter-drier is enough to remove contamination and clear the oil. If the discoloration is severe and is caused by contamination alone, the oil should be replaced and a new liquid line filter-drier installed as many times as necessary to eliminate the contamination.

If the second or third situation exists, the oil should be replaced, the system controls readjusted to prevent the motor-compressor from operating in a vacuum and/or forced air cooling be provided on the body of the motor-compressor if it is operating below 0°F suction temperature.

SERVICE DIAGNOSIS CHART

SYMPTOM	CAUSE	REMEDY
A. Compressor does not run.	1. Motor line open.	1. Close start or disconnect switch.
	2. Fuse blown.	2. Replace fuse.
	3. Tripped overload.	3. See electrical section C.
	4. Control contacts dirty or jammed in open position.	4. Repair or replace.
	5. Piston seized.	5. Remove motor-compressor head. Look for broken valve and jammed parts.
	6. Frozen compressor or motor bearings.	6. Repair or replace.
	7. Control in off position because of cold location.	7. Use thermostatic control or move control to warmer location.
	8. Defective starting component (single phase comp. only).	8. Locate and replace.
B. Unit short cycles.	1. Control differential set too closely.	1. Widen differential.
	2. Discharge valve leaking.	2. Correct condition.
	3. Motor-compressor overload.	3. Check for high head pressure, tight bearings, seized pistons, clogged air or water-cooled condenser or water shut off.
	4. Refrigerant shortage.	4. Repair leak and recharge.
	5. Refrigerant overcharge.	5. Purge.
	6. Cycling on high pressure cut-out.	6. Check water supply.
C. Compressor will not start - hums intermittently (cycling on overload).	1. Improperly wired	1. Check wiring against diagram.
	2. Low line voltage.	2. Check main line voltage - determine location of voltage drop.
	3. Relay contacts not closing.	3. Check by operating manually. Replace relay if defective.
	4. Open circuit in starting winding.	4. Check stator leads. If leads are all right, replace stator.
	5. Stator winding grounded.	5. Check stator leads. If leads are all right, replace stator.
	6. High discharge pressure.	6. Eliminate cause of excessive pressure. Make sure discharge shut-off valve is open.
	7. Tight compressor.	7. Check oil level - correct binding.

SERVICE DIAGNOSIS CHART (Cont'd.)

	SYMPTOM		CAUSE		REMEDY
D.	Unit operates long or continuously.	1.	Refrigerant shortage.	1.	Repair leak and recharge.
		2.	Control contacts sticking in closed position.	2.	Clean points or replace control.
		3.	Dirty condenser.	3.	Clean condenser.
		4.	Air in system.	4.	Purge.
		5.	Compressor inefficient.	5.	Check valves and pistons.
		6.	Improper wiring.	6.	Check wiring and correct if necessary.
E.	Fixture temperature too high.	1.	Refrigerant shortage.	1.	Repair leak and recharge.
		2.	Control set too high.	2.	Reset control.
		3.	Control wiring loose.	3.	Check wiring to control.
		4.	Expansion valve or strainer plugged.	4.	Clean and replace.
		5.	Compressor inefficient.	5.	Check valves and pistons.
		6.	Expansion valve set too high.	6.	Lower setting.
		7.	Iced or dirty coil.	7.	Defrost or clean.
		8.	Unit too small.	8.	Add unit or replace.
		9.	Clogged or small gas lines.	9.	Clear clogging or increase line size.
		10.	Oil logged system.	10.	Remove excess oil, check refrigerant charge.
F.	Head pressure too high.	1.	Refrigerant overcharge.	1.	Purge.
		2.	Air in system.	2.	Purge.
		3.	Dirty air-cooled condenser.	3.	Clean (clean area around air-cooled condenser and inspect for air-borne dirt source).
		4.	Insufficient water or high water temperature.	4.	Check water valves and inspect cooler.
		5.	Clogged water-cooled condenser.	5.	Clean or replace condenser.
		6.	Recirculating cooling air.	6.	Seal off unit from other machines and provide intake isolated from air outlet.
		7.	High side restriction.	7.	Remove blockage.
		8.	Head pressure control valve set wrong.	8.	Readjust.

SERVICE DIAGNOSIS CHART (Cont'd.)

SYMPTOM	CAUSE	REMEDY
G. Head pressure too low.	1. Refrigerant shortage.	1. Repair leak and recharge.
	2. Compressor suction or discharge valves inefficient.	2. Clean or replace leaky valve plates.
	3. Cold ambient or cold water.	3. No remedy as efficiency is generally increased. However, if condensing temp. is below 85°F expans. valve will not be able to feed properly and some form of head pressure control must be provided.
	4. Head pressure control valve set wrong or no head pressure valve installed.	4. Readjust or install a head pressure control valve.
Noisy unit.	1. Insufficient compressor oil.	1. Add oil to proper level.
	2. Tubing rattle	2. Bend tubes away from contact.
	3. Mountings loose.	3. Tighten.
	4. Oil slugging or refrigerant flooding back.	4. Adjust oil level or refrigerant charge. Check expansion valve for leak or oversize orifice.
	5. Unbalanced fan or defective fan motor.	5. Replace bent or broken fan blades. Check motor bearings.
Compressor loses oil.	1. Shortage of refrigerant.	1. Repair leak and recharge.
	2. Gas-oil ratio low.	2. Add 1 pt. oil for each 10 lbs. of refrigerant added to factory charge.
	3. Plugged expansion valve or strainer.	3. Clean or replace.
	4. Oil trapping in lines.	4. Drain tubing toward compressor.
	5. Short cycling.	5. Refer to part B.
	6. Superheat too high at compressor suction.	6. Change location of expansion valve bulb or adjust valve to return wet gas to compressor.
J. Frosted or sweating suction line.	1. Expansion valve admitting excess refrigerant.	1. Adjust expansion valve.
K. Hot liquid line.	1. Shortage of refrigerant.	1. Repair leak and recharge.
	2. Expansion valve open too wide.	2. Adjust expansion valve.

SERVICE DIAGNOSIS CHART (Cont'd.)

SYMPTOM		CAUSE		REMEDY
L. Frosted liquid line.	1.	Receiver shut-off valve partially closed or restricted.	1.	Open valve or remove obstruction.
	2.	Clogged dehydrator or strainer.	2.	Replace clogged part.
M. Unit on vacuum. Frost on expansion valve only.	1.	Ice plugging expansion valve orifice.	1.	Apply hot wet cloth to expansion valve. If suction pressure now increases, there is moisture in the system and a drier should be installed in the line.
	2.	Plugged expansion valve	2.	Clean strainer or replace expansion valve.

REPLACEMENT POLICY ON COPELAND MOTOR-COMPRESSORS UNDER THE HILL FIVE-YEAR WARRANTY

Each motor-compressor manufactured by the Copeland Refrigeration Corporation and sold by Hill Refrigeration is warranted for a 12 month period by the Copeland Corporation from date of manufacture as indicated by the date stamp. Replacements during the one-year Copeland warranty must be made through the local Copeland distributor.

After the expiration of the Copeland one-year warranty, the Hill Company warrants the motor-compressor only for an additional four years, if the customer has so requested and paid the additional charge. No other components of the condensing unit are included in this warranty. Replacements during this period should also be made through the local Copeland distributor.

To secure reimbursement, the following information and documents must be sent to the Hill Service Department when a replacement is made during the four-year period.

1. The invoice from the Copeland distributor covering the replacement motor-compressors.

2. The credit memo from the Copeland distributor for the allowance on the defective motor-compressor. This is a standard allowance established by Copeland. Hill's reimbursement will be for the difference between the value of the replacement invoice and the credit memo for the defective unit.

NOTE: The serial number and the date stamp of the defective motor-compressor must appear on either the invoice or the credit memo.

If the information we receive is in order, reimbursement will be made either by check or credit memo.

HILL®

HILL WARRANTY

FOURTEEN MONTH WARRANTY. We warrant to the original purchaser or distributor every new Refrigerator Fixture (i.e., Walk-In Coolers, Reach-In Refrigerators, Display Cases, Self-Service Cases), refrigerating equipment, Hill Environmental Program Equipment, and all parts thereof, to be free from defects in material and workmanship under normal use and service, for a period of fourteen months from the date of shipment from the factory of the fixture, equipment or part to the original purchaser or distributor, our obligation hereunder being limited to repairing or replacing, F.O.B. factory, any part or portion tereof, of our manufacture or sold under the HILL name, which upon examination we judge to be thus defective.

THREE YEAR FRONT GLASS WARRANTY (Display Cases). We warrant to the original purchaser that in every new HILL Display Case, operated under normal use and service and at the temperature for which it is made, the multiple front glass will remain clear and free from moisture accumulation between the panes for a period of three years from the date of shipment from Trenton, N.J. of the fixture to the original purchaser, our obligation hereunder being limited to replacing the assembly within such period, any such multiple front glass which upon examination we judge to be thus defective.

The Warranties stated herein ("The Warranties") do not include the cost of labor incurred in the handling, removing or installing any equipment or component thereof, or loss of refrigerant.

The Warranties do not apply to any material that has been subjected to improper installation or operation, misuse, neglect, alteration, or accident, such as accidental damage to the exterior or interior enameled finish and accidental breaking of glass on the front of the Display Case or in any glass doors or obstruction to circulation, or to any Refrigerator Fixture, other equipment, or part thereof which has been repaired or altered by other than ourselves, or an authorized HILL distributor, in any way so as in our judgment to affect its quality or efficiency. The Warranties also are subject to the User's normal responsibility.

THE WARRANTIES ARE EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED AND OF ALL OTHER OBLIGATIONS OR LIABILITIES ON OUR PART. THE OBLIGATION TO REPAIR OR REPLACE PARTS OR COMPONENTS JUDGED TO BE DEFECTIVE IN MATERIAL OR WORKMANSHIP STATES OUR ENTIRE LIABILITY WHETHER TORT, CONTRACT OR WARRANTY. WE NEITHER ASSUME NOR AUTHORIZE ANY OTHER PERSON TO ASSUME ANY OTHER LIABILITY IN CONNECTION WITH OUR PRODUCTS.

We assume no responsibility for spoilage or perishable contents of equipment sold with HILL label or vendor's equipment and parts sold under their label — the warranty shall parts as specified herein.

Removal of original Serial Number from any Refigerator Fixture shall be deemed to from all obligations hereunder or any other obligations, express or implied.

The Warranties do not apply to accessories not manufactured by us and not sold und name on which the purchaser will receive the Warranty, if any, of the manufacturers the shall not be deemed to be our Warranty, even though such accessories are included in tract or financed by us. Failure of the purchaser to receive such manufacturer's Warranty no way create any Warranty, express or implied, or any other obligation or liability on our respect thereof.

Warranties embodied herein are not binding upon us if at the time a claim is made the [illegible]er is delinquent in any payment due under the terms of his contract.

HILL REFRIGERATION CORPORATION

360 Pennington Avenue, Trenton, NJ 08601
5804 E. Slauson Avenue, Los Angeles, CA 90040
200 Brock Street, Barrie, L4N 2M5 OntarioCanada

INFORMATION NEEDED WITH ORDERS

Be sure to accompany orders with all ne[illegible] essary information, including a complete [illegible]ery ification sheet and sketches.

Give specific shipping instruction[illegible] est freight station and post office and [illegible] routing if wanted. Advise date of ins[illegible]tion, but do not specify date on customer's [illegible]der.

To change any order already in the fa[illegible] it must go through the Order Departme nt.

When turning in complaints, give all de- tails, including model number, serial num ber, length of fixture, date of original order if possible and name and address of custome r.

Revis[illegible] July 1982

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