17DA
Open-Drive Centrifugal Liquid Chillers
50/60 Hz
HFC-134a

Start-Up, Operation, and Maintenance Instructions

SAFETY CONSIDERATIONS

Centrifugal liquid chillers are designed to provide safe and reliable service when operated within design specifications. When operating this equipment, use good judgment and safety precautions to avoid damage to equipment and property or injury to personnel.

Be sure you understand and follow the procedures and safety precautions contained in the chiller instructions as well as those listed in this guide.

⚠ DANGER

DO NOT VENT refrigerant relief valves within a building. Outlet from rupture disc or relief valve must be vented outdoors in accordance with the latest edition of ANSI/ASHRAE 15 (American National Standards Institute/American Society of Heating, Refrigeration, and Air Conditioning Engineers). The accumulation of refrigerant in an enclosed space can displace oxygen and cause asphyxiation.

PROVIDE adequate ventilation in accordance with ANSI/ASHRAE 15, especially for enclosed and low overhead spaces. Inhalation of high concentrations of vapor is harmful and may cause heart irregularities, unconsciousness, or death. Misuse can be fatal. Vapor is heavier than air and reduces the amount of oxygen available for breathing. Product causes eye and skin irritation. Decomposition products are hazardous.

DO NOT USE OXYGEN to purge lines or to pressurize a chiller for any purpose. Oxygen gas reacts violently with oil, grease, and other common substances.

NEVER EXCEED specified test pressures, VERIFY the allowable test pressure by checking the instruction literature and the design pressures on the equipment nameplate.

DO NOT USE air for leak testing. Use only refrigerant or dry nitrogen.

DO NOT VALVE OFF any safety device.

BE SURE that all pressure relief devices are properly installed and functioning before operating any chiller.

RISK OF INJURY OR DEATH by electrocution. High voltage is present on motor leads even though the motor is not running when a solid-state or inside-delta mechanical starter is used. Open the power supply disconnect before touching motor leads or terminals.

⚠ WARNING

DO NOT WELD OR FLAMECUT any refrigerant line or vessel until all refrigerant (*liquid and vapor*) has been removed from chiller. Traces of vapor should be displaced with dry air or nitrogen and the work area should be well ventilated. *Refrigerant in contact with an open flame produces toxic gases*.

DO NOT USE eyebolts or eyebolt holes to rig chiller sections or the entire assembly.

DO NOT work on high-voltage equipment unless you are a qualified electrician.

DO NOT WORK ON electrical components, including control panels, switches, starters, or oil heater until you are sure ALL POWER IS OFF and no residual voltage can leak from capacitors or solid-state components.

LOCK OPEN AND TAG electrical circuits during servicing. IF WORK IS INTERRUPTED, confirm that all circuits are deenergized before resuming work.

AVOID SPILLING liquid refrigerant on skin or getting it into the eyes. USE SAFETY GOGGLES. Wash any spills from the skin with soap and water. If liquid refrigerant enters the eyes, IMMEDIATELY FLUSH EYES with water and consult a physician.

NEVER APPLY an open flame or live steam to a refrigerant cylinder. Dangerous over pressure can result. When it is necessary to heat refrigerant, use only warm (110 F [43 C]) water.

DO NOT REUSE disposable (nonreturnable) cylinders or attempt to refill them. It is DANGEROUS AND ILLEGAL. When cylinder is emptied, evacuate remaining gas pressure, loosen the collar and unscrew and discard the valve stem. DO NOT INCINERATE.

CHECK THE REFRIGERANT TYPE before adding refrigerant to the chiller. The introduction of the wrong refrigerant can cause damage or malfunction to this chiller.

Operation of this equipment with refrigerants other than those cited herein should comply with ANSI/ASHRAE 15 (latest edition). Contact Carrier for further information on use of this chiller with other refrigerants.

DO NOT ATTEMPT TO REMOVE fittings, covers, etc., while chiller is under pressure or while chiller is running. Be sure pressure is at 0 psig (0 kPa) before breaking any refrigerant connection.

CAREFULLY INSPECT all relief devices, rupture discs, and other relief devices AT LEAST ONCE A YEAR. If chiller operates in a corrosive atmosphere, inspect the devices at more frequent intervals.

DO NOT ATTEMPT TO REPAIR OR RECONDITION any relief device when corrosion or build-up of foreign material (rust, dirt, scale, etc.) is found within the valve body or mechanism. Replace the device.

DO NOT install relief devices in series or backwards.

USE CARE when working near or in line with a compressed spring. Sudden release of the spring can cause it and objects in its path to act as projectiles.

⚠ CAUTION

DO NOT STEP on refrigerant lines. Broken lines can whip about and release refrigerant, causing personal injury.

DO NOT climb over a chiller. Use platform, catwalk, or staging. Follow safe practices when using ladders.

USE MECHANICAL EQUIPMENT (crane, hoist, etc.) to lift or move inspection covers or other heavy components. Even if components are light, use mechanical equipment when there is a risk of slipping or losing your balance.

BE AWARE that certain automatic start arrangements CAN ENGAGE THE STARTER, TOWER FAN, OR PUMPS. Open the disconnect *ahead* of the starter, tower fans, or pumps.

USE only repair or replacement parts that meet the code requirements of the original equipment.

DO NOT VENT OR DRAIN waterboxes containing industrial brines, liquid, gases, or semisolids without the permission of your process control group.

DO NOT LOOSEN waterbox cover bolts until the waterbox has been completely drained.

DOUBLE-CHECK that coupling nut wrenches, dial indicators, or other items have been removed before rotating any shafts.

DO NOT LOOSEN a packing gland nut before checking that the nut has a positive thread engagement.

PERIODICALLY INSPECT all valves, fittings, and piping for corrosion, rust, leaks, or damage.

PROVIDE A DRAIN connection in the vent line near each pressure relief device to prevent a build-up of condensate or rain water.

CONTENTS

INTRODUCTION

General — All persons concerned with the start-up and operation of the centrifugal refrigeration machine should be familiar with the equipment involved. This instruction book is intended to cover general rules for start-up procedures, followed by operation and maintenance instructions.

Because of machine variations it is not possible to prepare an instruction book covering all minor details. This instruction book will fulfill common requirements. Additional information pertaining to this particular chiller is included in the special job binder provided with the chiller upon delivery. This includes the prime mover, custom controls, instruments, etc.

Special attention should be given to precautionary instructions emphasized in this book to avoid start-up difficulties. These precautions are, in general, applicable to all sizes of 17DA centrifugal refrigeration machines.

Instructions for the prime mover if not included with Carrier Air Conditioning instructions should be obtained from the manufacturer.

Factory Test — Prior to shipment, the compressor is completely assembled and tested. Performance as to lubrication, speed balance and general mechanical operation has been determined to be satisfactory.

Job Data — The job consists of the following:

1. 17DA Start-Up, Operation and Maintenance Instructions
2. Job drawings showing:
   a. Machine assembly
   b. Machine wiring
   c. Machine piping
   d. Controls and related wiring
3. Manufacturer's Installation and Start-Up Instructions for:
   a. Drive
   b. Gear (if applicable)

Field-Supplied Tools — The following field-supplied tools are need for installation and start up of the 17DA chiller:

- General mechanics tools
- Alignment tools consisting of a laser alignment instrument or dial indicators and brackets and a low profile hydraulic cylinder jack with hydraulic pump. These are used to accomplish initial alignment and “hot check.”
- Digital volt-ohmmeter. This is used for instrument calibration. (Test voltage from analog ohmmeters can destroy RTD [resistance temperature detector] sensors.)
- 4-20 mA signal generator. This is used for instrument calibration including valve positioners.
- Portable vacuum pump capable of reaching dehydration vacuum with a capacity of 5 cfm or greater used for chiller evacuation and dehydration.
- Electronic or wet-bulb vacuum indicator for measurement of vacuum level.
- Electronic leak detector suitable for non-chlorinated refrigerants.

Inspect Machine Room — All installation work as outlined in 17DA Installation Instructions book should be completed, and all construction debris must be removed from the immediate area of the machinery prior to initial start-up of the machine.

Drive Arrangement — Inspect drive mounting, location, coupling, speed rating, etc., for agreement with job drawings and specifications. Gear assembly (if used) must agree with installation recommendations outlined in gear manufacturer's instructions.

Piping — Check the following piping installation locations:

1. Refrigerant pumpout system
2. External or auxiliary oil system
3. All bypass lines and valves
4. Turbine drive piping
   a. Blowdown valves for each turbine stage installed per manufacturer's instructions.
   b. Trace all field installed piping to the turbine to ensure that it conforms to the turbine manufacturers installation instructions.
   c. Steam supply line condensate traps must be properly installed to keep condensate out of the turbine. A condensate drain should be located immediately ahead of the trip and throttle valve so that all condensate may be cleared from the steam line immediately before steam is admitted to the turbine.
   d. Proper supports on steam supply and exhaust line to prevent stress or strain on the turbine at operating temperatures.
   e. Coupling alignment should be checked before and after the steam pipe is heated and before the turbine warm-up has begun. A change in alignment indicates a possible pipe strain that must be corrected.
5. Gas engine drive piping (check the following piping for agreement with job blueprints):
   a. Gas pressure reducing valves with shutoff valves.
   b. Engine coolant piping with coolant thermostatic valve installed so that water flows in direction marked on valve.
   c. Oil cooler package piping
   d. Exhaust piping

NOTE: Exhaust piping is critical. Refer to drive manufacturer's recommendations for installation of exhaust piping.

Wiring — Refer to job wiring diagrams. All wiring must agree with these drawings.

AUXILIARY EQUIPMENT WIRING — Check the following:

1. Brine pump
2. Condenser water pump
3. Cooling tower fan motor
4. Auxiliary oil pump
5. Oil heater
6. Overload selections in all motor starters. Overload values must agree with motor nameplate data.

TURBINE DRIVE WIRING — Check the following:

1. Turbine solenoid trip mechanism.
2. Auxiliary oil pump if used. Check pump starter for proper voltage, amperage, and overload setting. Operate pump to determine direction of rotation. Do not operate dry of oil.
3. Check job drawings for other electrical devices used with the turbine. Ensure that their wiring agrees with the job wiring blueprints.

GAS ENGINE DRIVE WIRING — All wiring must agree with job wiring diagrams. Refer to engine manufacturer's instructions for starting techniques.

Safety Controls — Safety controls can be a combination of electronic sensors supplying information to the programmable logic controller (PLC), mechanical switches which supply an open/closed signal to the PLC, and mechanical devices that act directly on the equipment with follow-up action provided by the PLC. The PLC is shown in Fig. 1. A turbine overspeed trip is a good example of the type of safety that acts directly. If specified, there may be both sensor inputs and mechanical switches monitoring some points.

Refer to Table 1 for set points, except for the settings supplied with the machine documentation. Job documentation will take precedence over these standard settings.

Temperature switches should be set in a temperature bath and compared to an accurate standard or electronic thermometer.

Pressure switches should be set using an accurate gage and a controlled pressure source.

Pressure transducers should be checked using an accurate gage and a controlled pressure source.

Thermistor and RTD sensor panel readouts should be compared to the temperature to which they are exposed. If possible, hold the sensor in ambient air and compare the reading with an accurate thermometer.

Mechanical interlock and limit switch operation must be confirmed by testing the actuator.

The turbine overspeed linkage should be tested before the turbine is powered. The trip actuator in the shaft can only be tested by running the turbine. Once the turbine can run, it should be gradually brought up to trip speed. If the turbine fails to trip at the trip speed, then it should be shut down immediately and not be started until a turbine manufacturer's representative corrects the problem.

Motor Drive — Accurate communication between the controls and the starter/VFD (variable frequency drive) must be confirmed by test. For equipment of the size and capacity of the 17DA chiller, it is likely that the control panel and the starter/VFD will communicate through a data line, not through hardwired circuits. There may be an "Emergency Stop" button hardwired between the control panel and the starter.

Where the chiller controls and ancillary equipment controls are connected to a building automation system via data lines, it must be confirmed that the central system cannot override the chiller safeties nor energize any chiller component directly. The starter or VFD, in particular, must be protected from being energized by a command from anywhere other than the chiller controls. With the starter in a safety mode or disconnected from the motor, attempts to energize the starter should be made from the building controls to confirm that the building control system cannot energize the starter directly.

If the starter can be energized, reprogramming of the control system is essential before the starter is put on-line. Accidental starting of the motor could have extreme consequences to the chiller.

The program correction should be made in the starter/VFD control system rather than in the building control system so that future updates to the building controls do not remove this protection.

Gas Engine Drive — Engine drives will be tested and started by the engine manufacturer's representative. Control interfaces will be tested by the Carrier technician in co-operation with the engine manufacturer's representative. A check list from the engine manufacturer must be completed before the engine service representative is called.

Turbine Drive — Turbines have their own safety systems which should be tested according to the instructions found in their manufacturer's literature. If the manufacturer's instructions are not available, they must be obtained from the local Carrier representative or from the turbine manufacturer.

Interlocks between the chiller controls and the turbine controls must be tested. The chiller must energize a solenoid which then allows the trip and throttle valve to be set. If the solenoid is deenergized, then the turbine trip and throttle valve must immediately close.

A feedback switch to the chiller controls is located on the trip and throttle valve. The switch must close when the valve is opened. This provides a RUN signal to the chiller controls which will then start to load the compressor. If the trip and throttle valve is closed by a trip from either the chiller or turbine controls, then this switch will open. This is a signal to the chiller that the turbine has tripped and the chiller will enter a safety shutdown mode.

Other interlocks, signals and feedbacks will vary with the job. Consult the job controls manual and the field control drawings for the entire chiller and for the turbine.

All items on Pre-Start-Up Checklist must be completed before the turbine service representative is called.

Pumpout System — The low-pressure cutout should be set at the saturated pressure of refrigerant R-134a at 34 F (1 C). A manual bypass switch is required to allow complete evacuation of the cooler. See Table 2.

Leak Test and Dehydration — Check the absolute pressure on the refrigerant side of the machine. The final operation of the 17DA installation is to leak test the machine and dehydrate it to the point where it maintains a pressure of 0.21 psia (1 kPa) (equivalent to 29.48 in. [749 mm] mercury vacuum referenced to a 30 in. [762 mm] barometer). Refer to the Leak Testing and Chiller Dehydration sections on pages 15 and 16.

If the machine absolute pressure is higher than the above values, repeat the evacuation and dehydration pumpdown operations until the machine proves to have a leak rate or vacuum loss at a rate less than 0.1 in. (2 mm) mercury column in 24 hours.

The oil will always contain a minimal amount of dissolved refrigerant. It is normal for a refrigerant sensor to sense refrigerant if placed too near the vent caps. If the seal allows refrigerant vapor to pass, a sensor located at floor level 3 to 4 ft (0.9 to 1.2 m) from the sump vent cap will be quickly triggered as the heavy refrigerant vapor will drop into the sump and flow out the vent cap to floor level.

Table 1 — Control Settings

CONTROL	LOCATION	SETTING	
		English	Metric
Low Chilled Water Temperature Cutout	Cooler Water Box	36 F or 5 F lower than brine temperature	2.2 C or 3 C lower than brine temperature
High Discharge Gas Temperature Cutout	Compressor End Wall	220 F	104 C
High Thrust Bearing Temperature	Compressor Bearing Chamber	185 F	85 C
High Condenser Pressure Cutout	Instrument Panel	185 psig	13.0 kg/sq cm
Low Cooler Pressure Cutout	Instrument Panel	2 psi below design suction pressure	0.14 kg/sq cm
Low Seal Oil Pressure Cutout	Instrument Panel	Trip 11 psid	Trip 0.76 kg/sq cm
Low Bearing Oil Pressure Cutout	Instrument Panel	Trip 8 psig Reset 13 psig	Trip 0.56 kg/sq cm Reset 0.90 kg/sq cm
Auxiliary Oil Pump Differential Pressure Control	Instrument Panel	Stop 27 psid Start 23 psid	Stop 1.90 kg/sq cm Start 1.60 kg/sq cm

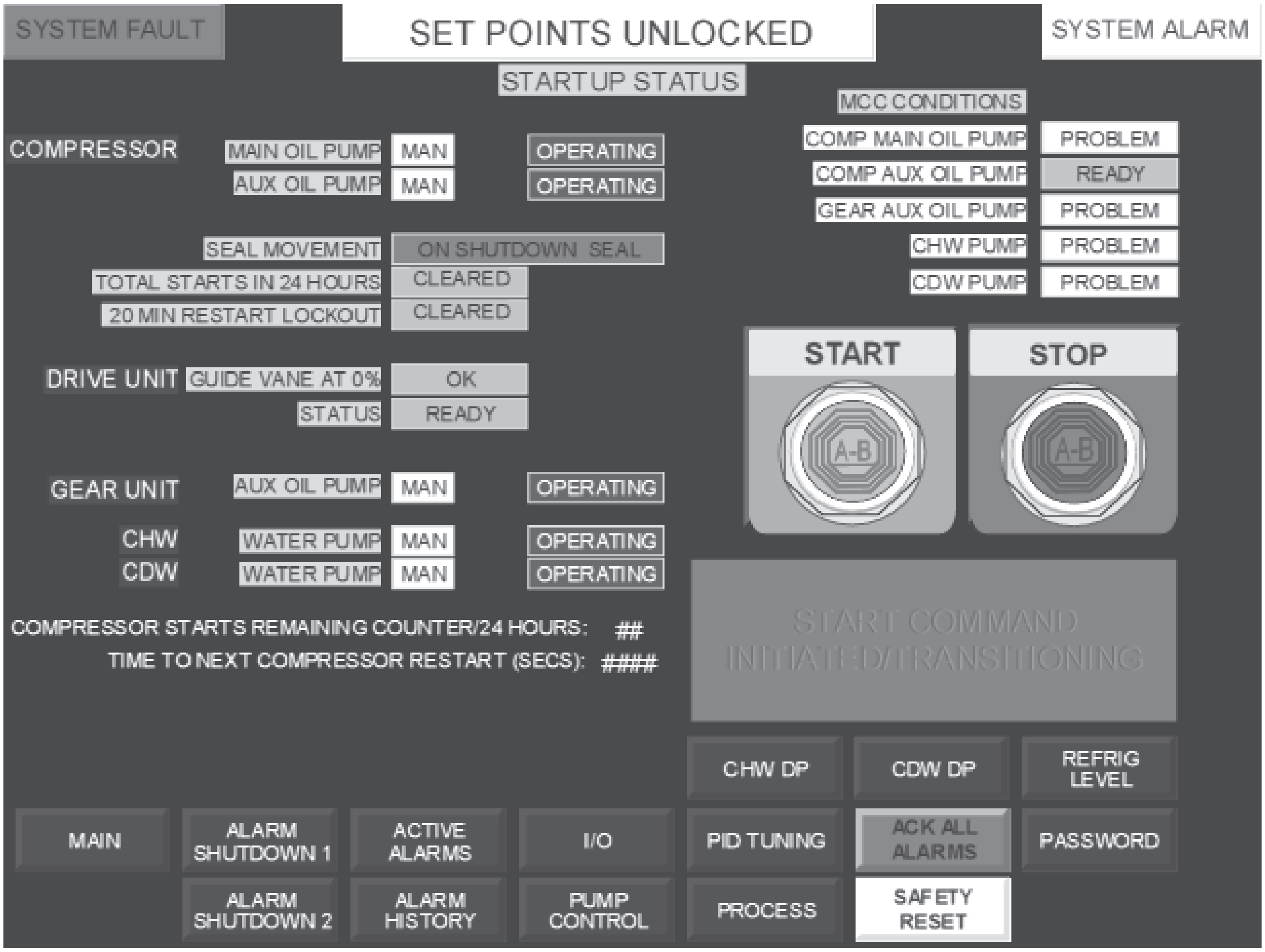


Fig. 1 — Typical PLC Screen on Control Panel

Table 2 — Pumpout System Ratings

PUMPOUT SYSTEM SETTING	SATURATED CONDITIONS (R-134a)			
	Pressure		Maximum Temperature	
	psig	kPa	F	C
Normal Condensing Pressure	146	1007	110	43
Low-Pressure Cutout	31.5	217	36	2
High-Pressure Cutout	175	1207	121	49
Relief Valve	185	1276	125	52

Charge Machine with Water — When the machine has been proved leak tight and dry, it may be filled with water, brine or other process fluid as the case may be. Vent all lines and check for leaks.

It is advisable to install indicators on the coupling halves between the compressor and drive or gear to check for alignment drift while charging with water and refrigerant. The weight of these materials will always cause a shift in the position of the machine components. Before and after indicator readings will give a good clue to the direction final alignment should take.

Charge Machine with Oil — The 17DA chiller has an integral lubrication system mounted on a common base with the compressor. A parallel auxiliary oil pump system may also be furnished. Charge the oil system with 35 gallons (132.5 L) of oil, Carrier P/N PP23BZ106.

Refrigerant R-134a requires the use of polyolester oil. Polyolester oils have a different molecular structure proprietary to each manufacturer and have property differences that may or may not make them suitable for operation in the 17DA chiller. Carrier supplied oil has been laboratory tested by Carrier and has been field tested in the 17DA chiller.

Ensure that there is adequate lubrication prior to the operation of all drive line components. Check the gear and drive manufacturer's instructions for proper initial lubrication procedure.

Oil pressure from the main pump is set to maintain a pressure 35 psi (241 kPa) greater than the refrigerant pressure behind the shaft seal. If the oil pressure differential across the seal falls below 23 psid (158 kPa), the auxiliary oil pump will start.

Final Pre-Operation Alignment Check — Prior to operating the compressor and speed increasing gear (if used), coupling alignment and separation must be checked.

1. Ensure that coupling alignment is within coupling manufacturer's specified tolerances.
2. Refer to the coupling vendor's drawing for hub separation tolerances.
3. When checking hub separation, electric motor shaft must be in center position of shaft float or in magnetic center as specified by the motor manufacturer.

4. If realignment is required, follow instructions supplied by coupling manufacturer. Carrier Standard Service Techniques, Form SM-15, Rev A, also details realignment techniques.

Operate Drive — It is good practice to operate the drive uncoupled from the compressor first and then couple it to the compressor. Refer to the drive manufacturer's instructions for drive protection devices and settings. Check turbine overspeed and confirm correct motor direction of rotation at this time. Reassemble coupling after operating the drive successfully.

NOTE: If there is a gear between the motor and compressor, then it reverses rotation. Make sure that the gear output shaft is turning in the correct direction.

Set Purge Valves — Open all the purge service valves.

Check Water Supply — Be certain that chilled water, condensing water and oil cooler water supplies are available and that pumps will run before operating compressor.

Check Air Supply (Pneumatic Machines) — Make sure that control air is 35 psig (241 kPa).

START-UP

Pre-Operation Settings — Complete these settings before starting compressor for first time.

Drive Operation — Refer to drive manufacturer's start-up instructions. Complete drive starting requirements before operating compressor.

Initial Refrigerant Charge

⚠ CAUTION

When liquid refrigerant R-134a is injected into a low vacuum of 29.48 in. (749 mm) mercury, it will immediately flash to a gas at a temperature lower than –100 F (–73 C). It is for this reason that water must be circulating before charging liquid refrigerant. Non-circulating water would quickly freeze and damage the machine. If an auxiliary refrigerant storage tank (receiver) is furnished, then liquid refrigerant may be charged directly into this evacuated receiver without damage.

Large machines run with liquid refrigerant in the cooler so refrigerant is charged into the cooler or low-pressure side of the machine. For general instructions on how to handle refrigerant refer to Carrier Standard Service Techniques, Form SM-1. Use the Charging by Weight method, cross checking with the machine's refrigerant sight glass provided on the back of the cooler shell, and the suction pressure gage.

Charge refrigerant as follows:

1. Start cooler and condenser water circulating pumps.
2. Charge the first refrigerant in the vapor state, continuing until the machine pressure exceeds 35 psig (241 kPa). The refrigerant temperature corresponding to this pressure is high enough to prevent water freezing damage and will also satisfy the refrigerant low-pressure cutout safety switch setting (31.5 psig [217 kPa]).
3. Turn the refrigerant bottles or drums over and begin charging the refrigerant in the liquid phase. Continue charging liquid refrigerant until about 2/3 of the estimated full load charge is in the machine.

Initial Compressor Operation

⚠ CAUTION

Do not apply power to any system or instrument that is exposed to dehydration vacuum. Insulation breakdown and serious damage can result.

1. Energize the control panel.
2. Place the guide vanes in MANUAL operation.
3. Manually energize the oil cooler solenoid and verify flow through the oil cooler. Return the solenoid to automatic control.
4. Observe whether the compressor shaft moves forward (toward the suction) off the shutdown seal. Manually energize a compressor oil pump. Observe the shaft and verify that the seal movement indication changes on the PLC.
5. Turn off the oil pump and observe the shaft move back toward the driver. The PLC should indicate that the shutdown seal is closed. If the PLC does not indicate the shaft position to be on the shutdown seal, terminate the startup. Correct the shaft feedback before attempting a start to prevent damage to the shaft and seal.
6. Place Compressor Oil Pumps into AUTOMATIC mode.
7. Place Capacity Control in MANUAL mode.
8. Open all valves to seal oil separator pot. Energize the separation pot heater if manually controlled. If the heater is PLC controlled verify its operation after the compressor starts.
9. Ensure that there is water in the cooling tower and that it is operational.

⚠ CAUTION

No brine or water over 100 F (37 C) can be allowed to flow through the cooler. Damage to unit will result.

10. Open chilled and condenser water valves and start the water pumps. If these are automatically controlled, verify that they have opened and started.
11. Start the compressor and let it run for approximately 5 minutes. While it is running, observe bearing temperatures, vibration levels, and oil pressure. Listen for unusual sounds.
12. Stop the compressor. During coast down again verify that the compressor is rotating in the correct direction which is counterclockwise if it is seen from the drive.
13. Observe the shaft movement to verify that the shutdown seal has closed. If the shutdown seal is manually controlled, open the bleed valve on the inboard side of the bearing chamber (inboard is the heat exchanger side.)

Adjust Refrigerant Charge — To adjust the refrigerant charge, perform the following procedure.

1. Adjust control station to operate at MANUAL. Ensure that the guide vanes are closed as indicated on the main guide vane indicator.
2. The condenser liquid level control consists of a level transmitter, the liquid line valve and a control program in the PLC. As an initial set point, place the level setting even with the condensed liquid thermowell. The well is located on the same end of the vessel as the level transmitter. It can be on either side of the vessel. After the machine has reached stable operation, the level should be set such that the condensed liquid temperature is 1 to 3° F (0.5 to 1.6° C) below saturated condensing temperature.

The proportional band can be adjusted on the PLC to stabilize the level if necessary.

3. Start the compressor. Observe the machine's operation for 15 to 20 minutes before increasing the load. During this period, make the following checks and adjustments:
   a. Check oil pressure.
   b. Adjust water flow thru oil cooler so that bearing temperatures stay between 150 and 170 F (65 and 77 C) approximately.
   c. Watch bearing temperatures carefully. This is the first time that the machine has been run under refrigeration load. Bearing temperatures may level off at some temperature slightly higher than 170 F (77 C) listed above. This may be the normal stable condition for this bearing. High thrust bearing temperature will shut the machine down at 180 F (82 C).
   d. Watch the discharge temperature and if the temperature climbs past 150 F (65.5 C), open the guide vanes in small steps of 5% or less until the discharge temperature starts to decrease.
4. Slowly open the guide vanes, by manual control, thus increasing the load. Do not exceed the current rating of the electric motor. Watch for other signs of overloading a turbine or engine drive.
5. Add liquid refrigerant, trimming the charge off at the point where the machine reaches design operating temperature and pressure conditions.

⚠ CAUTION

Excessive overcharge may cause liquid refrigerant carry-over into the compressor, causing severe overload and possible compressor damage.

6. Shut the machine off. When the refrigerant level settles down, mark this optimum level on the sight glass. Maintain this shutdown level.
7. To determine the approximate refrigerant charge for the machine, add the cooler charge to the applicable condenser charge as listed in Tables 3A and 3B.

Hot Alignment Check and Doweling — After the machine has been running at about full load for 4 hours, its components will have come up to steady state operating temperature conditions and the final hot alignment check may be made.

Realign component locations until angular and parallel alignments are within coupling manufacturer's specified tolerances.

Dowel all equipment into place as soon as the hot alignment check proves that the machine is within these running tolerances. See Carrier Standard Service Techniques, Form SM-15, Rev A, for these operations.

Operational Testing — When the chiller is in operation, and it is time to set the flows and confirm that the machine is operating according to design conditions, a heat balance must be determined. In brief, a heat balance is the sum of the energy being absorbed by the cooler plus the energy supplied through the driver (turbine, motor) compared with the energy being discharged through the condenser.

Cooler Tons + Motor Tons = Condenser Tons

When these two items are equal it is certain that the readings and measurements are accurate. The motor kW must be corrected for motor efficiency and gear losses must be subtracted from motor kW to get actual compressor input horsepower.

Motor kW is converted to equivalent tons by this formula: Tons = kW / 3.515

Cooler and condenser tons: (for fresh water, specific heat [sp ht] = 1 and specific gravity [sp gr] = 1)

Tons = (gpm * T * sp ht * sp gr) / 24

A perfect heat balance is 0, but this is practically impossible to achieve. With laboratory quality instrumentation, less than a 2% heat balance at full load conditions should be achievable. Greater than 5% should be regarded as very inaccurate and requires further investigation of the start-up conditions.

Instruct Customer Operator — Ensure the operator(s) understand all operating and maintenance procedures. Point out the various chiller parts and explain their function as part of the complete system.

CONTROL PANEL

1. Internal safeties
2. Communication with chiller controls
3. Starter operational sequence
4. Current and voltage monitor operation

VFD

1. Detailed description of component, section, purpose, and operation
2. Control section processor and access to screens
3. Procedures to switch from bypass to VFD operation (if bypass equipped)

Table 3A — Typical 17DA Cooler and Condenser Charges (R-134a) (lb)

COOLER SIZE	15-FT TUBES	18-FT TUBES	22-FT TUBES
61	3,000	3,600	4,400
63	3,600	4,300	5,300
65	3,600	4,300	5,300
67	4,200	5,100	6,200
71	4,600	5,500	6,800
73	5,000	5,900	7,300
75	5,600	6,600	8,100
81	6,500	7,700	9,500
82	7,700	9,300	11,300
83	6,900	8,300	10,200
84	8,200	9,900	12,200
85	7,700	9,200	11,300
86	10,200	12,300	15,200
87	8,600	10,400	12,600
88	11,000	13,500	16,500
90	13,000	15,600	19,200

CONDENSER SIZE	15-FT TUBES	18-FT TUBES	22-FT TUBES
61	2,000	2,400	2,900
63	2,000	2,400	2,900
65	2,500	3,000	3,600
67	2,500	3,000	3,600
71	2,600	3,100	3,800
73	2,600	3,100	3,800
75	3,100	3,700	4,500
81	3,500	4,100	5,000
83	4,000	4,700	5,800
85	4,600	5,400	6,700
87	4,500	5,300	6,500

Table 3B — Typical 17DA Cooler and Condenser Charges (R-134a) (Kg)

COOLER SIZE	4.6 M TUBES	5.5 M TUBES	6.7 M TUBES
61	1362.0	1634.4	1997.6
63	1634.4	1952.2	2406.2
65	1634.4	1952.2	2406.2
67	1906.8	2315.4	2814.8
71	2088.4	2497.0	3087.2
73	2270.0	2678.6	3314.2
75	2542.4	2996.4	3677.4
81	2951.0	3495.8	4313.0
82	3495.8	4222.2	5130.2
83	3132.6	3768.2	4630.8
84	3722.8	4494.6	5538.8
85	3495.8	4176.8	5130.2
86	4630.8	5584.2	6900.8
87	3904.4	4721.6	5720.4
88	4994.0	6129.0	7491.0
90	5902.0	7082.4	8716.8

CONDENSER SIZE	4.6 M TUBES	5.5 M TUBES	6.7 M TUBES
61	908.0	1089.6	1316.6
63	908.0	1089.6	1316.6
65	1135.0	1362.0	1634.4
67	1135.0	1362.0	1634.4
71	1180.4	1407.4	1725.2
73	1180.4	1407.4	1725.2
75	1407.4	1679.8	2043.0
81	1589.0	1861.4	2270.0
83	1816.0	2133.8	2633.2
85	2088.4	2451.6	3041.8
87	2043.0	2406.2	2951.0

4. Location of isolation transformer, incoming switch gear.
5. Operation and servicing of the VFD Cooling system (where applicable).
6. Interface with chiller control sequence.
7. Communication with chiller controls (hard wired, data line)

STEAM TURBINE

1. Control interface with chiller controls
2. Turbine operation and maintenance training should be done by the turbine manufacturer service representative.

GAS ENGINE

1. Control interface with chiller controls.
2. Engine operation and maintenance training should be done by the engine manufacturer service representative.

OPERATING PROCEDURES

1. Starting and stopping of chiller including preparation of turbine when applicable.
2. Valves that should be closed while machine is idle.
3. Move liquid refrigerant to storage tank for extended shutdowns. Vapor pressure in the chiller should remain above atmosphere to prevent air from entering and to allow periodic leak checking.

LOG SHEETS

1. Information to be recorded and how often.
2. Spotting trends in the data for advanced warning of impending service needs.

Operator Duties

1. Become familiar with the chiller and related equipment before operating the chiller.
2. Prepare the system for start-up, start and stop the chiller, and place the system in a shutdown condition.
3. Maintain a log of operating conditions and document any abnormal readings.
4. Inspect the equipment and make routine adjustments. Maintain the proper oil and refrigerant levels.
5. Protect the system from damage during shutdown periods.

Start Machine — These are general instructions for 17DA machines. Individual machines may vary in equipment furnished. See Fig. 2 and 3.

1. Energize controls. Investigate any alarm messages and make appropriate corrections.
2. Check refrigerant level in cooler to be sure it is within operating limits (at least 1/2 sight glass). If level appears low, check the subcooler sight glass to see if missing refrigerant is in the subcooler. This refrigerant will redistribute soon after machine starts.
3. Check oil levels for compressor, gear, drive, and other auxiliary equipment.
4. Ensure that shutdown seal bleed valve (Fig. 3) is open.
5. Supply air to pneumatic controls. Check pressure and cleanliness.
6. Start water pumps, if not controlled by the chiller.
7. Close shutdown seal bleed valve if it is a manual valve. See Fig. 3. Valve must remain closed until the machine has stopped and the shaft is at full stop.
8. Open isolation valves to refrigerant/oil separator.
9. If the chiller is a motor drive, press the START button and then the machine will start.
10. If the chiller is a turbine drive, perform the following:
    a. Push the START button on control panel. The operator may now evacuate the surface condenser.
    b. When the surface condenser is under vacuum, set the governor for minimum speed. Open throttle valve slowly and bring turbine up to minimum speed. When the governor takes control, open the throttle valve fully.
    c. Run the turbine at minimum speed for the time specified by the manufacturer. Adequate oil pressure must be present on all drive components. If adequate oil pressure is not seen, shut down machine.
    d. Bring the turbine to operating speed. The machine controls will assume control of the turbine and begin to load the chiller.
11. Listen for unusual sounds which may indicate malfunction. If heard, shut down immediately.
12. Adjust oil cooling water to supply 120 F (49 C) oil to machine bearings. Observe oil temperatures on compressor, gear, and drive until they have leveled off satisfactorily.
13. Start thermal purge unit.

DATE ______________

REFRIGERATION LOG CARRIER 17DA CENTRIFUGAL REFRIGERATION MACHINE

Plant ______________ MACHINE MODEL NO. ______________ MACHINE SERIAL NO. ______________ REFRIGERANT TYPE ______________

DATE ______	COOLER					CONDENSER				COMPRESSOR							GEAR OIL		PRIME MOVER*				OPERATOR REMARKS
TIME	Refrigerant			Brine Temp		Refrigerant		Water Temp		Damper Position	Bearing Temp		Oil				Pressure	Temp	A	B	C	D	
													Pressure		Temp (reser-voir)	Level							
	Press.	Temp	Shut Down Level	In	Out	Press.	Temp	In	Out		Thrust End	Seal End	Supply	Seal Housing									

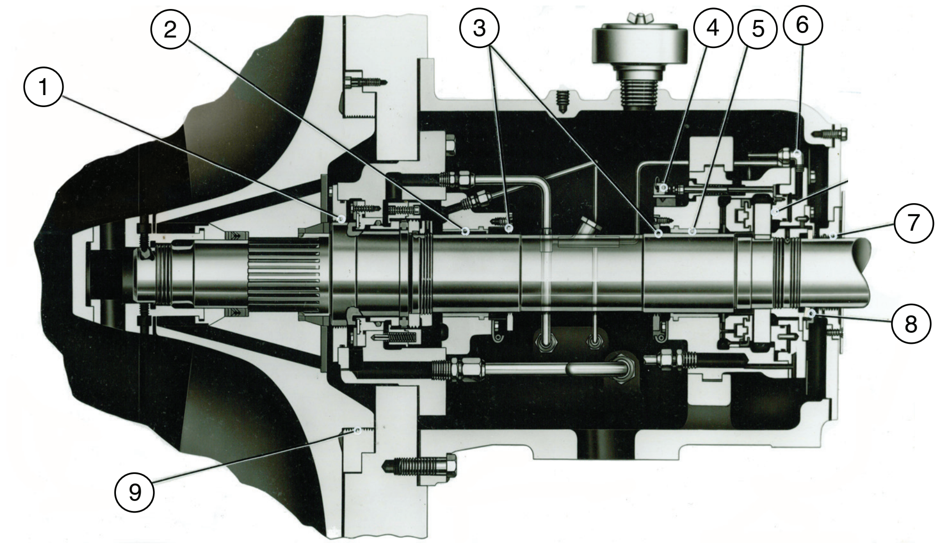
REMARKS: Indicate shutdowns on safety controls, repairs made and oil or refrigerant added or removed. Include amounts.

* **ELECTRIC MOTOR**
A Volts
B Amps
C Bearing Temp
D Oil Level

STEAM TURBINE
Steam Pressure
Load Steam Pressure
Bearing Temp
Oil Pressure

GAS ENGINE
Gas Pressure
Manifold Pressure
Jacket Water Temp
Oil Temp

Fig. 2 — Refrigeration Log



LEGEND

1 — Shaft End Labyrinth, Seal End
2 — Journal Bearing, Seal End
3 — Journal Bearing Labyrinth, Seal End, Thrust End
4 — Seal Movement Switch
5 — Journal Bearing, Thrust End
6 — Shutdown Seal Bleed Line (valve on opposite side)
7 — Shaft End Labyrinth, Thrust End
8 — Seal ring
9 — Balancing Piston Labyrinth

Fig. 3 — Compressor Details

14. See Table 4 for normal operating ranges. Check these characteristics hourly, recording readings in refrigeration log. Refrigeration log should include all temperatures and pressures mentioned above plus other machine history. This important data helps service engineers determine kind and frequency of service required. See your Carrier Service Representative for refrigeration log forms (see Fig. 2).

Table 4 — Normal Operating Ranges

ITEM	DESCRIPTION	RANGE
1	Chilled Water Temperature	36-45 F (2-7 C)
2	Condenser Entering Water	65-85 F (18-29 C)
3	Compressor Supply Oil	110-120 F (43-49 C)
4	Compressor Seal End Bearing	140-180 F (60-82 C)
5	Compressor Drive End Journal Bearing	140-180 F (60-82 C)
6	Compressor Drive End Drive Bearing	140-180 F (60-82 C)
7	Condenser Temperature	105 F (41 C) Avg
8	Cooler Suction Temperature	28 F (-2 C) min
9	Seal Oil Supply Pressure	35 psi (241 kPa) greater than item 10
10	Back of Seal Pressure	Approx. 2 lb (0.9 kg) higher than suction pressure
11	Thrust Bearing Oil Supply Pressure	18-22 psig (124-152 kPa)
12	Cooler Refrigerant Level	Varies with load*
13	Speeds Maximum Continuous Speed Nominal Speed	Compressor (17DA7,17DA8) 6350, 5300 rpm (106, 88 r/s) 5350, 4510 rpm (89, 75 r/s)

* Compare refrigerant level with optimum level when machine is shut down.

OPERATION

Manual Operation — Control machine manually at the PLC by setting guide vanes on MANUAL and adjusting guide vane position. Operator must watch chilled water temperature constantly when running machine in this manner.

Cold Weather Operation — Leaving condenser water should be maintained at 65 F (18 C) minimum. Throttle condenser water flow or cycle cooling tower fans to suit.

Stop Machine

1. Check drive manufacturer's recommendations for adjustments required before shutdown.
2. Push STOP button. Drive will immediately slow down with a change in sound level. The compressor should come to rest within a minute or two. Check drive and gear, when used, to be sure lubrication is maintained.
3. After compressor shaft has stopped rotating, shut off condensing water, chilled water and oil pumps.
4. Shut off cooling water to compressor oil, gear oil. and turbine oil coolers.
5. Shut off main steam (or gas) valve.
6. Open shutdown seal bleed valve (Fig. 3) after machine completely stops rotating.

⚠ CAUTION

Open seal shutdown valve only after machine comes to a full stop. If this valve is opened before the machine is fully stopped, the Teflon shutdown seal surface will be damaged. A damaged seal will allow the full refrigerant charge to be lost unless detected by the operator. If a hissing sound is heard coming from the chamber or the odor of refrigerant is detected, immediately start the oil pump and inform the servicing contractor. Leave the oil pump running until the leak can be fixed.

7. Leave controls energized for except for seasonal shutdowns.
8. Leave oil separation tank heaters energized.
9. Isolate oil separation tank from the oil sump.

Extended Shutdown

1. Pump refrigerant into storage tank and valve it off to prevent loss.

2. If the machine will be exposed to freezing temperatures, drain all water from cooler and condenser. Blow out oil cooler lines to remove all traces of water. Leave water box drains open until time to refill.
3. Deenergize the drive controls and refrigeration machine control panels.
4. If refrigerant charge is to be left in machine, the shutdown seal bleed valve must be left open to seal off the refrigerant side of machine. Best practice is to remove liquid refrigerant and pump vapor pressure down to be equal with atmospheric pressure.
5. Protect drive equipment as outlined in drive manufacturer's instructions. Before putting machine back into operation after an extended shutdown period, it may be wise to flush condenser and cooler water circuits with clean water to remove soft rust which may have formed.

Pumpout System Operation — The pumpout system operation permits transfer of refrigerant (liquid or gas) from cooler to storage tank (or reverse). It can also be used for machine evacuation and removal of contaminants.

Machines not containing refrigerant may be pressurized with the pumpout unit. Since the pressurizing agent is unprocessed air, some moisture and contaminants can be introduced to the machine by this method. Pressurizing with dry air or nitrogen is recommended. Procedures are based on typical piping arrangements. See Fig. 4 for a typical piping schematic and valve number designations.

The system consists of storage tank, pumpout compressor, condenser, valves, and piping. Liquid refrigerant drains by gravity if storage tank is below cooler. If tank is above cooler, liquid is forced up by compressed refrigerant gas pressure. Gas remaining in cooler is pumped out, condensed, and passed through a high-pressure trap into the tank. Pressures may then be equalized, by valve adjustment, permitting gravity flow of refrigerant in opposite direction.

Compressor must rotate per arrow on crankcase for proper lubrication.

LUBRICATION — Pumpout compressors are factory charged with oil. The 5F20 open-drive is charged with 5 pints plus 1 pint for the oil separator. Use Carrier oil part no. PP23BZ103-001. This is a one gallon container. The oil level should be at the center of the sight glass when the compressor is not running. Always check the oil level before operating the compressor.

CONTROL DESCRIPTION — The pumpout unit is equipped with a low pressure safety, a high pressure safety, and a time delay low oil pressure safety.

CONTROL SETTING — Set the safety switches using a metered air supply. The high-pressure switch setting can be checked by operating the pumpout compressor while throttling the pumpout condenser water. Exercise care when performing the check in this manner. Watch the discharge pumpout discharge pressure gage to prevent exceeding the specified cutout pressure.

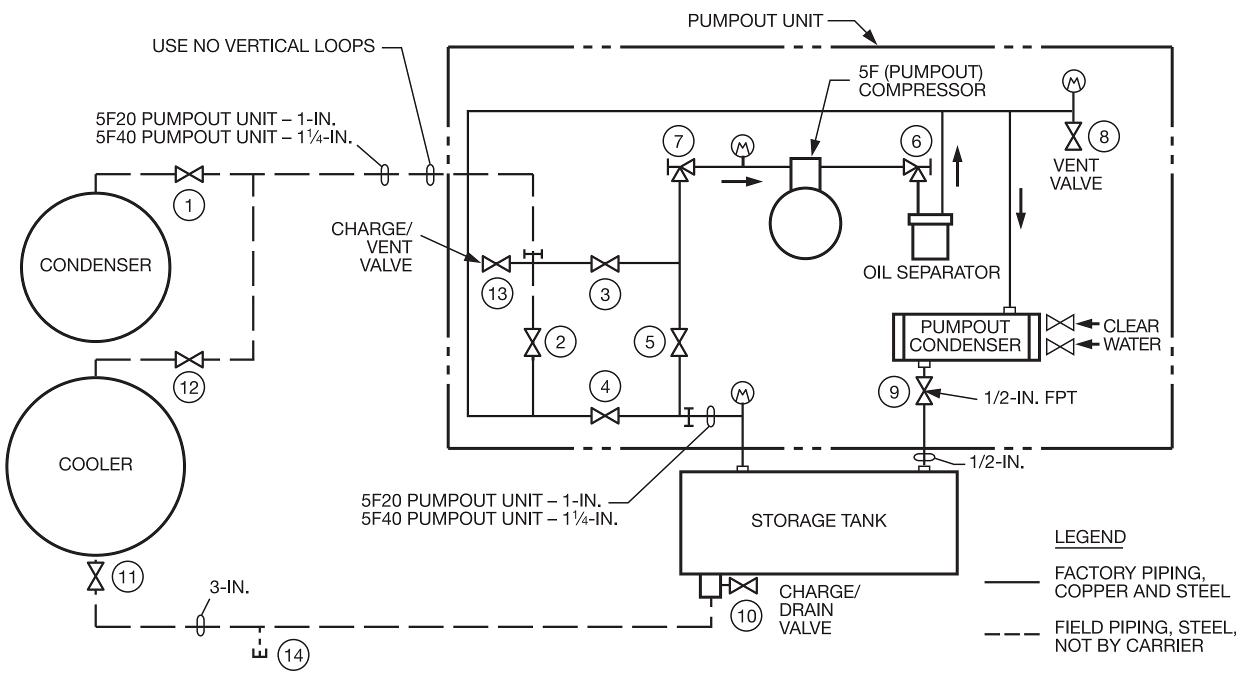
Safety Device	Setting
Low Oil Pressure	14 psig (96 kPa)
Low Suction Pressure	31 psig (214 kPa)
High Discharge Pressure	165 psig (448 kPa)

The pumpout compressor is operated by a ON-OFF-AUTO switch. The AUTO position enables the Low Suction Pressure switch. This position is used to prevent a freeze-up when applying suction to a heat exchanger containing liquid refrigerant. Otherwise, the ON position is used.

MACHINE AND STORAGE TANK EVACUATION (No Refrigerant in System) — Perform the following procedure. See Fig. 4 for valve numbers.

1. Place the control switch in the OFF position.
2. Close valves 2, 4, 9, 10, and 13.
3. Open valves 1, 3, 5, 6, 7, 8, 11, and 12.

Valve	1	2	3	4	5	6	7	8	9	10	11	12	13
Condition	O	C	O	C	O	O	O	O	C	C	O	O	C



NOTE: Numbers in schematic correspond to valve numbers in Pumpout System Operation section and are used in conjuction with the tables and text to specify which valves should be open and closed.

Fig. 4 — Pumpout System Schematic

4. Start the pumpout compressor (control switch at ON position).
5. Operate pumpout compressor until suction gage reads highest sustained vacuum (about 28 in. Hg VAC or 1 psia [6.9 kPa]).
6. Close valve 8.
7. Stop compressor (control switch at OFF position).

REMOVE AIR AFTER OPENING CHILLER TO ATMOSPHERE (Refrigerant Charge in Storage Tank) — Perform the following procedure. See Fig. 4 for valve numbers.

1. Place the control switch in the OFF position.
2. Close valves 2, 4, 5, 9, 10, 11 and 13.
3. Open valves 1, 3, 6, 7, 8, and 12.

Valve	1	2	3	4	5	6	7	8	9	10	11	12	13
Condition	O	C	O	C	C	O	O	O	C	C	C	O	C

4. Start pumpout compressor by putting control switch in the ON position.
5. Operate pumpout compressor until suction gage reads highest sustained vacuum (about 28 in. hg or 1 psia [6.9 kPa]).
6. Close valve 8.
7. Stop compressor by placing the control switch in the OFF position.

TRANSFER REFRIGERANT CHARGE (From Storage Tank to Machine) — Perform the following procedure. See Fig. 4 for valve numbers.

1. Place control switch in OFF position.
2. Operate cooler water pump and ensure that there is water flow through the cooler.
3. Close valves 2, 4, 5, 6, 7, 8, 9, 10, and 11.
4. Open valves 1, 3, 12, and 13.

Valve	1	2	3	4	5	6	7	8	9	10	11	12	13
Condition	O	C	O	C	C	C	C	C	C	C	C	O	O

⚠ CAUTION

Follow steps 5 and 6 carefully to prevent damage from a freeze-up.

5. Slowly open valve 5 and allow refrigerant vapor into the chiller until chiller pressure increases to 35 psig (141 kPa) for R-134a. Feed refrigerant slowly to avoid freeze-up.
6. Close valve 5.
7. Start the pumpout compressor (control switch in the AUTO position).
8. When the cooler pressure is lower than storage tank pressure, open valve 11 and refrigerant will flow from the storage tank to the machine.
9. Shut valve 11 when refrigerant level reaches the charge level mark on the cooler sight glass.
10. Turn off the pumpout compressor (control switch in the OFF position).
11. Close valves 3, 4, and 12.

TRANSFER REFRIGERANT CHARGE (From Machine to Storage Tank Located Below Machine) — Perform the following procedure. See Fig. 4 for valve numbers.

1. Vent storage tank to machine by opening valves 1, 2, 4, and 12.
2. Open valves 11 and drain liquid from the cooler.

Valve	1	2	3	4	5	6	7	8	9	10	11	12	13
Condition	O	O	C	O	C	C	C	C	C	C	O	O	C

3. Operate the cooler water pump.
4. Open valves 3, 6, 7, and 9.
5. Close valves 2, 4, 5, 10 ,11, and 13.

Valve	1	2	3	4	5	6	7	8	9	10	11	12	13
Condition	O	C	O	C	C	O	O	C	O	C	C	O	C

6. Run cooling water through the pumpout condenser.
7. Operate the pumpout compressor (control switch in the ON position).
8. At 25 in. Hg VAC (2.5 psia, 17.21 kPa) in cooler, stop the pumpout compressor. Close all valves and shut off pumps.

TRANSFER REFRIGERANT CHARGE (From Machine to Storage Tank Located Above or Level with Machine) — Perform the following procedure. See Fig. 4 for valve numbers.

1. Operate the cooler and machine condenser water pumps.
2. Open valves 1, 2, 5, 6, 7, and 12.
3. Close valves 3, 4, 8, 9, 10 ,11, and 13.

Valve	1	2	3	4	5	6	7	8	9	10	11	12	13
Condition	O	O	C	C	O	O	O	C	C	C	C	O	C

4. Operate the pumpout compressor (control switch in the ON position).
5. When the storage tank pressure is less than machine pressure, open valve 11.
6. After the liquid has been transferred, stop the pumpout compressor and the condenser water pump. Continue to operate the cooler water pump.
7. Open valves 3, 6, 7 and 9.
8. Close valves 2, 4, 5, 10, 11, and 13.

Valve	1	2	3	4	5	6	7	8	9	10	11	12	13
Condition	O	C	O	C	C	O	O	C	O	C	C	O	C

9. Run cooling water through the pumpout condenser.
10. Operate the pumpout compressor (control switch in the ON position).
11. At 25 in. Hg VAC (2.5 psia, 17.21 kPa) in cooler, stop the pumpout compressor. Close all valves and shut off pumps.

PRESSURIZE MACHINE AND STORAGE TANK (No Refrigerant in System) — Perform the following procedure. See Fig. 4 for valve numbers.

1. Open valves 3, 4, 6, 7, 9, 11, and 13.
2. Close valves 1, 2, 5, 8, 10 , and 12.

Valve	1	2	3	4	5	6	7	8	9	10	11	12	13
Condition	C	C	O	O	C	O	O	C	O	C	O	C	O

3. Operate the pumpout compressor (control switch in the ON position) until desired pressure is reached. Do not exceed design pressure of vessels.
4. Stop the pumpout compressor (control switch in the OFF position).
5. Close valve 13.

⚠ WARNING

Do not use refrigerant or air for leak testing. Personal injury could result. Only use nitrogen for leak testing.

DISTILL REFRIGERANT CHARGE — Water, oil, and impurities can be removed from the refrigerant while transferring the charge from storage tank to machine. Perform the following procedure. See Fig. 4 for valve numbers.

1. Operate the cooler and machine condenser water pumps.

2. Open valves 1, 2, 5, 6, 7, and 12.
3. Close valves 3, 4, 8, 9, 10 ,11, and 13.

Valve	1	2	3	4	5	6	7	8	9	10	11	12	13
Condition	O	O	C	C	O	O	O	C	C	C	C	O	C

4. Operate the pumpout compressor (control switch in the ON position).
5. When all of the liquid refrigerant has been removed from the storage tank, stop the pumpout compressor and close valves 1, 2, 5, 6, 7, and 12 (all valves closed).
6. Open valve 10 and plugged drain connection 14. Drain water and impurities. Do not allow storage tank pressure to drop below 0 psig.
7. Close valve 10 and plugged drain connection 14.
8. If, after distilling the refrigerant, there is excess refrigerant in the cooler over the normal operating charge, then return the excess to the storage tank. Follow the procedure Transfer Refrigerant from Machine to Storage Tank on page 12.

CHARGE REFRIGERANT — The pumpout unit can aid in charging refrigerant into a dehydrated machine. Perform the following procedure. See Fig. 4 for valve numbers.

1. Follow the procedure for Machine and Storage Tank Evacuation (No Refrigerant in System) on page 11 to remove any non-condensable gases, if present.
2. Using temporary charging lines, connect the vent of the refrigerant supply cylinder to valve 13 and the cylinder liquid drain to valve 10. Purge the lines as final connection is made to the valves.
3. Open valves 2, 4, 5, 6, 7, 10, and 13.
4. Close valves 1, 3, 8, 9, 11, and 12.

Valve	1	2	3	4	5	6	7	8	9	10	11	12	13
Condition	C	O	C	O	O	O	O	C	C	O	C	C	O

5. Drain any remaining liquid by raising cylinder pressure above storage tank pressure. Close valve 4 and operate pumpout compressor with control switch in ON position.

MAINTENANCE

The primary controls, both operating and safety are now incorporated into the programmable logic controller (PLC) which is incorporated into the chiller main control panel. Customer specifications may require some or all of the sensors and safeties to be duplicated by mechanical switched. For this reason both types of sensors and safeties will be covered in the following procedures.

Weekly Maintenance

CHECK OIL LEVEL — Mark edge of sight glass at normal oil level using grease pencil. Record date and amount of oil added in refrigeration log.

CHECK PURGE FREQUENCY — Operate the purge only when there is air in the system as indicated by the pressure in the purge chamber when the machine is in operation. When purge chamber pressure is within 8 psid of condenser pressure, the vent valve can be opened to bleed air from the chamber. Close the valve when the differential is higher than 16 psid.

WATER IN PURGE WATER CHAMBER — Refrigerants R-22 and R-134a hold a greater percentage of water in the liquid state than in the vapor state. As a result, a typical condensing purge does not separate water from refrigerant. Alternate methods such as refrigerant analysis are used to detect water in these refrigerants.

Yearly Maintenance

NOTE: The primary controls, both operating and safety, are now incorporated into the PLC, which is incorporated into the chiller main control panel. Customer specifications may require some or all of the sensors and safeties to be duplicated by mechanical switches. For this reason both types of sensors and safeties will be covered in the following procedures.

CHECK/CALIBRATE WATER TEMPERATURE SENSORS — The water temperature sensors are located in the outlet piping near the water nozzles.

1. Each sensor should be compared against a calibrated sensor in a calibration bath or dry block calibrator.
2. Compare the reading of the calibrated sensor with the temperature reading on the PLC screen. Replace or calibrate the sensor as required.
3. Confirm that any set points on the PLC match the recommended alarm or trip points for the chiller.

CHECK REFRIGERANT LOW-PRESSURE CUTOUT — The primary low-pressure cutout will be a function of the PLC and the pressure will be transmitted to the PLC from a transducer. An optional mechanical secondary switch may also be installed which will send an open-closed signal to the PLC.

1. Compare the reading of the cooler pressure transducer with a test gage and/or the condenser pressure transducer when the machine is not in operation. Confirm that the correct cutout pressure is configured in the PLC.
2. The chilled water low-temperature cutout set point must be temporarily set low enough that the refrigerant low-pressure cutout will react first. A mechanical low chiller water temperature switch should be jumpered for the duration of the test.
3. Start the machine and observe both chilled water temperature and refrigerant temperature.
4. Slowly reduce the chilled water temperature control point. Watch the thermometer in the leaving chilled water line and/or the leaving chilled water temperature display on the PLC screen. Do not allow chilled water temperature to drop below 35 F.
5. The machine should shut down when refrigerant temperature reaches one degree below design suction temperature or 28 F (-2.22 C) minimum (chilled water duty).
6. Restore the chilled water low-temperature cutout to its normal set point. Remove the jumper on the mechanical chilled water low-temperature cutout switch.

CHECK CONDENSER HIGH-PRESSURE CUTOUT — This PLC function and optional mechanical pressure switch senses condenser gas pressure and shuts down the compressor when the condenser pressure exceeds 165 psig (1138 kPa) for R-134a or 275 psig (1896 kPa) for R-22. Do not attempt to test this safety by forcing the condensing pressure to rise during machine operation.

1. Compare the reading of the condenser pressure transducer with a test gage and/or the cooler pressure transducer when the machine is not in operation. Confirm that the correct cutout pressure is configured in the PLC.
2. To check a mechanical cutout switch, first turn off the control power.
3. Use an air or nitrogen supply which can be regulated to the desired pressure.
4. Check the control with an ohmmeter to determine if the switch has opened when the desired pressure is reached. Adjust as necessary.

CHECK AUXILIARY OIL PUMP CONTROL — The purpose of the auxiliary oil pump is to take over the job of supplying lubricating oil at the required pressure to the bearings and the seal in the event that the main oil pump loses pressure. The auxiliary oil pump should start before the machine trips on low oil pressure. The pressure being measured is the differential pressure between the machine internal pressure on the refrigerant side of the seal and the oil supply being controlled by the differential pressure regulator. The pressure being supplied to the seal is maintained at 35 psid above the pressure on the refrigerant side of the shaft seal. The auxiliary oil pump should start if the differential pressure falls to or below 23 psid.

Lower the oil pressure by adjusting the differential oil pressure regulator until the oil pressure drops to 23 psid. On completion of the test, reset the oil pressure regulator to its normal setting of 35 psid. The auxiliary pump will stop when the oil pressure rises above 27 psid.

CHECK SEAL OIL DIFFERENTIAL PRESSURE TRANSDUCER — This function shuts down the compressor if the seal oil pressure differential drops below its fault limit. The transducer should be checked for proper calibration by comparing against a known pressure gage. If two individual single input transducers are used instead of a differential transducer, the measured pressures will be compared by the PLC to calculate the differential pressure reading.

CHECK THRUST BEARING OIL PRESSURE TRANSDUCER — This function shuts down the compressor if the thrust bearing oil pressure drops below its fault limit. The thrust bearing is in the ambient atmosphere so the oil pressure is referenced to ambient pressure. The transducer should be checked for proper calibration by comparing against a known pressure gage and the set point should be checked on the PLC screen.

CHECK DISCHARGE GAS HIGH-TEMPERATURE CUTOUT — This function shuts down the compressor if the compressor discharge gas temperature exceeds its fault limit. The sensor is located in a temperature well in the back wall of the compressor. It is located to the immediate right of the bearing chamber on the 7 frame compressor and to the immediate left of the bearing chamber on the 8 frame compressor. The sensor should be compared against a calibrated sensor in a calibration bath or dry block calibrator.

CHECK THRUST BEARING OIL HIGH-TEMPERATURE CUTOUT — This function shuts down the compressor if the temperature of the oil leaving the compressor exceeds its fault limit. The sensor is located in the bearing chamber and is inserted into the leaving oil temperature well that is an integral part of the thrust bearing housing.

The sensor should be compared against a calibrated sensor in a calibration bath or dry block calibrator.

CHECK SHAFT MOVEMENT SWITCH — The shaft movement switch will shut down the compressor if the thrust bearing has been damaged. This protects the impeller from damage. The switch is mounted inside the bearing chamber at splitline level. It is actuated by a trigger screw that protrudes from the main shaft.

With the shaft in the thrust position, the clearance between the screw head and the switch should be 0.014 to 0.015 in. (0.356 to 0.038 mm) as shown in Fig. 5.

Check the integrity of the wiring and connections between this switch and the bulkhead terminals. If this switch has opened during compressor operation, do not restart the machine. Contact a Carrier service representative immediately.

CHECK COOLER AND CONDENSER MINIMUM FLOW PROTECTION — Flow monitoring devices are specified per job, however the common purpose is to prevent damage to the chiller due to insufficient water flow. With the chiller not in operation, reduce water flow to each vessel in turn until the low flow cutout function activates. Confirm the flow rate is correct. Calibrate the monitor(s) as required.

CHECK AUXILIARY INTERLOCKS — Refer to the job wiring drawing for interlock wiring. Interlocks and safety controls must deenergize the main holding coil, turbine solenoid trip, etc. to shut down the refrigeration compressor under unsafe conditions. Serious damage to the machine could result if safety devices are bypassed.

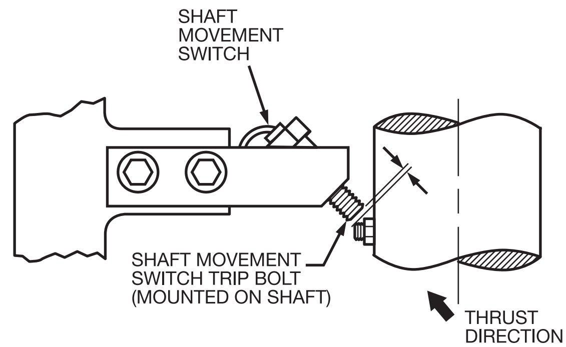


Fig. 5 — Shaft Movement Switch Detail

CHECK CONDENSER SUBCOOLER LEVEL CONTROL — The purpose of this function is to control the liquid valve in the condenser drain line. The liquid level in the condenser shell should be as close as possible to the deck that divides the condenser section from the subcooler section. When the level is correct and the chiller is running near design conditions, the correct level should result in a temperature reading of 0 to 2° F below saturated condensing temperature at the condensed liquid thermowell near the subcooler inlet.

The control consists of a level transmitter with the PLC supplying the signal to the liquid valve. A self-contained pneumatic or electronic level control may also be supplied which controls the liquid valve directly.

To calibrate either type of control, initially set the level so that the sight glass or transmitter output indicates that the level is approximately at the level of the condensed liquid thermowell. Make final adjustment based on the condensed liquid temperature. If the temperature is too low, drop the level. If the temperature is too high, raise the level.

CHECK COMPRESSOR GUIDE VANE CONTROL — The standard guide vane actuator is a pneumatic piston actuator controlled by a built-in positioner. The positioner receives a 3 to 15 psig signal. The signal comes from an electric-to-pneumatic transducer controlled by the PLC. The actuator is equipped with a solenoid operated "quick-dump" valve. This allows the vanes to immediately close on compressor shutdown and prevents the guide vanes from operating until the chiller is fully in "run" condition. The solenoid is controlled by the PLC.

The maximum guide vane opening should be set in the PLC such that the vanes stop opening when the position indicator beneath the actuator points to 90.

Set the supply air pressure regulator for 80 psig minimum, 100 psig maximum. The cushion air supply to the bottom of the piston should be set for 40 psig. The cushion air pressure may be varied to suit job conditions. Cushion air pressure closes the guide vanes. If an adjustment is made it must be proven that the vanes can readily close before the compressor is started. Increasing cushion air pressure slows the vane opening speed and increases the vane closing speed. Ensure that the air supply is filtered and dry.

CHECK OIL PRESSURE REGULATORS — Maintain by making proper adjustments and providing clean and ample oil supply. See Oil Cycle section on page 18 for more information.

Thrust Bearing Oil Pressure Regulator — The regulator reduces the main oil pump discharge pressure to 18 psig for drive end journal bearing and thrust bearing lubrication.

Differential Back-Pressure Regulator — The regulator maintains a differential pressure of 35 psid between oil pump discharge pressure and pressure in refrigerant side, back-of-seal section of compressor. Excess oil is relieved directly to oil sump. This control maintains oil supply pressure higher than machine refrigerant pressure, so that any oil leakage through the seal is always in an inward direction.

CHECK STARTERS AND VFDS — Refer to the starter/ VFD manufacturer's instructions for specific procedures.

General items that must be addressed (where applicable):

- Tightness of all power cable and other wire connections
- Inspect all connections for evidence of excessive temperature and investigate cause when evidence is found, clean and remake the connection:
- Operation of cooling fans
- Dirt, corrosion, carbon tracking and oily contamination of mechanisms and contacts
- Soot, stained areas, evidence of smoke must be investigate before cleaning
- Megohm testing of power cables
- Lubrication and free operation of contactor mechanisms
- Contact condition, alignment and remaining overtravel. Manufacturer's literature will provide the minimum overtravel
- Circuit breaker calibration
- Operation of all safeties and interlocks
- Calibration of safeties
- Isolation switch operation

COMPRESSOR BEARING MAINTENANCE — The key to good bearing maintenance is proper lubrication. Use the proper grade of oil, maintained at recommended level, temperature, and pressure. Inspect the lubrication system regularly and thoroughly.

CHANGE OIL AND OIL FILTER — Periodic oil samples should be used as guidance regarding the necessity of oil changes. Contaminants and evidence of deterioration by the presence of acid are of primary importance. Synthetic oil does not break down and lose viscosity over time under normal operation.

The oil filters should be changed at a minimum of one year intervals. The oil charge is 35 gallons. Carrier supplies suitable oil under part number PP23BZ106.

To remove oil charge from oil reservoir, proceed as follows:

1. Find two 1/2-in. plugs in the side of the reservoir located beneath the pump motor end. Use bottom plug.
2. Remove plug. Drain oil into suitable container and replace plug.

INSPECT COOLER TUBES — Inspect tubes and clean at the end of the first operating season. Condition indicates frequency of cleaning required in future and also whether or not water treatment is required in chilled water circuit.

A yearly eddy current test of the heat exchanger tubes will reveal most damage and enable corrective action to prevent an eventual failure.

INSPECT CONDENSER TUBES — Inspect tubes and clean yearly or more often if water is contaminated. Higher than normal condenser pressure usually indicates dirty tubes. Air in machine also results in high pressures.

Open systems and make-up water result in condenser tubes fouled by scale and algae. A specialist should analyze water and recommend treatment required.

Brushes designed to prevent scraping of tube walls are sold through Carrier Service Center. Hard scale may require chemical cleaning.

INSPECT PURGE RECOVERY UNIT — Close purge service valves. This unit handles corrosive mixtures at their highest concentration and protects machine. Keep it in good operating condition. See Fig. 6 for purge evacuator assembly components. Proceed as follows:

1. Remove purge cover from purge evacuator assembly.
2. Remove evacuator valve and float assembly.
3. Clean refrigerant float chamber.
4. Operate float valve through full travel. Valve must move freely without binding.
5. Examine valve plunger and seat for dirt and wear. Replace plunger and seal assembly if worn.
6. Reinstall components using new sealing gaskets.
7. Check 1/16-in. orifice in strainer/orifice assembly (Item 6, Fig. 6). Clean strainer (Item 7, Fig. 6).
8. Replace the strainer.

General Maintenance

REFRIGERANT LEVEL — Excessive refrigerant in cooler causes liquid droplets to be pulled into compressor suction and requires excess power for tonnage produced.

Too little refrigerant reduces the number of tubes that cool the water, causing inlet guide vanes to open, thus further reducing cooler pressure. The machine may shut down on refrigerant low-pressure cutout even though chilled water temperature is too high.

Proper refrigerant charge is indicated when difference between leaving chilled water temperature and cooler temperature reaches design conditions, or becomes a minimum at design load conditions. To determine the approximate refrigerant charge for your machine, add the cooler charge to the applicable condenser charge as listed in Table 3.

The optimum operating charge for the machine must be determined by adjusting the charge during operation at or near full design load. See Charge Refrigerant in the Start-up section of this manual. The optimum charge level should be marked on the cooler level sight glass. This allows the correct amount of refrigerant to be returned to the machine after service or a seasonal shutdown.

Refrigerant loss is always due to leaks, since the 17DA machine operates at pressures above atmospheric. Check over the machine frequently with approved refrigerant leak-detecting equipment. Repair all leaks.

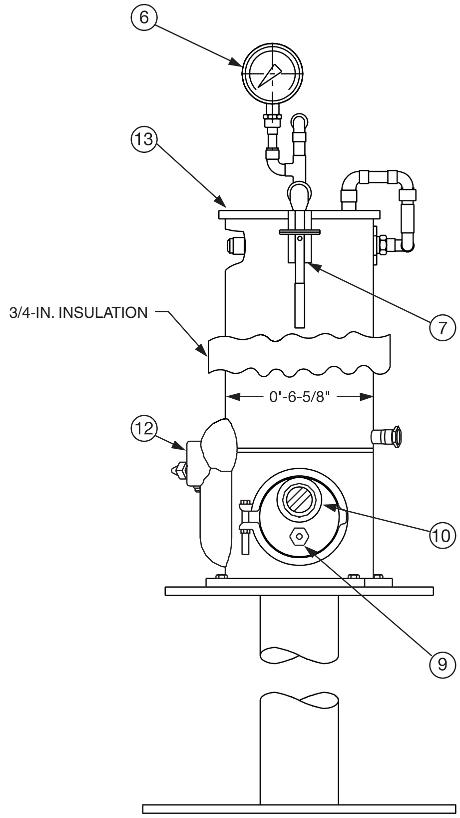
LEAK TESTING — Since HFC-134a is above atmospheric pressure at normal operating temperatures, effective leak testing can be done with refrigerant in the machine. Refrigerant may have to be pumped out to storage tank before leaks are repaired.

If the machine is empty of refrigerant, proceed as follows:

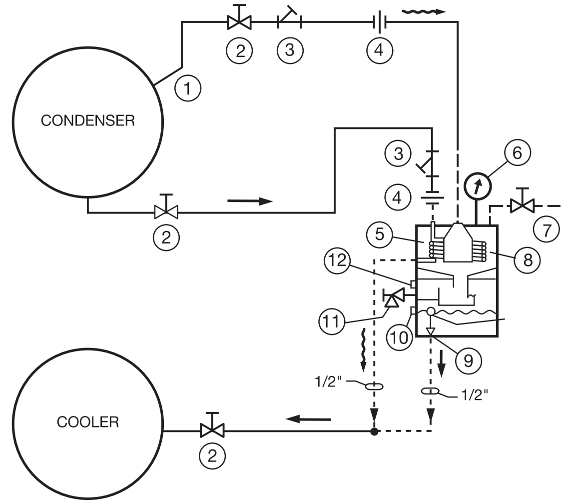
1. Use HFC-134a as a tracer gas. Pressurize the machine with HFC-134a vapor to 20 psig (138 kPa).
2. Complete the pressurization using a dry gas (nitrogen) to 90 to 100 psig (620 to 690 kPa). Maximum test pressure is 150 psig (1034 kPa). Never use air to pressurize machine for a leak test. A serious explosion may result.
3. Leak test using an electronic leak detector suitable for HFC-134a. Test all joints and flanges, including the pumpout and purge units. Repair all leaks and repeat tests until machine is tight. A heavy concentration of refrigerant in the machine room decreases leak testing efficiency. Ventilate the room well with ample fresh air before attempting final leak test operation.

CHECK LEAKAGE RATE — Proceed as follows:

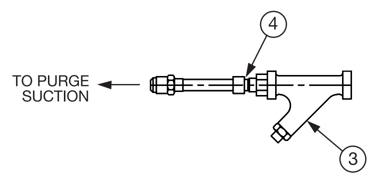
1. Start the chilled water and condensing water pumps.
2. Use external vacuum pump to pull 25 in. (635 mm) mercury vacuum on machine.
3. Valve machine off. Turn vacuum pump off. Stop water pumps. Leave oil pump running.
4. A vacuum loss rate of 0.05 in. (1 mm) mercury per 24 hours or less indicates acceptable leak tightness.



EVACUATOR ASSEMBLY



PURGE SYSTEM



VALVE ASSEMBLY

LEGEND

1 — Purge Connection
2 — Shutoff Valves
3 — Strainer
4 — Orifice
5 — Condensing Chamber
6 — Condensing Chamber Pressure Gage
7 — Non-Condensable Vent Valve
8 — Cooling Coil
9 — Refrigerant Chamber and Purge Float Valve
10 — Refrigerant Sight Glass
11 — Water Chamber and Hand Drain Valve
12 — Water Sight Glass

Fig. 6 — Purge Cycle Schematic Piping

BREAKING VACUUM — When breaking vacuum during leak testing or other service work, always use dry refrigerant or other form of dry gas; i.e., nitrogen or air.

The use of dry gas to break machine vacuum is especially important in areas of high humidity to prevent corrosion damage due to water condensing in refrigerant spaces within machine.

PREPARING MACHINE FOR CHARGING REFRIGERANT — After servicing machine and checking the leakage rate, apply a vacuum pump and pull machine pressure down to 0.15 in. (4 mm) mercury absolute pressure or less. Valve off and charge with refrigerant.

After the first few minutes of operation, residual air not removed by the vacuum pump will collect in the condenser shell where it will be pulled off by the purge sampling tube.

CHILLER DEHYDRATION — Dehydration is recommended if the chiller has been open for a considerable period of time, if the chiller is known to contain moisture, or if there has been a complete loss of chiller holding charge or refrigerant pressure.

⚠ CAUTION

Do not start or megohm-test the compressor motor or oil pump motor, even for a rotation check, if the chiller is under dehydration vacuum. Insulation breakdown and severe damage may result.

Dehydration can be done at room temperatures. Using a cold trap (Fig. 7) may substantially reduce the time required to complete the dehydration. The higher the room temperature, the faster dehydration takes place. At low room temperatures, a very deep vacuum is required to boil off any moisture. If low ambient temperatures are involved, contact a qualified service representative for the dehydration techniques required.

Perform dehydration as follows:

1. Connect a high capacity vacuum pump (5 cfm [.002 m^3/s] or larger is recommended) to the refrigerant charging valve (Fig. 4, item 10). Tubing from the pump to the chiller should be as short in length and as large in diameter as possible to provide least resistance to gas flow.
2. Use an electronic vacuum indicator or a wet bulb vacuum indicator to measure the vacuum. Open the shutoff valve

to the vacuum indicator only when taking a reading. Leave the valve open for 3 minutes to allow the indicator vacuum to equalize with the chiller vacuum.

3. If the entire chiller is to be dehydrated, open all isolation valves (if present).
4. With the chiller ambient temperature at 60 F (15.6 C) or higher, operate the vacuum pump until the manometer reads 29.8 in. Hg vac, ref 30 in. bar. (0.1 psia) (–100.61 kPa) or a vacuum indicator reads 35 F (1.7 C). Operate the pump an additional 2 hours.

   Do not apply a vacuum greater than 29.82 in. hg vac (757.4 mm hg) or allow the temperature to drop below 33 F (0.5 C) on the wet bulb vacuum indicator. At this temperature and pressure, isolated pockets of moisture can turn into ice. The slow rate of evaporation (sublimation) of ice at these low temperatures and pressures greatly increases dehydration time.

   Filling the heat exchanger tubes with warm water (100 F [38 C] or cooler) will warm any moisture clinging to the tubes and thus will increase the evaporation rate. If the waterbox covers are open warm air can be blown through the tubes. Again observe the 100 F (38 C) limit.
5. Valve off the vacuum pump, stop the pump, and record the instrument reading.
6. After a 2-hour wait, take another instrument reading. If the reading has not changed, dehydration is complete. If the reading indicates vacuum loss, repeat Steps 4 and 5.
7. If the reading continues to change after several attempts, perform a leak test up to the maximum 160 psig (1103 kPa) pressure. Locate and repair the leak, and repeat dehydration.

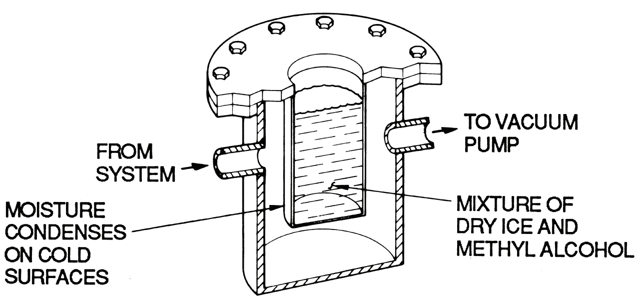


Fig. 7 — Dehydration Cold Trap

REMOVING REFRIGERANT — Machines with refrigerant are usually provided with a storage tank and pumpout unit to permit refrigerant removal when performing service work. Refer to Pumpout System Operation section.

WATER TREATMENT — In hard water areas, the condensing water system must be cleaned frequently (at least yearly) to prevent a rise in condenser pressure. Proper water treatment and cooling tower bleedoff reduces the amount of scaling and, thereby, reduces frequency of tube cleaning required.

Since water conditions vary in all parts of the country, it is recommended that a reliable water treatment specialist be consulted and a sample of the condenser water tested to determine the type of water treatment required.

CLEARANCES — Clearances for compressor components shown in Fig. 4 and listed in Table 5 are a guide to be used when checking or fitting a replacement part.

GEAR AND DRIVE — Refer to gear and drive manufacturer's instructions for maintenance requirements.

PUMPOUT SYSTEM — Refer to Carrier Service Instructions for 5F,H condensing units for maintenance.

Table 5 — Clearances

DESCRIPTION	ITEM (Fig. 4)	DIMENSION (in.)		MEASURE TYPE
		Min	Max	
Shaft End Labyrinth				
Seal End	**1**	**.008**	**.011**	**Dia.**
Thrust End	**8**	**.001**	**.003**	**Dia.**
Journal Bearing Labyrinth Seal and Thrust End	**3**	**.005**	**.009**	**Dia.**
Impeller Eye	**—**	**.026**	**.034**	**Dia.**
Balancing Piston	**10**	**.032**	**.036**	**Dia.**
Journal Bearings	**2, 5**	**.0035**	**.0055**	**Dia.**
Thrust Clearance	**—**	**.008**	**.012**	**Axial**
Thrust Disc Face Runout	**7**	**.0005 TIR**		**Axial**
Seal Ring	**9**	**.0015**	**.004**	**Dia.**
Seal Shoulder to Seal Housing Face	**—**	**1 50/64**	**1 61/64**	**Axial**
Shaft Movement (Safety) Switch	**Fig. 5**	**.014**	**.018**	**Fig. 5**
Seal Movement (Safety) Switch*	**4**	**.020**	**.025**	**Axial**

TIR — Total Indicator Reading

GENERAL DATA

Machine Nameplate — The machine nameplate with machine serial number and machine designation is located on the safety panel. These numbers include information about the machine. For example, 17DA81 indicates:

17 - Open-drive centrifugal refrigeration compressor

DA - Single-stage

81 - Compressor size

The overall assembly as well as each major component has a serial number. When corresponding with your Carrier representative, always give machine designation, machine serial number, and component serial numbers.

Refrigerant Properties — Refrigerant is relatively safe. The sweet-smelling vapor is nonflammable and nontoxic. Heavy concentrations may cause dizziness, headache, and loss of consciousness. When subjected to flame, refrigerant breaks down into toxic gases. Avoid breathing fumes.

Refrigerant dissolves oils and destroys natural rubber and all components containing rubber. Carefully selected neoprenes are safe to use.

Air or water floats on top of refrigerant in gas or liquid state respectively. Being heavier than air, refrigerant will settle in all low places. See Tables 6A and 6B for refrigerant temperature vs pressure (saturated) relationships.

Relief Valve Assembly — The relief valve assembly is located on the refrigerant storage tank. It prevents dangerous high pressure from developing within the machine from fire or any other reason.

System Components — The system components consist of the following:

- Cooler - Heat exchanger which cools "brine" passing through the tubes by evaporation of the refrigerant in which tubes are immersed.
- Compressor - Machine which compresses the evaporated refrigerant and discharges it to the condenser.
- Condenser - Heat exchanger which liquefies the evaporated refrigerant discharged into it from the compressor.
- Purge Recovery Unit - A small condensing unit with separator which continuously extracts gas from the top of the condenser and purifies it by removing air which may be present.

- Controls - Instruments which control the brine temperature, protect the various elements of the machine, and automatically start and stop the compressor. When specified, additional controls for automatic operation of interconnecting equipment such as fans and pumps are furnished.
- Drive - Prime mover which supplies the power to drive the compressor.
- A refrigerant pumpout and storage unit is usually furnished with this equipment. The refrigeration cycle covers the first three major components; the others are described in other portions of this manual.

Refrigeration Cycle — See Fig. 8. In the cooler, heat is transferred from water flowing thru the tubes to cold refrigerant around the tubes. The cooler refrigerant temperature corresponds to cooler pressure as listed in Tables 6A and 6B. Heat extracted from the water evaporates the liquid refrigerant, releasing large volumes of refrigerant gas which pass into the compressor.

Eliminators in the top of the cooler prevent any liquid refrigerant from being carried over into the compressor.

The compressor impeller raises the gas from cooler pressure up to condenser pressure. Gas flow into the compressor is controlled by adjusting the suction inlet guide vanes and the variable diffuser width. This controls cooler pressure and, therefore, machine capacity.

In the condenser, heat is transferred from the high-pressure refrigerant gas to water flowing through the tubes. The gas condenses on the tubes and the liquid drains in to the condenser subcooler section. A subcooler level control keeps the subcooler tubes covered with refrigerant and provides an effective liquid seal, preventing refrigerant gas flow from high-pressure to low-pressure side of the machine.

Since the coldest condenser water flows through the subcooler tubes, the temperature of the refrigerant is reduced as much as possible before it enters the cooler.

When the refrigerant clears the refrigerant flow valve and is once again at cooler pressure, the refrigeration cycle is complete.

Oil Cycle — See Fig. 9. External, positive displacement oil pump (Item 9) mounted on reservoir (Item 11) discharges to cooler (Item 7) and filter (Item 6). Auxiliary oil pump (Item 10) is provided to maintain continuous lubrication during emergencies.

Supply oil temperature is read on thermometer (Item 5) located in line between cooler and filter. Oil temperature is controlled by regulating water flow to the cooler. Differential pressure regulator (Item 8) maintains seal and seal end journal bearing (Item 15) oil pressure at 35 psid (241 kPa) above back-of-seal refrigerant pressure. Seal oil low pressure cutout (Item 1) shuts down compressor if seal oil pressure drops below cutout pressure. Seal end journal bearing temperature is read on thermometer (Item 14).

Pressure regulating valve (Item 4) regulates oil supply pressure to thrust bearing and seal-end journal bearing (Item 15). Bearing oil pressure is read on bearing oil supply pressure gage (optional). Thrust bearing oil low-pressure cutout safety function shuts down compressor if bearing oil pressure drops below cutout pressure.

Oil from the seal and bearings returns by gravity flow thru a common drain line to the oil reservoir. Oil leakage thru the seal to the refrigerant side drains to a separation tank (Item 13) where absorbed refrigerant is driven from the oil by a small heater.

The refrigerant gas is vented to the compressor suction. The oil is returned to the reservoir thru a float valve (Item 12) which controls the oil level in the separation tank.

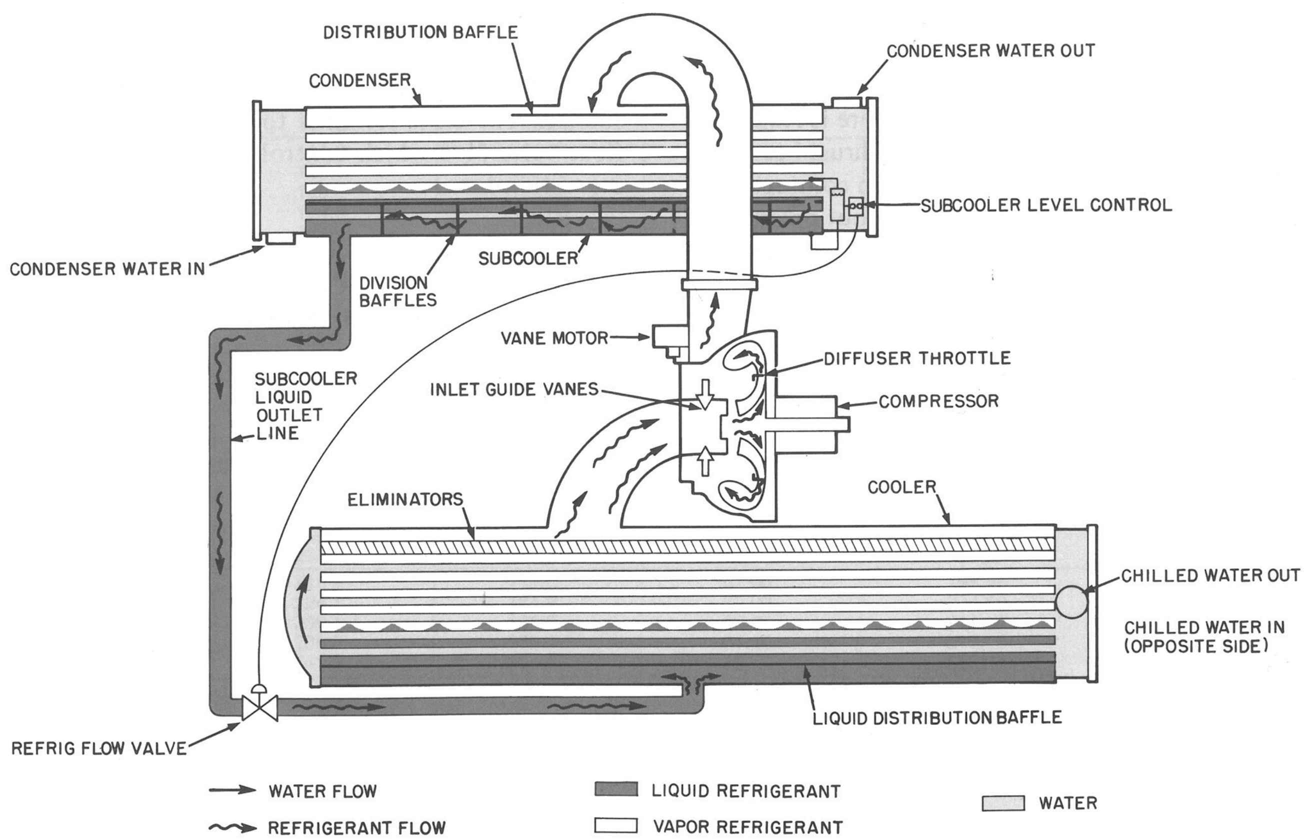
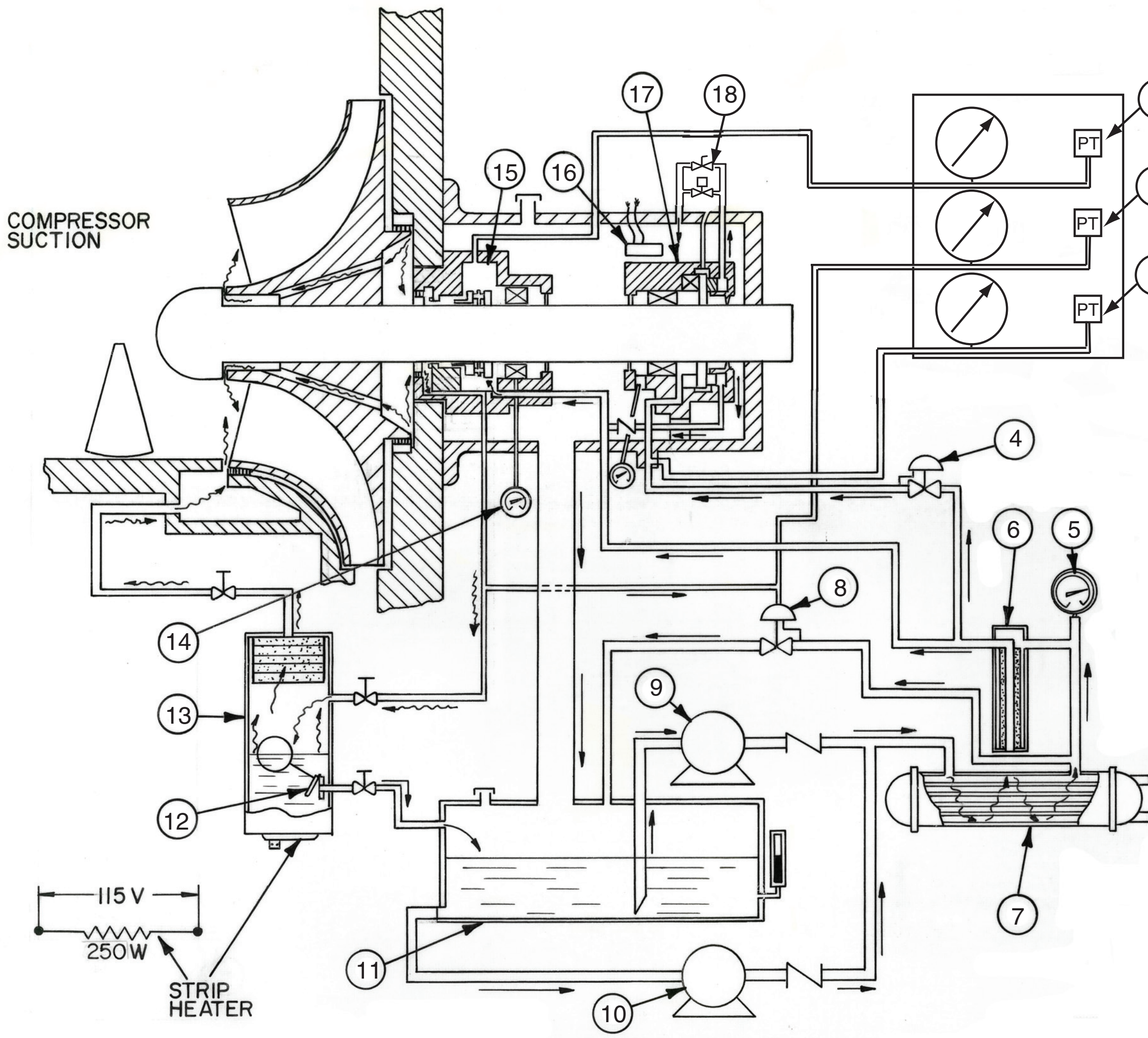


Fig. 8 — Refrigeration Cycle



LEGEND

1 — Seal Oil Supply Pressure Transmitter	**10** — Auxiliary Oil Pump
2 — Back-of-Seal Oil Pressure Transmitter	**11** — Oil Resevoir
3 — Bearing Oil Supply Pressure Transmitter	**12** — Seal Oil Return Float Valve
4 — Low Pressure Regulator	**13** — Oil/Refrigerant Separator
5 — Oil Supply Temperature Gage	**14** — Seal-End Journal Bearing Thermometer
6 — Oil Filter	**15** — Seal and Seal-End Journal Bearing
7 — Oil Cooler	**16** — Seal Movement Switch
8 — Differential Pressure Regulator	**17** — Thrust Bearing and Drive-End Journal Bearing
9 — Main Oil Pump	**18** — Shutdown Seal Automatic and Manual Bleed Valves

Fig. 9 — Schematic Oil Diagram

Auxiliary oil pump, if used, operates when seal oil and back-of-seal oil pressure difference is less than 23 psi. Control is located on machine safety panel.

Purge Cycle — See Fig. 6. Non-condensable gases, water vapor, and refrigerant vapor pass from top of machine condenser through strainer (Item 3) and orifice (Item 4) to purge condensing chamber (Item 5). Water and refrigerant vapors are condensed by cooling coil (Item 8) which is supplied with filtered refrigerant (Item 3) through orifice (Item 4) in machine condenser liquid line.

NOTE: Refrigerants HCFC-22 and HFC-134a hold a greater percentage of water in the liquid state than in the vapor state. As a result, HCPC-22 and HFC-134a refrigerants will not release water in the purge. Use another method to detect water in these refrigerants.

The condensed vapors fall in the condensing chamber (Item 5) and separate by gravity. Refrigerant collects in the lower chamber (Item 9) and water in the upper chamber (Item 11). As the refrigerant level in the lower chamber rises, float valve (Item 9) opens and refrigerant flows through valve (Item 2) to the cooler. Refrigerant vaporized in the cooling coil also returns to the cooler.

Air and any other non-condensables accumulate in the condensing chamber. As the pressure in the chamber rises to approach within 8 psi of the chiller condenser pressure, the non-condensables must be vented through the non-condensable Vent valve (Item 7). Watch the condensing chamber gage (Item 6), and close the vent valve when the chamber pressure drops to 16 psi below chiller condenser pressure.

During shutdown all pressures equalize and refrigerant will not separate from air in the purge. Do not vent the purge when the machine is not running.

TROUBLESHOOTING

When troubleshooting the 17DA machine, check the PLC display on the control panel first. Messages on the main screen will indicate the fault or faults, plus further information can be found on the screens applicable to that function or functions related to the fault.

Compressor Will Not Start

SAFETY SWITCH MALFUNCTION — There are standard mechanical switches on the chiller along with sensors that provide information to the PLC. Two standard sensors that are always provided are the seal movement safety switch and the shaft movement safety switch. If either switch or its wiring is open circuited, then the PLC will show an alarm.

Mechanical switches for various temperatures and pressures may be provided in addition to the sensors of the PLC, if specified by the customer. These mechanical switches are also connected to PLC inputs and the switch or circuit that is open will be reported by the PLC.

DRIVE MALFUNCTION — Safety switches and sensors on the motor, speed increaser or turbine normally are connected to and identified by the PLC. Variable frequency (speed) drives (VFD) will have their own display panel. Starters of the size used for the 17DA chillers generally have monitoring instruments that will provide information on internal problems, problems with incoming power, etc.

Compressor Surge — Surge is a repeated loss and recovery of the compressors aerodynamic lift. This loss of lift is characterized by a reversal of flow back through the compressor. During surge there will be an intermittent high pitched whistle signifying the reversal of the flow through the compressor. The pressure gages and the motor amps will rise and fall.

Intermittent operation in surge is not normally detrimental to the machine. Prolonged operation in surge can cause damage related to heat build-up.

The ability of a centrifugal compressor to produce pressure is directly related to the amount of gas passing through it, and the lift characteristics on the compressor at these load points. All of the possible causes are related to this fact. Computer modeling of the 17DA compressor for each application can provide guidance on how to adjust the characteristics of the operation to minimize the occurrence of surge.

The amount of required condenser water temperature reduction versus load reduction varies widely among centrifugal compressors based on design and duty. The 17DA chiller is able to handle deep load reductions without a major drop in condenser water temperature. This does not imply that condenser water temperature should be held near design temperature at all times. It is an advantage to power consumption to keep the condenser water temperature as low as possible down to a minimum temperature. The minimum and maximum temperatures vary with machine and duty. They may be obtained through your Carrier Service Office.

The following sections are some of the causes of surge and corrections associated with them.

INSUFFICIENT LOAD TO MAINTAIN STABILITY — Increase load on the machine. Open the optional hot gas bypass. Reduce condenser water temperature. If none of these can be done, stop the machine until load on the system increases.

CONDENSER WATER TEMPERATURE IS TOO HIGH — As machine cooling load drops below design, entering condenser water temperature must also drop. The ability of a centrifugal compressor to produce pressure is directly related to the amount of gas passing through it. Lower the condenser water pressure or temporarily raise the chilled water set point.

FOULED TUBES IN EITHER HEAT EXCHANGER — Clean the tubes.

LOW WATER FLOW IN EITHER HEAT EXCHANGER — Condenser water should remain at design flow. Cooler water flow can be varied to meet system needs. The allowable minimum must be determined for each machine. If surge occurs the load on the machine may seem sufficient when it is not unless flow rate and delta T are both checked.

VARIABLE SPEED DRIVE OPERATING TOO SLOWLY. — When leaving chiller water temperature is controlled by varying the compressor speed, it is possible that during low load conditions the rpm required for the capacity may be too low to maintain the required lift. In this case, the speed must be temporarily increased and the guide vanes used to control the water temperature. Conditions allowing return to speed control are indicated by the full opening of the guide vanes.

Chilled Water Temperature Too High — Following are some of the causes of a high chilled water temperature and corrections associated with them.

CHILLED WATER SET POINT TOO HIGH — Lower set point.

MOTOR IS LOAD LIMITED BELOW THE REQUIRED POWER TO MAINTAIN CHILLED WATER TEMPERATURE — Reset limit.

CHILLED WATER SET POINT HAS BEEN OVERRIDDEN BY THE BUILDING CONTROL SYSTEM — Check settings of building control system.

GUIDE VANES NOT FULLY OPENING (for reasons other than the above)

- Check supply air pressure to the actuator
- Check the instrument air signal
- Guide vane travel limited in the PLC
- Defective electronic-to-air signal transducer
- Guide vanes mechanically stuck
- Actuator or positioner malfunctioning
- “Quick dump” solenoid operated valve on the positioner is leaking

HIGH CONDENSER PRESSURE — See section entitled Condenser Pressure Too High.

COOLER WATERBOX DIVISION PLATE GASKET OUT OF PLACE — Fix gasket.

LEAVING CHILLED WATER SENSOR DEFECTIVE — Replace sensor.

EXCESSIVE WATER FLOW THROUGH THE COOLER — Check chiller configuration.

EXCESSIVE DIFFERENCE BETWEEN CHILLED WATER TEMPERATURE AND REFRIGERANT TEMPERATURE

- Low refrigerant charge
- Fouled cooler tubes
- Debris in waterbox blocking tubes

The temperature difference will increase at low flow. Check refrigerant-leaving chilled water difference at design flow.

Table 6A — HFC-134a Pressure — Temperature (F)

TEMPERATURE, F	PRESSURE (psig)
0	6.50
2	7.52
4	8.60
6	9.66
8	10.79
10	11.96
12	13.17
14	14.42
16	15.72
18	17.06
20	18.45
22	19.88
24	21.37
26	22.90
28	24.48
30	26.11
32	27.80
34	29.53
36	31.32
38	33.17
40	35.08
42	37.04
44	39.06
46	41.14
48	43.28
50	45.48
52	47.74
54	50.07
56	52.47
58	54.93
60	57.46
62	60.06
64	62.73
66	65.47
68	68.29
70	71.18
72	74.14
74	77.18
76	80.30
78	83.49
80	86.17
82	90.13
84	93.57
86	97.09
88	100.70
90	104.40
92	108.18
94	112.06
96	116.02
98	120.08
100	124.23
102	128.47
104	132.81
106	137.25
108	141.79
110	146.43
112	151.17
114	156.01
116	160.96
118	166.01
120	171.17
122	176.45
124	181.83
126	187.32
128	192.93
130	198.66
132	204.50
134	210.47
136	216.55
138	222.76
140	229.09

Table 6B — HFC-134a Pressure — Temperature (C)

TEMPERATURE, C	PRESSURE (kPa)
–18.0	44.8
–16.7	51.9
–15.6	59.3
–14.4	66.6
–13.3	74.4
–12.2	82.5
–11.1	90.8
–10.0	99.4
–8.9	108.0
–7.8	118.0
–6.7	127.0
–5.6	137.0
–4.4	147.0
–3.3	158.0
–2.2	169.0
–1.1	180.0
0.0	192.0
1.1	204.0
2.2	216.0
3.3	229.0
4.4	242.0
5.0	248.0
5.6	255.0
6.1	261.0
6.7	269.0
7.2	276.0
7.8	284.0
8.3	290.0
8.9	298.0
9.4	305.0
10.0	314.0
11.1	329.0
12.2	345.0
13.3	362.0
14.4	379.0
15.6	396.0
16.7	414.0
17.8	433.0
18.9	451.0
20.0	471.0
21.1	491.0
22.2	511.0
23.3	532.0
24.4	554.0
25.6	576.0
26.7	598.0
27.8	621.0
28.9	645.0
30.0	669.0
31.1	694.0
32.2	720.0
33.3	746.0
34.4	773.0
35.6	800.0
36.7	828.0
37.8	857.0
38.9	886.0
40.0	916.0
41.1	946.0
42.2	978.0
43.3	1010.0
44.4	1042.0
45.6	1076.0
46.7	1110.0
47.8	1145.0
48.9	1180.0
50.0	1217.0
51.1	1254.0
52.2	1292.0
53.3	1330.0
54.4	1370.0
55.6	1410.0
56.7	1451.0
57.8	1493.0
58.9	1536.0
60.0	1580.0

Chilled Water Temperature Too Low with Compressor Running

CHILLED WATER SET POINT IN THE PLC SET TOO LOW — Correct set point and check for overrides from the building control system.

LOW COOLING LOAD — The compressor cannot unload completely. If there is so little load that the guide vanes close fully, then the water temperature will continue to drop until the recycle function or chilled water low-temperature safety stops the machine.

INACCURATE THERMISTOR — The reading on the panel will not coincide with other sensors monitoring the leaving chilled water.

SENSORS OUTSIDE OF THE CHILLER CONTROLS ARE INACCURATE — The machine sensor could be correct and other sensor(s) are out of calibration.

GUIDE VANES NOT CLOSING

- Check pressure of supply air and cushion air pressure.
- Confirm that the air signal from the transducer matches the signal output from the PLC.
- Calibrate the positioner.
- Test the actuator for leakage past the piston seal.

Refrigerant Temperature Too Low

COOLER WATERBOX DIVISION PLATE GASKET OUT OF PLACE — Fix gasket.

LOW REFRIGERANT CHARGE — When the machine can be stopped, allow time for liquid to flow to the cooler. Compare the liquid level with the charging mark on the cooler level sightglass. Add refrigerant if required.

Check for leaks and check shutdown seal operation. Test refrigerant alarm sensors.

Leaving Chilled Water Temperature Fluctuates

RETURN CHILLED WATER TEMPERATURE FLUCTUATING FASTER THAN CONTROLS CAN RESPOND — Adjust controls.

CAPACITY CONTROL IN PLC NEEDS ADJUSTING — Adjust capacity controls.

GUIDE VANES MOVING ERRATICALLY

- Check actuator (see Guide Vanes Not Closing section above)
- With machine not running, disconnect the actuator and move the guide vanes manually. There should be a resistance, easily overcome, at the point where the discharge diffuser starts opening or closing. Check for obstructions.

Condenser Pressure Too High

LOW WATER FLOW OR HIGH WATER TEMPERATURE — Check the following:

- Check condensing water pump for proper operation.
- Check delta P and delta T across the condenser water side to determine if there is bypassing around the division plate.
- Check delta P across the condenser water pump.
- Check cooling tower controls and fans. Check to see if tower bypass is open.
- Check for correct level in the cooling tower.
- Check flow meter readings.
- If the condenser water valves automatically regulate condenser flow, check the control settings and valve operation.
- Ensure that condenser water strainers are clean.

AIR IN THE CONDENSER — Air or other non-condensable gases in the condenser will cause a rise in normal condensing pressures. Because of the subcooler, true condensing temperatures cannot be determined. If the subcooler level is set according to the method in the Charge Refrigerant section, then the actual condensing temperature will be close to the temperature at the subcooler inlet thermowell. This is located adjacent to the level control/transmitter.

If air is suspected, then check the purge. See the Purge Cycle section on page 19.

FOULED CONDENSER TUBES — Check for fouled or obstructed tubes. Clean as required.

Oil Pressure Too Low

PLUGGED FILTERS — Switch to alternate filter cartridge. Replace plugged filter.

PRESSURE REGULATOR SET TOO LOW — Adjust as required.

FAULTY PRESSURE REGULATOR — Replace regulator.

FAULTY PUMP OR MOTOR — Replace faulty component.

Oil Pressure Too High

PRESSURE REGULATOR SET TOO HIGH — Adjust as required.

RESTRICTION IN PRESSURE SENSING LINE — Check pressures and temperatures throughout lubrication system. Correct as required.

Oil Reservoir Temperature Too Low

EXCESSIVE WATER FLOWING THROUGH OIL COOLER

- Adjust water flow.
- If equipped with an automatic regulator, adjust the regulator.
- Check for good thermal contact between the regulator sensing bulb and the oil line leaving the oil cooler. Check the capillary tube for damage.
- Replace the regulator if faulty.

Oil Reservoir Temperature Too High

INSUFFICIENT WATER FLOW THROUGH OIL COOLER

- Adjust water flow.
- If equipped with an automatic regulator, then adjust the regulator.
- Check for good thermal contact between the regulator sensing bulb and the oil line leaving the oil cooler. Check the capillary tube for damage. Check for contamination plugging the regulator valve.
- Replace the regulator if faulty.

FOULED OR OBSTRUCTED OIL COOLER TUBES — Check oil cooler. Clean if necessary.

TEMPERATURE OF OIL RETURNING FROM BEARINGS TOO HIGH — Check for bearing wear, in particular the thrust bearing. Check the bearings for foreign particles or any indication of wiping.

A bad bearing can cause extensive damage to machine. Be sure to diagnose and correct reasons for overheated bearings before restarting the machine.

Compressor Discharge Gas Temperature Too High

EXTREMELY LOW LOAD — Verify low load condition. Add load to machine if possible.

LOW COOLER REFRIGERANT LEVEL — Insufficient charge in the machine or condenser refrigerant level too high.

EXCESSIVE TRAVEL OF DIFFUSER THROTTLING RING — This can only be determined through compressor disassembly.

CONTROLS

Safety Controls — Safety controls come in multiple forms. Safety functions are programmed into the PLC which use the same sensors as the operating functions. Per customer specifications, these may be supplemented by mechanical switches which directly measure pressures or temperatures. These switches are connected to discrete inputs of the PLC and the PLC controls the machine.

Starters and VFDs contain their own safeties that will shut down the starter/drive and then report the trip to the PLC via the communications line. It may be necessary to go to the drive control panel to read the actual trip code. On the PLC, the display may only show that the trip was initiated by the drive.

STANDARD SAFETY FUNCTIONS — The following safety functions are standard:

- low chilled water flow
- low condenser water flow
- high discharge gas temperature
- chilled water low temperature
- condenser high pressure
- cooler low pressure
- seal oil pressure
- bearing oil pressure
- thrust bearing high temperature
- seal movement switch
- excess shaft movement switch
- gear and turbine oil pressure switches

JOB SPECIFIC SAFETY FUNCTIONS — The settings for job specific safety functions will be found in the custom operating manuals provided with the machine. Examples of job specific safety functions are:

- vibration monitoring
- optional RTD bearing temperature sensors for the compressor and the drive components
- turbine overspeed
- failure of a synchronous motor to synchronize
- TEWAC (totally enclosed, water cooled) motor cooling coil leak

Operating Controls — Figures 10 and 11 are schematic representations of the basic control system governing water temperature, power demand limit, and condenser liquid level (liquid flow control). A comprehensive description of the complete control logic specific to each machine is provided in the custom operating manual. A brief description of the basic schematic follows.

The primary control devices are the compressor guide vanes, the hot gas bypass valve (optional) and the condensed liquid valve. Compressor speed may also be varied on some jobs. That will not be covered here.

Compressor inlet guide vanes control the amount of refrigerant gas that the compressor pulls from the cooler. By varying this capacity, the control system maintains correct leaving water temperature. The correct temperature is set on the PLC and can be also be set remotely. The PLC directs the position of the guide vanes based on the leaving water temperature. The guide vanes can also be controlled manually from the PLC.

The guide vane position signal is sent to an actuator that moves the guide vanes in proportion to the control signal. The standard actuator is pneumatic and the signal from the PLC is converted to a 3 to 15 psi instrument signal to the actuator positioner. A solenoid valve in the instrument line prevents the actuator from opening the guide vanes until the start-up sequence is complete. The solenoid will also cause the guide vanes to close immediately upon machine shut down. This prevents the pressure equalization gas flow from the condenser to the cooler from back spinning the compressor and driver.

In case of supply air failure, the reserve air tank has sufficient volume to close the vanes.

The hot gas bypass valve works together with the guide vanes. At low loads, the guide vane opening will be small. The hot gas valve will start to open as the guide vanes approach the minimum opening. The purpose of the hot gas bypass is to provide enough gas flow to the compressor to allow it to operate in a stable way at low chiller loads.

The guide vane position as determined by water temperature can be overridden by other functions. Functions can override only to close the vanes and reduce the machines capacity. No override can increase the guide vane position.

Override functions are:

- refrigerant temperature too low
- condenser pressure too high
- motor current too high, based on the demand limit set point.

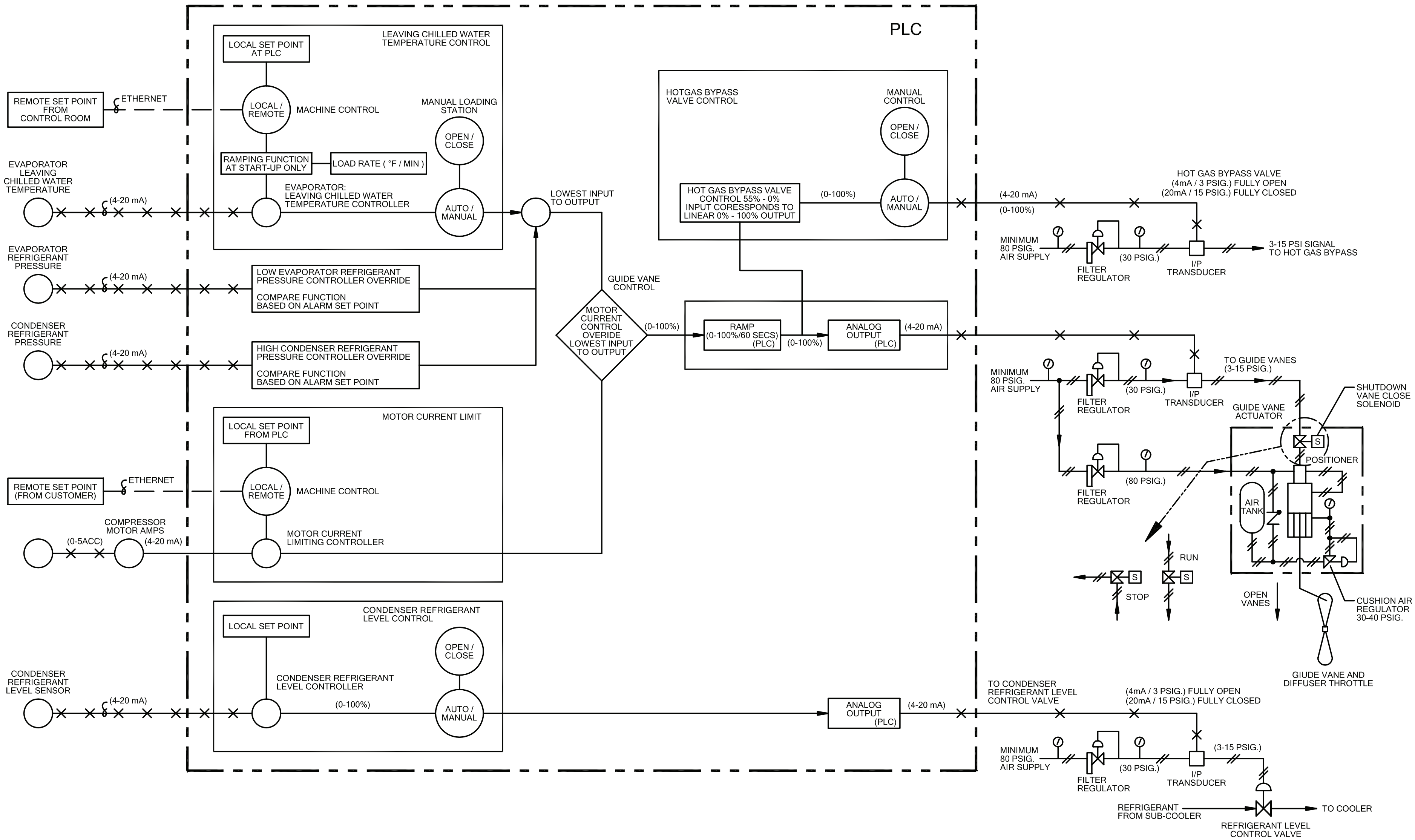
Inside the compressor, the guide vane actuator shaft also moves a diffuser throttle ring. Its position is determined by cams. During low loads, typically below 50%, the guide vanes and throttle ring move together. The diffuser throttling ring provides optimum performance down to 10% load. At higher loads the throttle ring is fully open and capacity is controlled by the guide vanes alone or in conjunction with variable compressor speed.

Variable frequency drives (VFDs) can be used along with the guide vanes to control machine capacity. When a variable speed drive or turbine is used, refer to the custom operating manual for specific details of the control sequence.

Figure 12 shows a typical turbine control which determines the required compressor speed using the difference between leaving chilled water and entering condenser water. This is not the only way to determine speed and sometimes the speed and guide vane position are varied together to optimize power consumption. As long as the compressor speed required to maintain the desired leaving chilled water temperature is sufficient to maintain the required condenser pressure, it is most economical to control capacity by varying speed alone. If higher compressor rpm is required to maintain condenser pressure, the guide vanes will temporarily take control of capacity. The sequence is chosen based on individual job requirements.

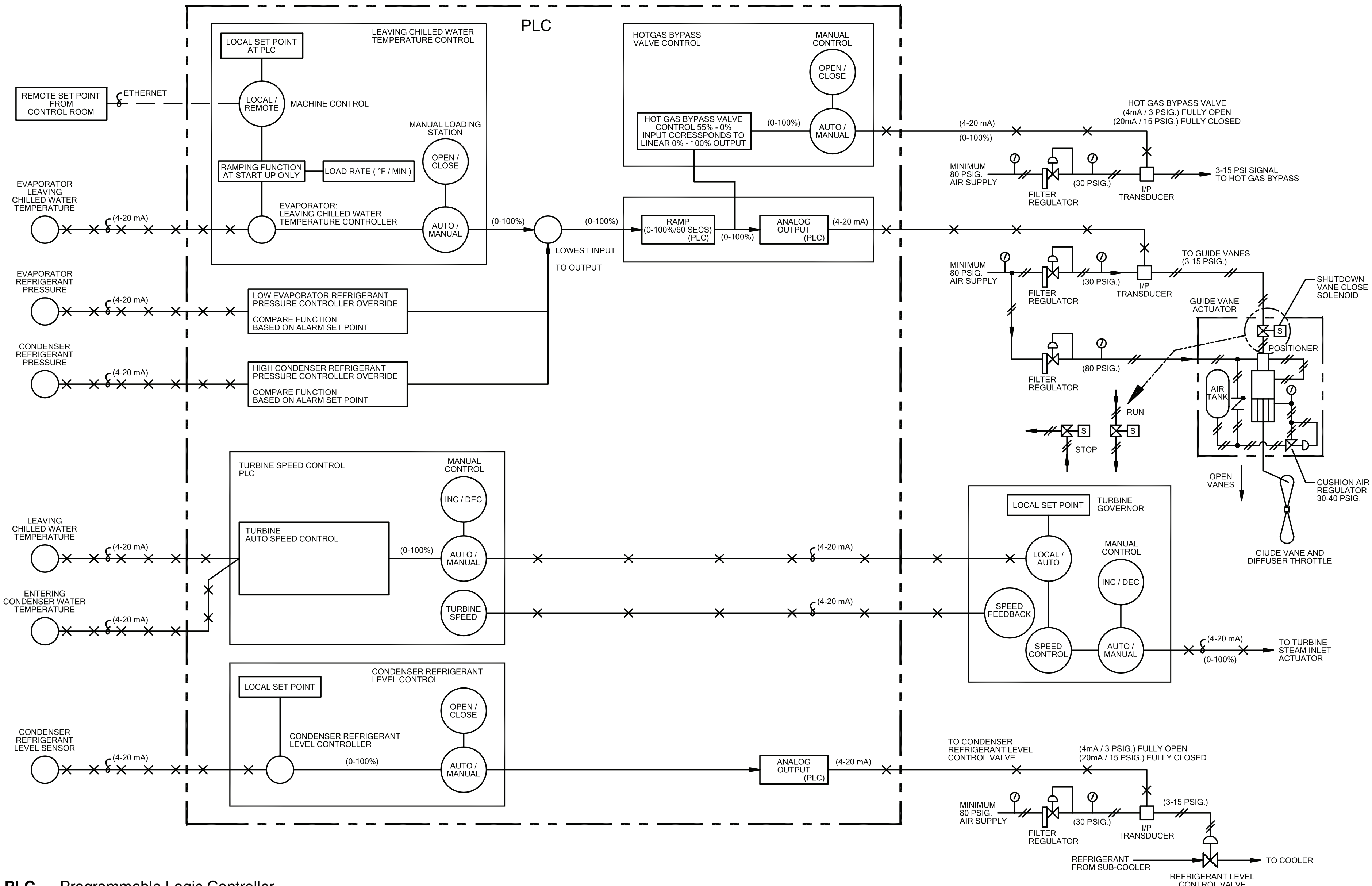
Condenser refrigerant level is set when the machine is commissioned. The level ensures that the subcooler tubes are covered with liquid and the liquid level does not reach the condenser tubes. A level control on the condenser operates the control valve in the line connecting the condenser drain with the cooler liquid inlet.

The level control function can reside in the PLC. In that case a level transmitter is mounted on the condenser in place of a level controller. The control still operates the liquid line valve.



PLC — Programmable Logic Controller

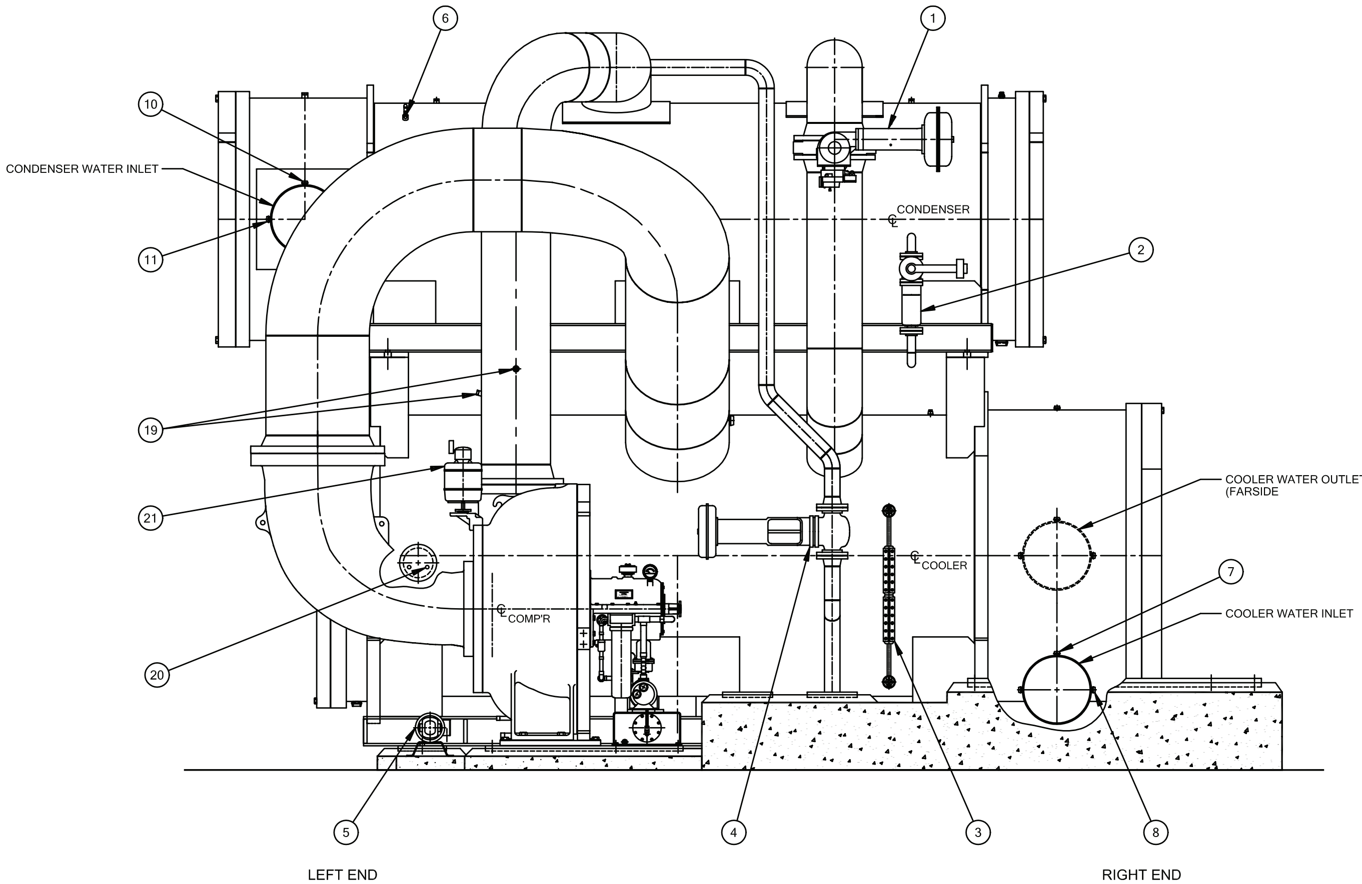
Fig. 10 — Typical 17DA Motor-Driven Machine Control Diagram



PLC — Programmable Logic Controller

Fig. 11 — Typical 17DA Turbine-Driven Machine Control Diagram

FRONT VIEW



REAR VIEW

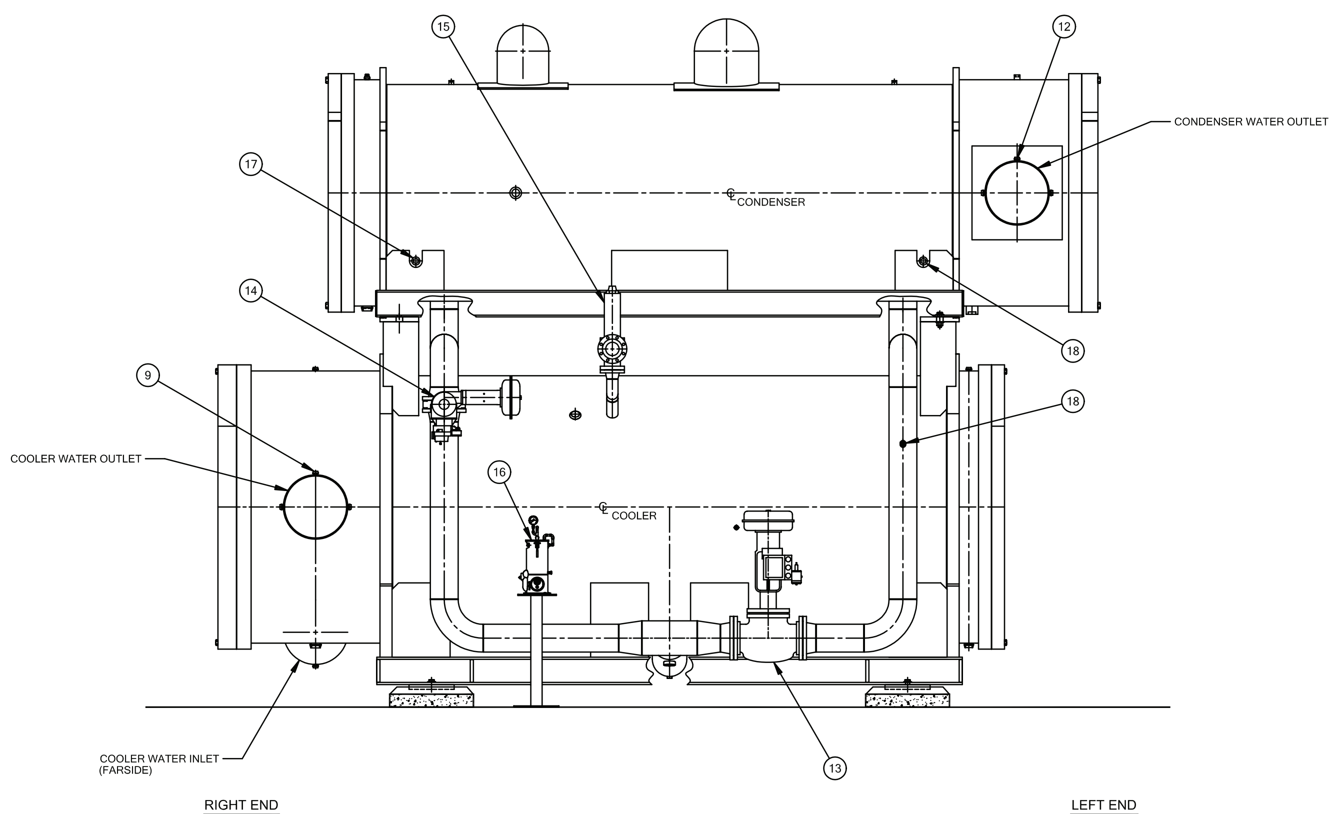
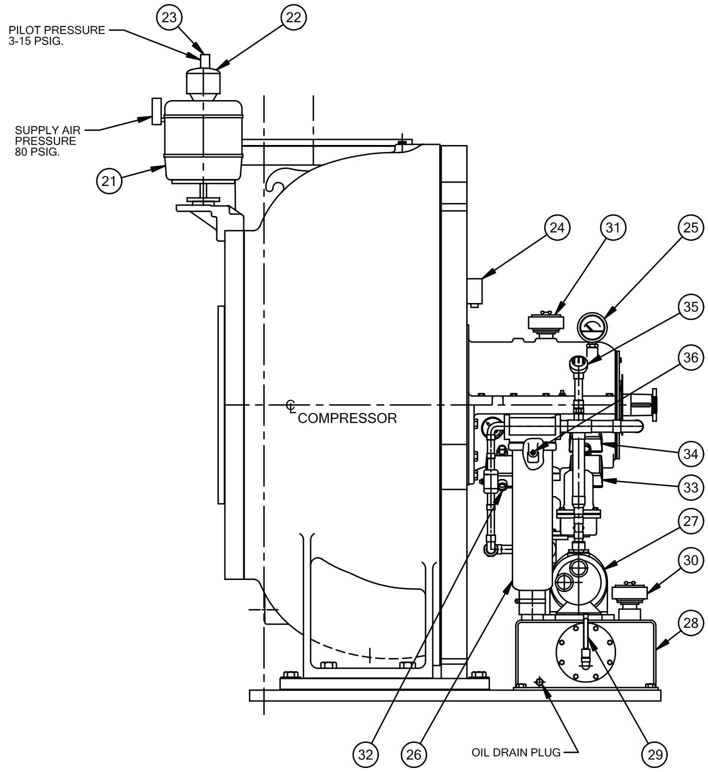
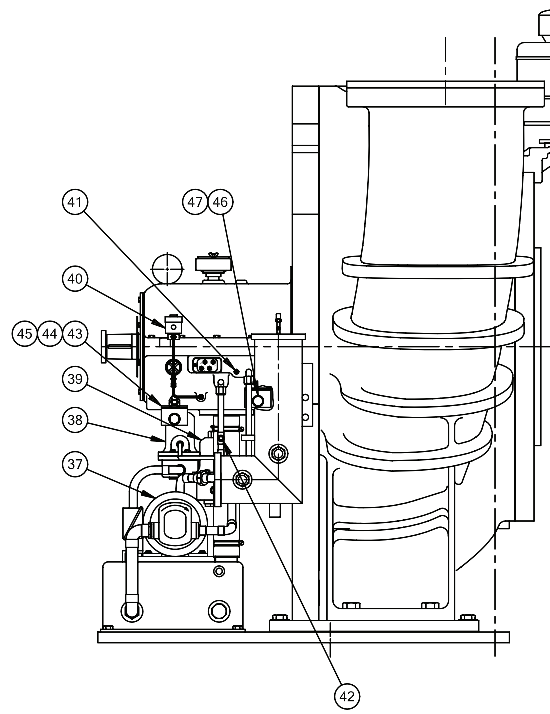


Fig. 12 — Machine Configuration

COMPRESSOR FRONT VIEW



COMPRESSOR REAR VIEW



LEGEND

1 — Free Cooling Vapor Valve (optional)
2 — Sub-Cooler Refrigerant Level Controller
3 — Cooler Sight Glass
4 — Hot Gas Bypass Valve (optional)
5 — Compressor Auxiliary Oil Pump
6 — Purge Vapor Connection
7 — Cooler Entering Water Temperature Instrument
8 — Cooler Entering Water Flow Instrument
9 — Cooler Leaving Water Temperature Instrument
10 — Condenser Entering Water Temperature Instrument
11 — Condenser Entering Water Flow Instrument
12 — Condenser Leaving Water Temperature Instrument
13 — Refrigerant Level Control Valve
14 — Free Cooling Liquid Valve (optional)
15 — Relief Valve
16 — Purge
17 — Condenser Refrigerant Liquid Temperature Instrument
18 — Sub-Cooler Refrigerant Liquid Temperature Instrument
19 — Discharge Temperature Instrument Connection
20 — Cooler Refrigerant Liquid Temperature Instrument
21 — Guide Vane Actuator
22 — Positioner
23 — Solenoid Valve
24 — High Discharge Temperature Switch
25 — Thrust Bearing Temperature Instrument
26 — Oil Filter
27 — Oil Cooler
28 — Oil Reservoir
29 — Oil Reservoir Level Sightglass
30 — Oil Reservoir Vent
31 — Bearing Housing Vent
32 — Compressor Seal End Journal Bearing RTD
33 — Compressor Thrust End Journal Bearing RTD
34 — Thrust Bearing Oil Return RTD
35 — Oil Supply RTD
36 — Bearing Supply Oil Pressure Transmitter
37 — Oil Pump and Motor
38 — OIl Differential Pressure Regulator Valve
39 — Oil Pressure Regulator Valve
40 — Shut Down Seal Solenoid Valve
41 — Seal Supply Oil Pressure Transmitter
42 — Seal Oil Return Pressure Transmitter
43 — Thrust End Journal Bearing Transducer (X)
44 — Thrust End Journal Bearing Transducer (Y)
45 — Thrust End Bearing Transducer
46 — Seal End Journal Bearing Transducer (X)
47 — Seal End Journal Bearing Transducer (Y)

Fig. 12 — Machine Configuration (cont)

PRE-START UP CHECK LIST

1. Steam System
   a. Is steam available? ______
   b. Have the steam lines been blown out and checked for cleanliness? ______
   c. Have the turbine steam inlet and exhaust chambers been checked for foreign material before steam lines are attached? ______
   d. Are there adequate pipe hangers and supports on the steam lines and has an analysis of the piping been concluded to eliminate piping stress on the turbine? ______
   e. Have limiting rods been placed on expansion joints when they are used? ______
   f. If a trip and throttle valve is supplied, does it have adequate support under it so that no weight or stress is placed on the turbine? ______
   g. Have all steam leak-off lines and drains been piped as indicated on the Dresser-Rand Outline drawing? ______
   h. Has an atmospheric relief valve been installed in the exhaust line between the turbine and the first block valve? ______
2. Turbine Preparation
   a. Has the turbine been rough aligned to the driven machine and grouted in? ______
   b. Have all shipping plugs and/or blind flanges been removed from the oil pipes and lube console and oil lines cleaned prior to installing? ______
   c. Has oil tank been cleaned and inspected in preparation to filling with oil? ______
   d. When oil console is supplied by others, has provisions been made to circulate oil and checked for cleanliness without passing oil through the turbine? ______
   e. Is piping complete and water available for oil cooler? ______
   f. Has proper oil for turbine and driven machine been obtained and brought to jobsite? ______
   g. Has auxiliary oil pump, where supplied, been checked for correct rotation? ______
   h. Are pneumatic and electrical connections to the turbine governor and safety devices completed? ______
   i. Is piping and wiring to gauge board, where furnished, complete? ______
3. Condensing Turbines Only
   a. Has a means been provided to drain the casing while under vacuum? ______
   b. Have the condenser condensate pumps been checked for correct rotation? ______
   c. Has the condenser hot well level control been checked for correct operation? ______

Signed By: ____________________________________ Date: ____________

Firm Name: ____

CUT ALONG DOTTED LINE

CUT ALONG DOTTED LINE