Carrier®

Start-Up, Operation and Maintenance Instructions

19EB

Carrier Corporation • Syracuse, N.Y 13221

Hermetic Centrifugal Liquid Chillers

A SAFETY GUIDE

Centrifugal liquid chillers 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 machine instructions as well as those listed in this guide.

⚠ DANGER

DO NOT USE OXYGEN to purge lines or to pressurize a machine 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 VALVE OFF any safety device.

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

⚠ WARNING

DO NOT USE eyebolts or eyebolt holes to rig machine 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 de-energized before resuming work.

DO NOT syphon refrigerant by mouth.

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 any 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 overpressure can result. When necessary to heat refrigerant, use only warm (110 F/43 C) water.

DO NOT REUSE disposable (nonreturnable) cylinders nor attempt to refill them. It is DANGEROUS AND ILLEGAL. When cylinder is emptied, bleed off remaining gas pressure, loosen the collar and unscrew and discard the valve stem. DO NOT INCINERATE.

CHECK THE REFRIGERANT TYPE before charging machine. High-pressure refrigerant in a low-pressure machine can cause vessels to rupture if the relief devices cannot handle the refrigerant volume.

DO NOT ATTEMPT TO REMOVE fittings, covers, etc. while machine is under pressure or while machine is running. Be sure pressure is at zero psig before breaking any refrigerant connection.

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

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

DO NOT VENT refrigerant relief valves within a building: vent to outside. The accumulation of refrigerant in an enclosed space can displace oxygen and cause asphyxiation.

DO NOT install relief valves 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 cause personal injury.

DO NOT climb over a machine. 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 such equipment when there is a risk of slipping or losing your balance.

DO NOT WELD OR FLAME CUT any refrigerant line or vessel until all refrigerant has been removed from the vessel.

BE AWARE that certain automatic start arrangements CAN ENGAGE THE STARTER. Open the disconnect *ahead of* the starter in addition to shutting off the machine or pump.

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

DO NOT VENT OR DRAIN water boxes containing industrial brines, liquid, gases or semisolids without permission of your Process Control Group.

DO NOT LOOSEN water box cover bolts until the water box 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.

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Form 19EB-3SSM

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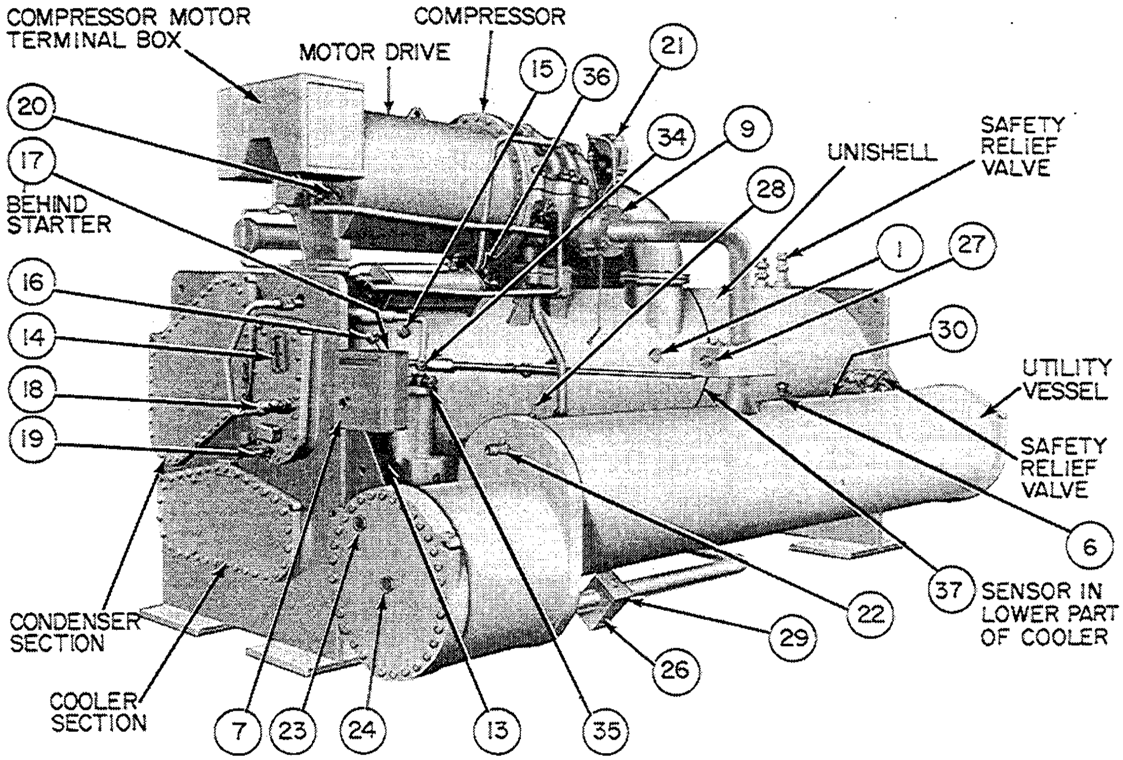
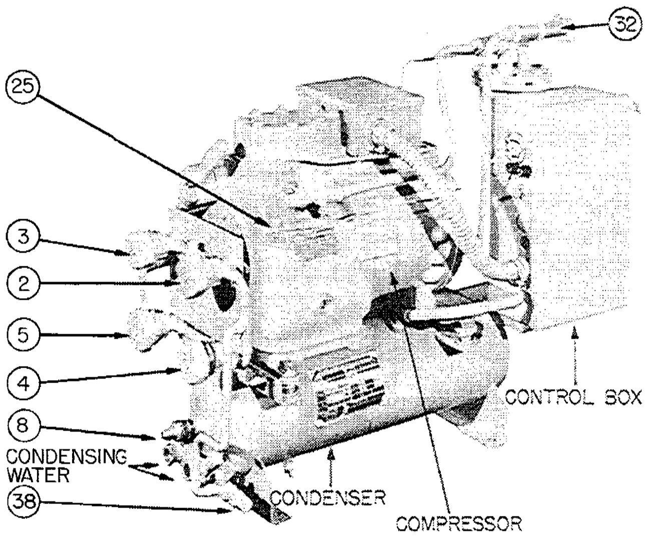
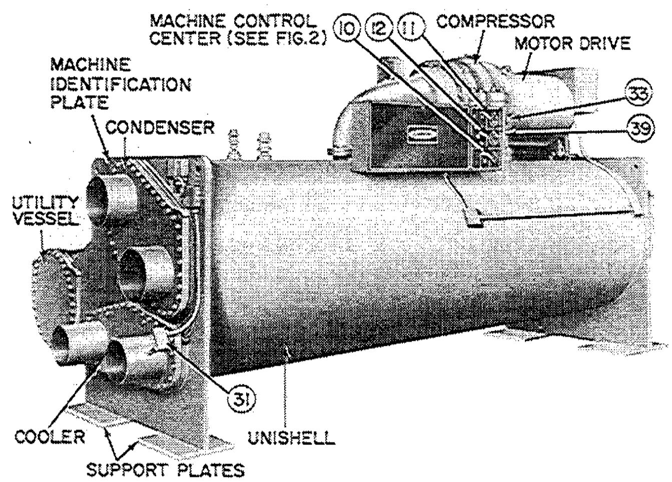




PUMPOUT UNIT



FRONT VIEW

LEGEND

1 — Pumpout Service Valve 1
2 — Pumpout Service Valve 2
3 — Pumpout Service Valve 3
4 — Pumpout Service Valve 4
5 — Pumpout Service Valve 5
6 — Pumpout Service Valve 6
7 — Oil Pump Starter
8 — Frangible Plug
9 — Economizer Damper Valve
10 — Differential Pressure Gage (oil)
11 — Condenser Pressure Gage
12 — Cooler Pressure Gage
13 — Dehydrator Water Valve
14 — Oil Level Sight Glass
15 — Oil Temperature Gage
16 — Oil Heater (with indicator light)
17 — Oil Heater Thermostat
18 — Oil Pressure Regulating Valve
19 — Oil Reservoir Charging Valve
20 — Sight Glass — Rotation
21 — Guide Vane Actuator
22 — Angle Valve — Maximum Liquid Level
23 — Sight Glass — Liquid Level
24 — Sight Glass — Liquid Level
25 — Oil Return Line Connection
26 — Refrigerant Drain and Charging Valve
27 — Isolation Valve (one of 2 types shown)
28 — Isolation Valve (hidden)
29 — Isolation Valve
30 — Isolation Valve — ball valve between unishell and utility vessel (hidden)
31 — Chilled Water Temperature Sensor
32 — Pumpout Vent Valve with Flare Cap
33 — Bearing Return Oil Thermometer (hidden)
34 — Dehydrator Pressure Gage
35 — Dehydrator Discharge Vent Valve
36 — Oil Cooler Plug Valve
37 — Refrigerant Low-Temperature Sensor
38 — Pumpout Condenser Discharge Valve
39 — Compressor Discharge Temperature Sensor (hidden)

Fig. 1 — Machine Components

INTRODUCTION

Everyone involved in the start-up, operation and maintenance of the 19EB machine should be thoroughly familiar with these instructions and other necessary job data before initial start-up. This book is outlined so that you may become familiar with the control system before performing start-up procedures. Procedures are arranged in the sequence required for proper machine start-up and operation.

⚠ WARNING

This unit uses a microprocessor control system. Do not short or jumper between terminations on printed-circuit boards; control or board failure may result.

Be aware of electrostatic discharge (static electricity) when handling or making contact with the printed-circuit boards. Always touch a chassis (grounded) part to dissipate body electrostatic charge before working inside control center.

Use extreme care when handling tools near boards and when connecting or disconnecting terminal plugs. Circuit boards are delicate and can easily be damaged. Always hold boards by edges and avoid touching components and pin connections.

This equipment uses and can radiate radio frequency energy and if not installed and used in accordance with the instruction manual may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference, in which case the user, at his own expense, will be required to take whatever measures may be required to correct the interference.

Always store and transport replacement or defective boards in anti-static shipping bag.

ABBREVIATIONS

A/D — Analog to Digital
CPU — Central Processing Unit
DIP — Dual Inline Package
I/O — Input/Output
LCD — Liquid Crystal Display
L/R — Local/Remote
POR — Power-On Reset
RLA — Rated Load Amps
S/D — Set Point/Display

CONTROLS

General — The 19EB hermetic centrifugal liquid chiller contains a microprocessor-based control center that monitors and controls all operations of the machine. The microprocessor control system matches the cooling capacity of the machine to the cooling load while providing state-of-the-art machine protection. The system controls cooling load within the set point deadband by sensing the leaving chilled water or brine temperature and regulating the inlet guide vane via a mechanically linked actuator motor. The guide vane is a variable flow prewhirl assembly that controls the refrigeration effect in the cooler by regulating the amount of refrigerant vapor flow into the compressor. An increase in guide vane opening increases capacity. A decrease in guide vane opening decreases capacity. Machine protection is provided by monitoring certain digital and analog inputs and executing capacity overrides or safety shutdowns, if required.

An analog signal varies in proportion to the monitored source. It quantifies values between operating limits. (Example: A temperature sensor is an analog device because its resistance changes in proportion to the temperature, generating many values.)

A digital (discrete) signal is a 2-position representation of the value of a monitored source. (Example: A switch is a digital device because it only indicates whether a value is above or below a set point or boundary by generating an ON/OFF, HIGH/LOW, or OPEN/CLOSED signal.)

Volatile memory — Memory that is incapable of being sustained if power is lost and subsequently restored. The central processing unit (CPU) memory is volatile.

The controller consists of a processor board, an input/output board (I/O), and a set point/display board (S/D). (See Fig. 1 and 2.) These 3 components, along with supporting peripheral devices, comprise a control system with the following features:

1. CAPACITY CONTROL — Controls chilled water or brine temperature within a selectable 1°F (0.56 C) or 2 F (1°C) deadband with a selectable 5 F (2.8 C) or 15 F (8.3 C) proportional band regardless of machine load.
2. CONSTANT DATA CONFIGURATION — If control power is lost and subsequently restored, control and safety limit set points will automatically be re-established in the CPU memory.
3. LIQUID CRYSTAL DISPLAY (LCD) — Displays status of machine during operation or displays diagnostic codes in the event of control overrides or safety shutdowns.
4. SAFETY PROTECTION — Monitors digital and analog safety limits and shuts down the machine when a limit is exceeded.

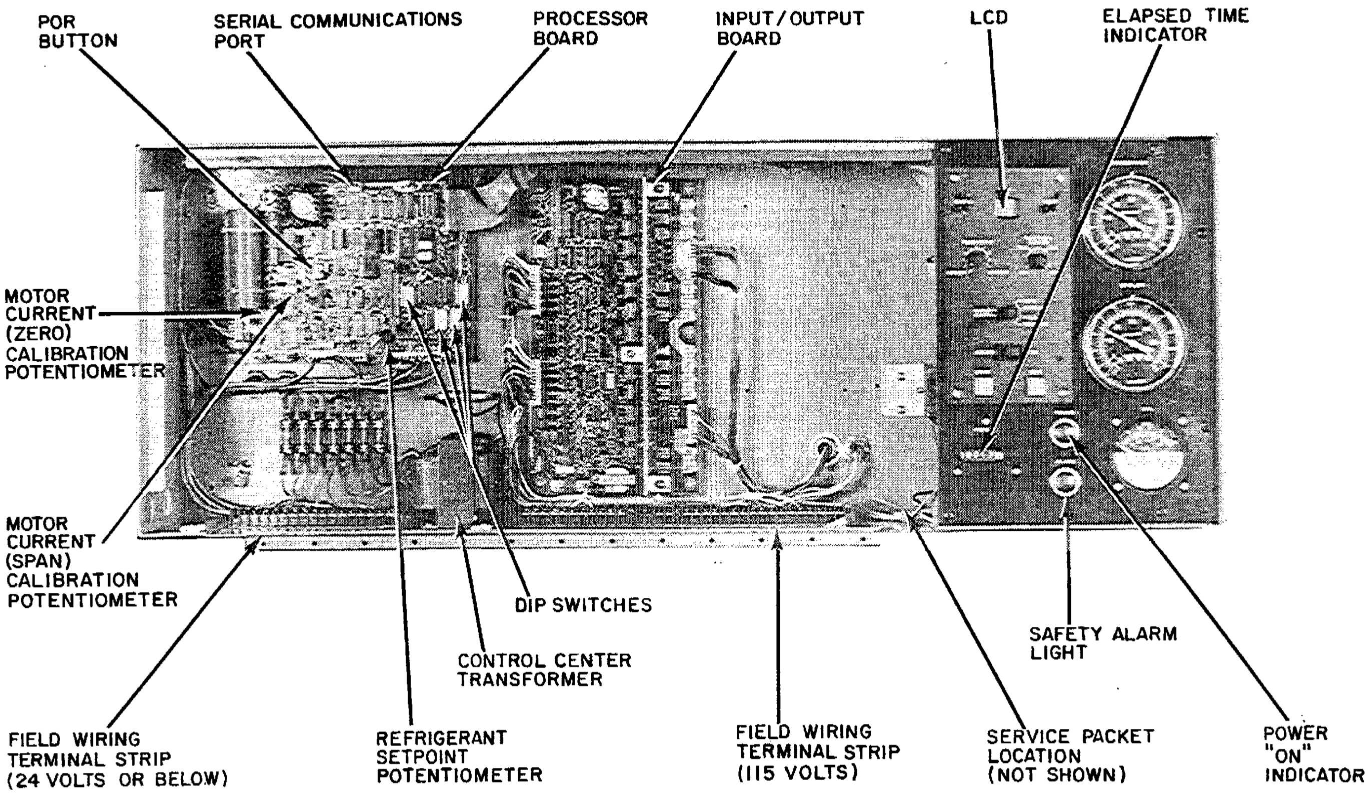


Fig. 2 — Control Center

5. DIAGNOSTIC CAPABILITIES — Monitors individual analog and digital inputs for control malfunction and displays troubleshooting information.

6. CONTROLS TEST — A self-diagnostic routine that displays individual status of peripheral control inputs and outputs. Exercises operating controls to confirm proper operation.

7. SHUTDOWN STATUS RECALL — Stores and displays on command the reasons for the last 5 safety shutdowns, beginning with the most recent.

8. SELECTABLE RAMP LOADING RATE — Allows 8 different leaving temperature pulldown rates during start-up, to prevent rapid increases in compressor loading and IkW.

9. THERMOSTAT CONTROL — Permits local adjustment of leaving chilled water temperature between 35 F and 65 F (1.67 C and 18.3 C) or brine temperature between 0° F and 40 F (-17.8 C and 4.5 C).

10. CAPACITY OVERRIDE CONTROL — Inhibits or closes the guide vanes to suppress a safety shutdown that may be caused when refrigerant, motor winding temperature or motor current conditions approach the safety limit.

11. ELECTRICAL DEMAND CONTROL — Limits maximum compressor current down to 40% of rated load amps (RLA).

12. CAPACITY CONTROL KNOB — Four-position switch permits selection of automatic or manual control over guide vane actuator position.

13. SEQUENCING OF PUMPS AND TOWER FANS — Starts and stops cooler and condenser water pumps and cooling tower fan individually, based on operating mode.

14. SAFETY SHUTDOWN ALARM — Panel-mounted alarm light and dry contact is provided for installation of field-supplied remote alarm.

15. REMOTE START/STOP — Input channel is provided for manual start-up and shutdown by time clock or other contact closure.

16. SPARE SAFETY INPUT — Input channel is provided for monitoring and initiating a machine shutdown upon request from additional field-supplied safeties.

17. POWER "ON" INDICATION — Power lamp indicates when control center is energized.

18. COMPRESSOR ANTI-RECYCLE — Start inhibit timers prevent rapid manual compressor restart by limiting start-to-start time to 15 minutes minimum and stop-to-start time to 3 minutes minimum.

19. COMPRESSOR STARTS REMINDER — Inhibits manual compressor start after recommended limit of 3 manual starts per 12-hour period. Override of start counter requires a manual reset.
20. VOLTAGE PROTECTION — Monitors power supply for high, low, or loss of line voltage and initiates a safety shutdown if limits are exceeded.
21. LIMITS MOTOR ACCELERATION TIME — Monitors motor inrush current to guard against excessive motor acceleration time.
22. LIMITS STARTER TRANSITION TIME — Monitors transition time to prevent motor and starter damage that could occur if limit is exceeded.
23. FAILSAFE SHUTDOWN SEQUENCE — Keeps oil pump, water pumps and tower fan energized if starter contacts fail to open on a shutdown command.
24. CONTROL EXPANDIBILITY — Easily accommodates a variety of control options and also interfaces with a higher level controller (i.e., mainframe computer) for maximizing control automation and energy management.
25. LOW-LOAD RECYCLE — Stops the machine when chilled water or brine load drops below a temperature indicating minimum machine capacity. Automatically restarts the machine when the leaving temperature rises to a point indicating the need for further cooling and the start inhibit timers have expired.

Processor Board — The processor board is mounted inside the control center panel and functions as the central computing and control unit for the system. It contains the logic (CPU) and time base necessary to perform all machine control functions. The processor board controls the I/O board and the S/D board, and directly monitors and converts all analog inputs to digital outputs. These include temperature sensors and motor current signal conditioning. In addition, the processor board monitors digital inputs from the impeller displacement switch and the I/O board and initiates capacity overrides or safety shutdowns when required.

The configuration control switches (DIP switches); motor current zero and span adjustments; refrigerant temperature set point potentiometer (for brine chilling duty); power-on reset pushbutton (POR); and serial communications port are all located on the processor board.

Input/Output Board — The I/O board is mounted inside the control center panel and functions as a logical block for interfacing 115-vac input and output control signals to the low-voltage processor board. Inputs are optically isolated from the processor board. Outputs are optically coupled triac drivers. All triacs are fused to provide overcurrent protection. The I/O board contains a 5-vdc regulator for its power supply and a line voltage monitor capable of detecting high, low or loss of voltage and generating an interrupt to the processor board.

Set Point/Display Board — The S/D board is mounted in the control center gage panel and allows the operator to interface with the CPU when the local/remote (L/R) switch is positioned in local. It is the input center for all local machine set points and operating commands or for a stop command during remote operation.

The following components are located on the S/D board:

1. NUMERICAL 2-DIGIT LCD WITH DECIMAL for displaying diagnostic codes and operational data.
2. ROCKER SWITCH for selecting local or remote (L/R) machine control.
3. START AND STOP PUSHBUTTONS for initiating and terminating machine operation.
4. RESET PUSHBUTTON for clearing a lockout due to a condition exceeding a safety limit (after the condition is within limits); advancing through the controls test; or overriding the 3 manual starts per 12-hour counter.
5. RECALL PUSHBUTTON for displaying up to 5 stored safety shutdown codes.
6. DEMAND LIMIT CONTROL KNOB for limiting motor current down to 40% of RLA.
7. TEMPERATURE CONTROL KNOB for adjusting the leaving chilled water or brine temperature set point.
8. FOUR-POSITION CAPACITY CONTROL KNOB for selecting automatic operation or manual control of guide vane position.

Safety Controls — The microprocessor monitors all safety control inputs and if required shuts down the machine to protect it against possible damage from high bearing, motor winding and discharge temperature; low oil pressure; cooler refrigerant low temperature; condenser high pressure; inadequate water flows; excessive impeller displacement; high, low or loss of voltage; excessive motor acceleration or starter transition time; and low-load recycle with motor current greater than 50% of RLA. In addition, compressor motor overload can shut down the machine.

If the controller initiates a safety shutdown, it displays a blinking diagnostic code on the LCD indicating the reason, and energizes the safety alarm output. The diagnostic code will also be stored in volatile memory for recall and display by depressing the recall pushbutton. Safety control limits are listed in Table 1. Diagnostic codes are listed in the Troubleshooting section.

Reset Pushbutton — A start lockout due to a condition exceeding a safety limit can be cleared by correcting the cause, positioning the L/R switch to local and depressing the reset pushbutton. The reset pushbutton may be used to override the 3 manual starts/12-hour counter when code 41 (more than 3 starts in past 12 hours) appears on the LCD. One additional start will be permitted after the depression. The reset pushbutton is also used to advance through the controls test.

Deadband is the tolerance on the leaving chilled water or brine temperature set point. If the leaving temperature goes outside the deadband, the microprocessor opens or closes the guide vane until it is within tolerance. The microprocessor may be configured with a 1° F (0.56 C) or 2 F (1° C) deadband. The 1° F setting controls leaving temperature within 0.5 F (0.1 C) of the set point with more frequent guide vane position corrections. The 2 F (1° C) setting controls within 1° F (0.56 C) of the set point with less frequent corrections. The latter setting is recommended when load is unstable.

Proportional Band is the rate at which the guide vane position is corrected in proportion to how far the leaving chilled water or brine temperature is from the set point. The farther away from the set point, the faster the guide vane moves. The nearer to the set point, the slower it moves. The microprocessor may be configured with a 5 F (2.8 C) or 15 F (8.3 C) proportional band. At the 5 F (2.8 C) setting, continuous guide vane position correction occurs when the leaving chilled water or brine temperature is approximately 1.5 F (0.8 C) below the set point or 5 F (2.8 C) above the set point. At the 15 F (8.3 C) setting, continuous correction occurs when the leaving chilled water or brine temperature is approximately 1.5 F (0.8 C) below the set point or 15 F (8.3 C) above the set point.

Ramp Loading slows the rate of guide vane opening during start-up to prevent undesirable demand spikes and rapid increases in compressor loading and to limit the average rate that the leaving chilled water or brine temperature can decrease in degrees/minute. Ramp loading rate is established by DIP switch setting as outlined in Table 1. During a recycle start-up, the ramp loading rate is fixed at 0.625 F/minute (.347 C/minute), regardless of the rate established by the DIP switch setting. Ramp loading is overridden when the capacity control knob is in the INC (increase) position. When using ramp loading to "soft load" the machine, ramp loading duration (in minutes) can be calculated with the following formula:

$$\text{Ramp Loading Duration} = \frac{\text{Leaving Temp at Start-Up} - \text{Leaving Temp Set Point}}{\text{Ramp Loading Rate}}$$

Capacity Overrides — The refrigerant low temperature, motor high temperature and motor current demand limit have 2 steps of override control to reduce the chance of nuisance safety trips occurring. The first step inhibits the guide vane from opening further and displays a blinking diagnostic code indicating the reason for the override. The second step drives the guide vane closed until the condition is below the override set point, terminating the override and returning the machine to temperature control. If either condition reaches the trip limit, a safety shutdown will be initiated. Override conditions are listed in Table 2.

Oil Heater and Thermostat — These controls are field wired from a separate power source as shown in Fig. 3. During machine shutdown, keep heater energized to maintain 140 - 145 F (60 - 63 C) and minimize refrigerant absorption by the oil.

Remote Start/Stop Controls — A remote device, such as a time clock, may be used to start and stop the machine. However, the device should not be programmed to start the machine in excess of 3 times in 12 hours. Any attempt to do so will result in a failure to start and the display of code 41 indicating the reason. A reset will be required to override the 3 manual start/12-hour counter.

Spare Safety Inputs — Normally closed digital inputs for additional field-supplied safeties may be wired to the spare protective limits input channel in place of the factory-installed jumper. (Wire multiple inputs in series.) The opening of any contact will result in a safety shutdown and display of code 79.

Pumpout Unit Controls — Include ON-OFF switch, 3-amp fuse, compressor overloads and internal thermostat, compressor contactor, refrigerant high-pressure cutout. The high-pressure cutout is factory set to open at 161 ± 5 psig (1110 ± 35 kPa). Pumpout unit fused-disconnect is field supplied. (See Fig. 4.)

Start-Up Sequence

MANUAL START-UP is initiated external to the microprocessor. Manual start-up can be initiated after the internal 15-minute start-to-start and 3-minute stop-to-start inhibit timers have expired by positioning the L/R switch to local and depressing the START pushbutton, or by positioning the L/R switch to remote and closing the remote start/stop device contact. The controller will perform a series of prestart checks to verify that all safeties are within limits shown in Table 1. If the checks are successfully completed, the evaporator water pump relay will be energized; 5 seconds later the condenser water pump relay will be energized; one minute later, the controller will begin monitoring the evaporator and condenser flow switch contacts and will

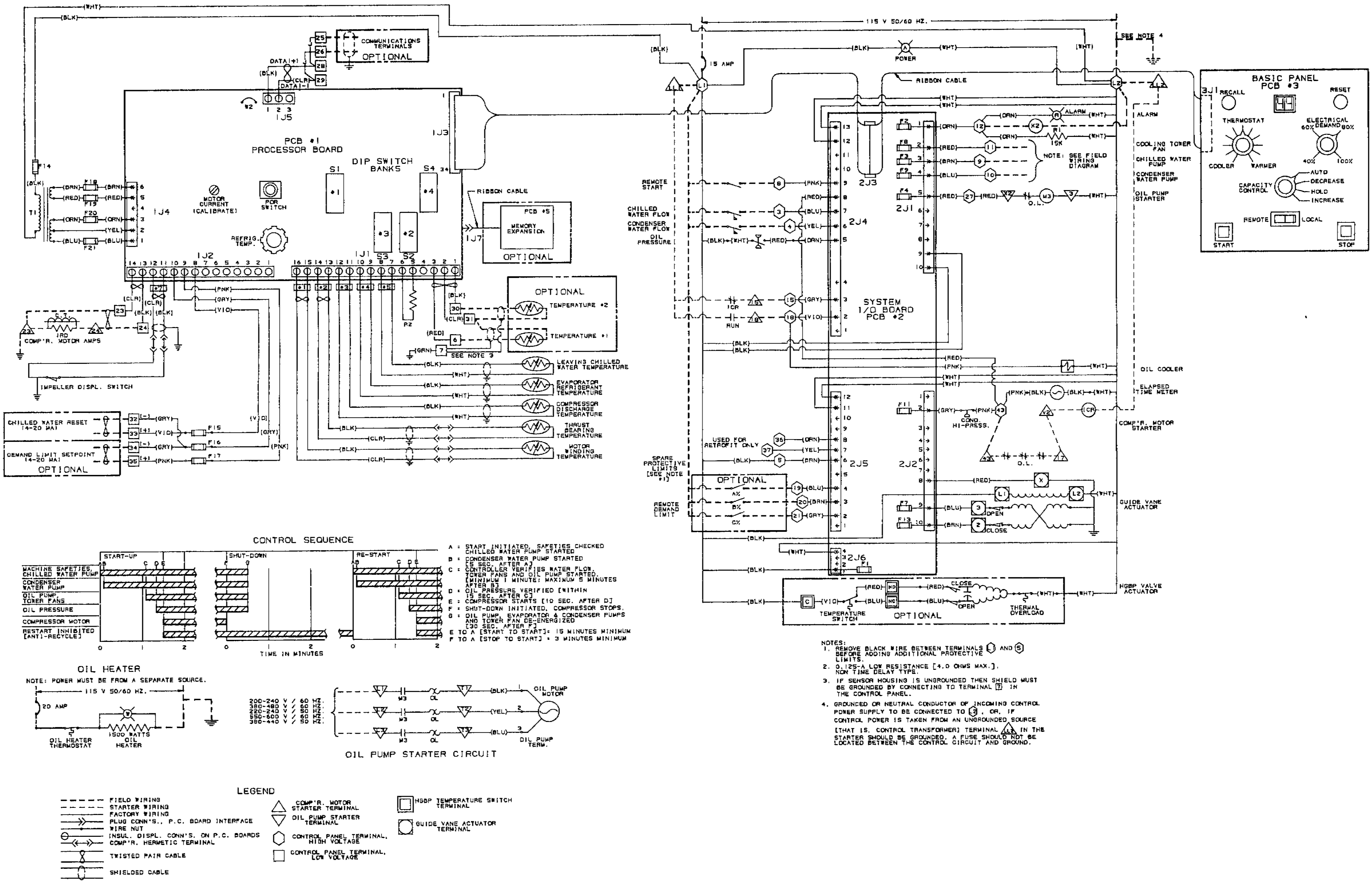


Fig. 3 — Control Wiring Schematic

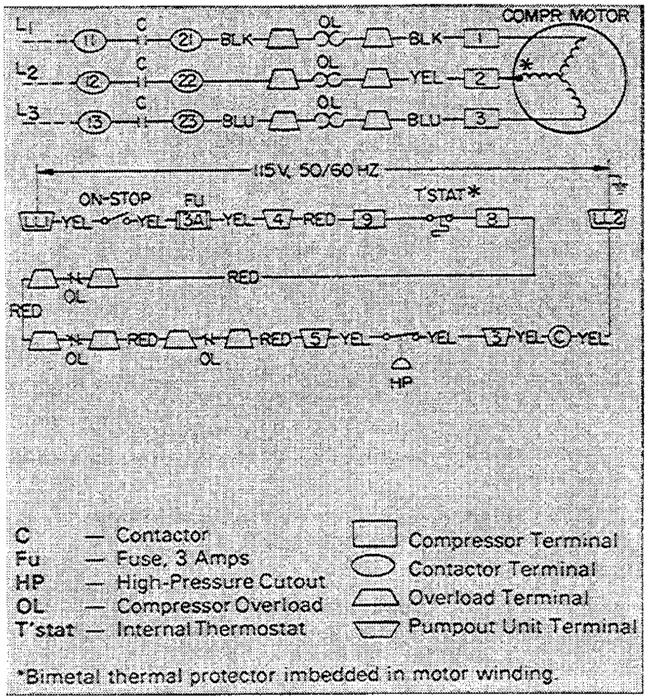


Fig. 4 — 19EB Pumpout Unit Wiring Schematic

wait up to 5 minutes to verify closure. Once flows are verified, the tower fan relay will be energized; if the oil pressure switch contact is open, the oil pump relay will be energized and the controller will wait up to 15 seconds for verification of oil pressure via contact closure. *Failure to verify any of the requirements up to this point will result in the controller aborting the start and displaying the applicable prestart failure code. Any failure after the compressor start relay (1CR) is energized results in a safety shutdown and display of the applicable shutdown status code.* A prestart failure does not advance the 3 manual starts/12-hour counter. Ten seconds after verification of oil pressure, the controller will energize the elapsed time meter and the 1CR relay and wait up to 2 seconds for verification of starter contact closure via 1CR auxiliary contact opening. After verification, the controller advances the 3 manual starts/12-hour counter; initializes the internal 15-minute start-to-start inhibit timer; monitors the condenser high-pressure switch contact for closure; and monitors motor acceleration time and, if applicable, starter transition time for enactment within the time limits specified in Table 1. If successful, the machine enters the run mode. See Control Sequence, Fig. 5.

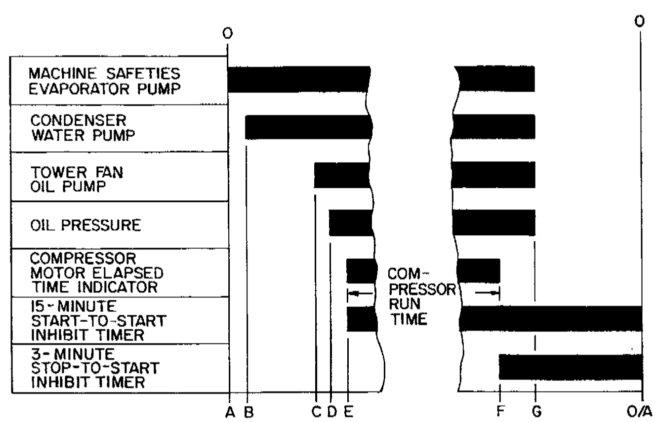
RECYCLE START-UP — A recycle start-up will be automatically activated by the microprocessor following a recycle shutdown when the leaving chilled water or brine temperature has risen more than 5 F (2.8 C) above the set point and the 15-minute and 3-minute internal start inhibit counters have expired. With the exception of initiating a fixed 0.625 F/minute (0.347 C/minute) ramp loading rate during start-up and not advancing the 12-hour starts counter at start-up, a recycle start-up sequence is identical to a manual start-up sequence.

Shutdown Sequence

MANUAL SHUTDOWN is initiated external to the microprocessor. Manual shutdown will be initiated any time the STOP pushbutton is depressed, regardless of the position of the L/R switch. However, if the STOP pushbutton is depressed with the L/R switch in remote, this will be considered a safety shutdown and will require a manual reset. A manual remote shutdown is initiated if the L/R switch is positioned in remote and the remote start/stop device contact opens.

The controller implements a shutdown by de-energizing the 1CR relay and monitoring it for deactivation. If 1CR does not deactivate within one second after de-energization, the controller closes the guide vane, energizes the safety alarm and displays the applicable diagnostic code. Oil pump, water pumps and tower fan relays remain energized.

If 1CR relay deactivation is verified, the controller initializes the 3-minute internal stop-to-start inhibit timer; energizes the guide vane close output; and 30 seconds later, de-energizes the oil pump, condenser water pump, evaporator pump, and tower fan relays. See Control Sequence, Fig. 5.



- **A** — Start initiated — prestart checks made, evaporator pump started.
- **B** — Condenser water pump started (5 seconds after A).
- **C** — Water flows verified — tower fan and oil pump started (one minute minimum; 5 minutes maximum after B).
- **D** — Oil pressure verified (one second minimum; 15 seconds maximum after C).
- **E** — Compressor motor starts — 15-minute inhibit timer starts, elapsed time indicator starts (10 seconds after D).
- **F** — Shutdown initiated — compressor motor stops, elapsed time indicator stops, 3-minute inhibit timer starts.
- **G** — Oil pump, tower fan, evaporator and condenser water pumps de-energized.
- **O/A** — Restart permitted (both inhibit timers expired) (minimum 15 minutes after E and minimum 3 minutes after F).

Fig. 5 — Control Sequence

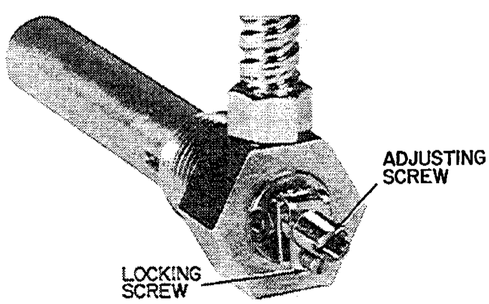
Table 1 — Safety Limits and Control Settings

ANALOG SAFETY CONTROL LIMITS

CONTROLLED PARAMETER	LIMIT	APPLICABLE SETTING/COMMENTS
Compressor Discharge Temperature	⩾ 220 ± 10F (104 ± 5.6C)	Preset, configure DIP switch for analog sensor.
Evaporator Refrigerant Temperature	⩽ 33F (0.56C) (for water chilling)	Preset, configure DIP switch for water chilling.
	⩽ 1°F (0.56C) below design refrigerant temperature [set point adjustable from −20 to 35F (−28.9 to 1.67C) for brine chilling]	Configure DIP switch for brine chilling. Adjust set point during field test with refrigerant temperature set point potentiometer on processor board. Set point will be displayed and updated on LCD.
Motor Winding Temperature	⩾ 220 ± 10F (104 ± 5.6C)	Preset, configure DIP switch for analog sensor.
Thrust Bearing Temperature	⩾ 220 ± 10F (104 ± 5.6C)	Preset, configure DIP switch for analog sensor.
Starter Acceleration Time (Determined by decrease in inrush current below 100% RLA)	> 45 ± .5 sec	For machine with reduced voltage (wye/delta) starter. Preset, based on machine and starter type. Selected with DIP switches.
	> 10 ± .5 sec	For machine with full-voltage (X-line) starter. Preset, based on machine and starter type. Selected with DIP switches.
Starter Transition Time	> 90 ± .5 sec	For machine with reduced inrush starter. Preset, based on machine and starter type. Selected with DIP switches.
Line Voltage Loss	< 57.5 volts ± 5% for one cycle	
High-Line Voltage	> 135.7 volts ± 3% for one minute	Preset, based on 115-v control center voltage supply and line frequency. Selected with DIP switch.
Low-Line Voltage	< 94.3 volts ± 3% for one minute	

MECHANICAL SAFETY LIMITS AND CONTROL SETTINGS

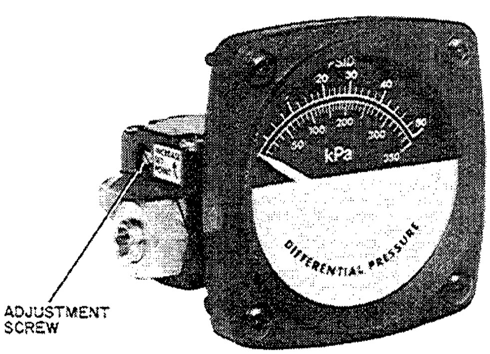
Oil Heater Thermostat (See Fig. 1.)



Set the oil heater thermostat to maintain oil reservoir temperature of 140 - 145F (60 - 63C) at machine shutdown.

NOTE: When altering set point, turn adjusting screw in small increments counterclockwise to raise set point; clockwise to lower set point.

Oil Low-Pressure Cutout (See Fig. 2.)

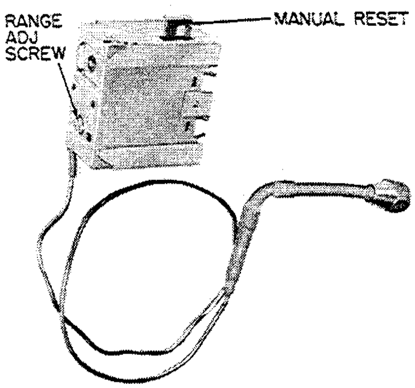


Switch is part of oil pressure gage assembly. Unscrew switch/gage assembly from the gage panel to gain access.

Reduce unishell pressure to 0 psig (0 kPa). Then disconnect switch pressure connections and check setting with a metered supply of air.

Switch should close at 17 ± 1 psi (117 ± 6.9 kPa) differential between reservoir pressure connection and oil pressure connection. Switch should open when pressure is reduced to 13 ± 1 psi (90 ± 6.9 kPa) differential.

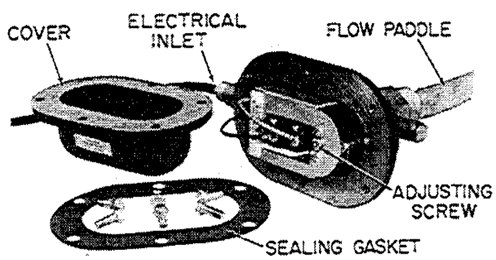
Condenser High-Pressure Cutout (See Fig. 2.)



Reduce unishell pressure to 0 psig (0 kPa). Disconnect switch pressure connections and check with metered supply of air.

Switch should trip at 161 ± 5 psig (1110 ± 35 kPa). Reduce pressure and check for manual reset at 130 ± 7 psig (896 ± 48 kPa).

Flow Switches (Field Supplied)



Operate water pumps with machine off. Manually reduce water flow and observe switch for proper cutout. Safety shutdown occurs when cutout time exceeds 5 seconds.

Table 2 — Capacity Override Set Points

OVERRIDE CONTROL	1ST-STAGE SET POINT	2ND-STAGE SET POINT	OVERRIDE TERMINATION
Low Refrigerant Temperature	⩽ 1°F (0.56 C) Above Trip Limit	⩽ 0.5 F (0.28 C) Above Trip Limit	> 1°F (0.56 C) Above Trip Limit
High Motor Temperature	⩾ 200 F (93.3 C)	⩾ 210 F (98.9 C)	< 200 F (93.3 C)
Motor Current Demand Limit	⩾ 100% of Set Point	⩾ 105% of Set Point	< 100% of Set Point

RECYCLE SHUTDOWN — A recycle shutdown is automatically initiated by the microprocessor during the run mode whenever the leaving chilled water or brine temperature is more than 5 F (2.8 C) below the set point or within 3 F (1.67 C) of the low refrigerant temperature set point. With the exception of de-energizing the evaporator pump relay, the recycle shutdown sequence is identical to the manual shutdown sequence.

SAFETY SHUTDOWN — A safety shutdown is identical to a manual shutdown with the exception that a diagnostic code indicating the reason for the shutdown will be displayed on the LCD and stored in volatile memory for recall. A safety shutdown requires a safety reset to put the machine back into operation.

Control Configuration — The microprocessor control program is configured by 4 DIP switch banks located on the processor board (Fig. 2). Each switch bank consists of 8 two-position switches protected by a plastic cover. Each switch must be set to the ON or OFF position according to function and description as outlined in Table 3. To identify an individual DIP switch, note switch bank number and switch position on bank. Always replace plastic cover after configuration is completed.

Controls Test — The controls test is a 34-step program that utilizes the LCD on the S/D board. The test verifies microprocessor controller inputs and outputs by exercising or displaying the status of peripheral control devices. The test can be initiated any time the machine is not operating by positioning the L/R switch to local and depressing the POR pushbutton. The LCD will show 03 minutes.

⚠ WARNING

Never depress the POR pushbutton while the machine is operating. Serious damage may result.

⚠ CAUTION

Depressing the POR pushbutton causes a system reset and a loss of all volatile memory. Always recall and record shutdown code history before initiating a POR.

To enter the test mode, depress the reset pushbutton within 10 seconds after POR pushbutton has been depressed. The number of the first test step (0.1) will be displayed. (For each test step, the reset pushbutton must be depressed twice. The first depression displays the number of the test step. The second depression displays the results of exercises the command for the test step number.) The results of test step number 0.1 is the display of 88. This test confirms if the elements in the LCD are operable. The test step is distinguished from the test results by a decimal point between the 2 digits in the test step number (i.e., the test step number is always a decimal fraction and the test step result is always a whole number [integer]). Flashing of a test results integer indicates a negative value. Successive depressions of the reset pushbutton will display the test numbers and results of the remaining steps as outlined in Table 4.

To recheck a step while in the test mode, the test can be reinitiated with the POR and reset pushbuttons or the program can be recycled by advancing past the last test step number (3.4) and back to the desired test step number by depressing the reset pushbutton in succession.

To exit the controls test program, depress the POR pushbutton and allow the time on the display to decrease until it goes blank (time 0).

Table 3 — Configuration (DIP) Switch Settings

SWITCH BANK	SWITCH POSITION	SWITCH FUNCTION	SWITCH STATUS	CONFIGURATION DESCRIPTION
1	1	Machine Type	Off On	19EB Other
	2	Machine Type	Off On	19EB Other
	3	Leaving Chilled Water or Brine Temperature Deadband	Off On	1°F (0.56 C) Deadband 2 F (1°C) Deadband*
	4	Leaving Chilled Water or Brine Temperature Proportional Band	Off On	5 F (2.8 C) Proportional Band* 15 F (8.3 C) Proportional Band
	5	Line Frequency	Off On	60 Hz 50 Hz
	6	Starter Type	Off On	Reduced Voltage (Wye/Delta) Full Voltage (X-Line)
	7	Motor Winding Sensor Type	Off On	Analog (19EB) Digital (Other)
	8	Thrust Bearing Sensor Type	Off On	Analog (19EB) Digital (Other)
2	1,2,3	Controller Identification Number (Optional configuration used as communications address when optional engineer's services panel is used.)	 Off-Off-Off On-Off-Off Off-On-Off On-On-Off Off-Off-On On-Off-On Off-On-On On-On-On	Identification Number 0 1 2 3 4 5 6 7
	4	LCD Temperature Read-Out (F/C)	Off On	°F Display °C Display
	5,6,7,8	N/A	N/A	N/A
3	1	Chilled Medium	Off On	Water Brine
	2,3,4,5	Not Applicable	N/A	N/A
	6,7,8	Ramp Loading Rate (Pulldown or Soft Loading)	 Off-Off-On On-Off-Off Off-On-Off On-On-Off Off-Off-Off On-Off-On Off-On-On On-On-On	°F/Minute (°C/Minute) 0.38 (0.21) 0.75 (0.42) 1.13 (0.63) 1.5 (0.83) 2.25 (1.25)* 3.00 (1.67) 5.25 (2.92) 10.50 (5.83)
4	Spare	Spare	N/A	N/A

N/A — Not Applicable

*Recommended setting for average conditions.

Table 4 — Controls Test

STEP NUMBER	TEST DESCRIPTION	DISPLAY CODE
0.1	Display 88 to verify proper operation	88 — OK XX — Faulty
0.2	Display set point of evaporator refrigerant temperature	33 — Water XX — Brine Temperature (adjust with refrigerant temperature set point potentiometer and note set point displayed in LCD).
0.3	Display % RLA of compressor motor current	0 — OK XX — Faulty Calibration (Adjust motor current zero potentiometer and note on LCD.)
0.4	Display controller identification number (00 to 07)	XX — Confirm
0.5	Display leaving chilled water sensor input status	1 — OK 0 — Faulty
0.6	Display condenser refrigerant sensor input	1 — OK 0 — Faulty
0.7	Display compressor discharge sensor input status	1 — OK 0 — Faulty
0.8	Display evaporator refrigerant temperature sensor input status	1 — OK 0 — Faulty
0.9	Display motor winding sensor input status	1 — OK 0 — Faulty 2 — Faulty Configuration
1.0	Display thrust bearing sensor input status	1 — OK 0 — Faulty 2 — Faulty Configuration
1.1	Display leaving chilled medium set point potentiometer input status	1 — OK 0 — Faulty
1.2	Display demand limit set point potentiometer input status	1 — OK 0 — Faulty
1.3	Display configuration status	2 — OK 0 or 1 — Faulty Configuration
1.4	Energize oil pump starter relay*	14 — Response (Confirm)
1.5	Energize leaving chilled water pump starter relay*	15 — Response (Confirm)
1.6	Energize condenser water pump starter relay*	16 — Response (Confirm)
1.7	Energize tower fan starter relay*	17 — Response (Confirm)
1.8	Not applicable	18 — No Response
1.9	Not applicable	19 — No Response
2.0	Energize increase guide vane position digital output*	20 — Response (Confirm)
2.1	Energize decrease guide vane position digital output*	21 — Response (Confirm)
2.2	Not applicable	22 — No Response
2.3	Energize alarm output indicating safety limit has been exceeded*	23 — Response (Confirm)
2.4	Display configuration status	1 — OK 0 — Faulty Configuration
2.5	Display configuration status	1 — OK 0 — Faulty Configuration
2.6	Display configuration status	0 — OK 1 — Faulty (Check Automatic Dehydrator Switch)
2.7	Display impeller displacement switch status	1 — OK (Closed) 0 — Faulty (Open)
2.8	Display spare safety input status	1 — OK (Closed) 0 — Faulty (Open)
2.9	Display chilled water flow switch contact status	1 — OK — Open, Pump Off (Confirm) 0 — Closed — Pump On (Confirm)
3.0	Display condenser water flow switch contact status	1 — OK — Open, Pump Off (Confirm) 0 — Closed — Pump On (Confirm)

*Energize command can be cancelled by depressing reset pushbutton within one second after test number is displayed.

Table 4 —Controls Test (cont)

STEP NUMBER	TEST DESCRIPTION	DISPLAY CODE
3.1	Display oil pressure switch status	1 — OK (Open) 0 — Faulty (Closed)
3.2	Display 1CR auxiliary contact status	1 — OK (Closed) 0 — Faulty (Open)
3.3	Display starter run contact	1 — OK (Open) 0 — Faulty (Closed)
3.4	Cycle back to first test (depress reset pushbutton)	0.1
	End controls test (depress POR pushbutton)	03 Minutes

BEFORE INITIAL START-UP

Job Data Required

1. List of applicable design temperatures and pressures (product data submittal).
2. Machine assembly, wiring and piping diagrams.
3. Starting equipment details and wiring diagrams.
4. Diagrams and instructions for special controls.
5. 19EB Installation Instructions.

Equipment Required

1. Mechanic's tools (refrigeration).
2. Digital volt-ohmmeter (DVM) and clamp-on ammeter.
3. Electronic leak detector.
4. Absolute pressure manometer or wet-bulb vacuum indicator.
5. Vacuum pump with capacity of at least 5 cfm (2.4 L/s).
6. 500-v insulation tester (megohmmeter) for compressor motors with nameplate voltage of 600 volts or less, or a 5000-v insulation tester for compressor motors with nameplate voltage above 600 volts.

Check Machine Tightness — Carrier ships the 19EB chiller with the refrigerant charge in the utility vessel (Fig. 1) and a holding charge of 10 psig (69 kPa) in the unishell. Several levels of leak testing may be required, depending upon the condition of the chiller on arrival and at the time of initial start-up.

Check utility vessel tightness first and then check the unishell and compressor. In some cases the utility vessel must be rechecked following the unishell test. The proper sequence and procedures for leak testing are outlined in Fig. 6. For refrigerant transfer and vessel evacuation, see Pumpout Procedures. Standing vacuum test and machine dehydration procedures are described in the following sections. *Retighten all gasketed joints before leak testing.*

If the machine is spring-isolated, keep all springs blocked in both directions to prevent possible piping stress and damage when refrigerant is transferred from vessel to vessel during the leak testing process. Adjust springs when refrigerant is in operating condition and water circuits are full.

CHECK MACHINE CONDITION — Determine utility vessel pressure by attaching an accurate 30″-0-200 psi gage (–101.3 to 1379 kPa gage) or vacuum indicator at one of the locations in Table 5.

The cooler gage on the machine control center (Fig. 1 and 2) shows the unishell/compressor pressure.

Compare the cooler gage reading with the reading taken at machine installation. Allow for any change in ambient temperature (approximately 1 psi [6.9 kPa] increase for each 20 F [11.0 C] increase in temperature).

Make all leak tests with an electronic leak detector.

When performing the standing vacuum test or machine dehydration, use a manometer or wet-bulb vacuum indicator; dial gages do not indicate the small amount of leakage acceptable during a short period of time.

CHECK SAFETY CONTROL SETTINGS — During leak testing, unishell pressure sometimes reduces to 0 psig (0 kPa) during the testing process. This may be a convenient time to check the oil low-pressure cutout and condenser high-pressure cutout described in Table 1.

If checked at this time, tag each switch with the setting values and the checking date.

LEAK TEST THE MACHINE — Follow the sequence and procedures given in Fig. 6. Figures 1 and 7 show valve numbers and locations.

PROCEDURE A — Test Unishell Side (as specified in Fig. 6).

1. Raise unishell pressure to 45 psig (310 kPa), following steps 1 through 5 of Return Refrigerant to Normal Operating Conditions.
2. Check unishell, compressor and piping for leaks, using a halide or electronic leak detector.
3. If no leak is found, perform remaining steps of Return Refrigerant to Normal Operating Condition. Retest for leaks.
4. → If leak is found in step 2 or 3 above, pump refrigerant gas back into utility vessel as follows:
   a. Turn on pumpout condenser water.
   b. Open valves 1, 3, 4, 6, 38 and pumpout compressor service valves.

VALVE NO.	1	2	3	4	5	6	26	27	28	29	30	32
CONDITION		C			C		C	C	C	C	C	C

c. Run pumpout compressor until machine pressure is reduced to 0 psig (0 kPa) if leak can be fixed quickly. If leak will take more than a minute or two to repair, continue removing refrigerant gas until the machine pressure is reduced to between 20 and 25 in. Hg (–6.7 and –84.7 kPa).
d. Repair leak and perform leak test to ensure repair.
e. If nitrogen was added in Step c, raise unishell pressure to 45 psig (310 kPa) with nitrogen and an HCFC or HFC refrigerant tracer. Test the repaired area.
f. Evacuate vessel if it is leak tight.
g. If nitrogen was not added in Step c, return to Step 1.

→ PROCEDURE B — Retest Utility Vessel (as specified in Fig. 6).

1. If the leak can be found quickly, follow the pumpout procedure shown in the Transfer Refrigerant from Utility Vessel to Unishell section on page 31 to reduce the utility vessel pressure to 0 psig (0 kPa). If leak will take more than a minute or two to repair, continue removing refrigerant gas until the vessel pressure is reduced to between 20 and 25 in. Hg (–67.7 and –84.7 kPa). Break vacuum with nitrogen.
2. Use the following procedures to repair the leak:
   a. Repair leak and perform leak test to ensure repair.
   b. If nitrogen was added in Step 1, raise utility vessel pressure to 45 psig (310 kPa) with nitrogen and HCFC or HFC refrigerant tracer. Test the repaired area.
   c. Evacuate vessel if it is leak tight and proceed to Step 3.
   d. If nitrogen was not added in Step 1, proceed to Step 3.
3. Valve refrigerant gas back into utility vessel as follows:
   a. Open valves 1, 3 and 6.
   b. Slowly open valve 5.

VALVE NO.	1	2	3	4	5	6	26	27	28	29	30	32
CONDITION		C		C			C	C	C	C	C	C

4. When utility vessel pressure reaches 45 psig (310 kPa), close valve 5 and check for leak with halide or electronic leak detector.
5. If leak persists, repeat procedure. If leak has been repaired, follow procedure. See Return Refrigerant to Normal Operating Conditions.

Standing Vacuum Test

1. Attach an absolute pressure manometer or wet-bulb vacuum indicator to the affected vessel as indicated in Table 5. Dial gages cannot register the small amount of leakage acceptable during a short period of time.
2. Evacuate the vessel (see Pumpout Procedures) to 22 in. Hg vac (–74 kPa), ref 30-in. bar. (4.0 psia) (28 kPa), using vacuum pump or pumpout unit.
3. Valve off pump to hold vacuum and record the manometer or indicator reading.
4. If leakage rate is less than 0.05 in. Hg (.17 kPa) in 24 hours, the vessel is sufficiently tight.
5. If the leakage rate exceeds 0.05 in. Hg (.17 kPa) in 24 hours, repressurize the vessel and test for leaks. Use nitrogen and refrigerant tracer. Raise the vessel pressure in increments until leak is detected. Limit the leak test pressure to 140 psig (965 kPa) maximum.
6. Repair leak, retest and proceed with dehydration.

Machine Dehydration is recommended if the machine has been open for a considerable period of time, or machine is known to contain moisture, or unishell holding charge or utility vessel refrigerant charge has been completely lost.

⚠ WARNING

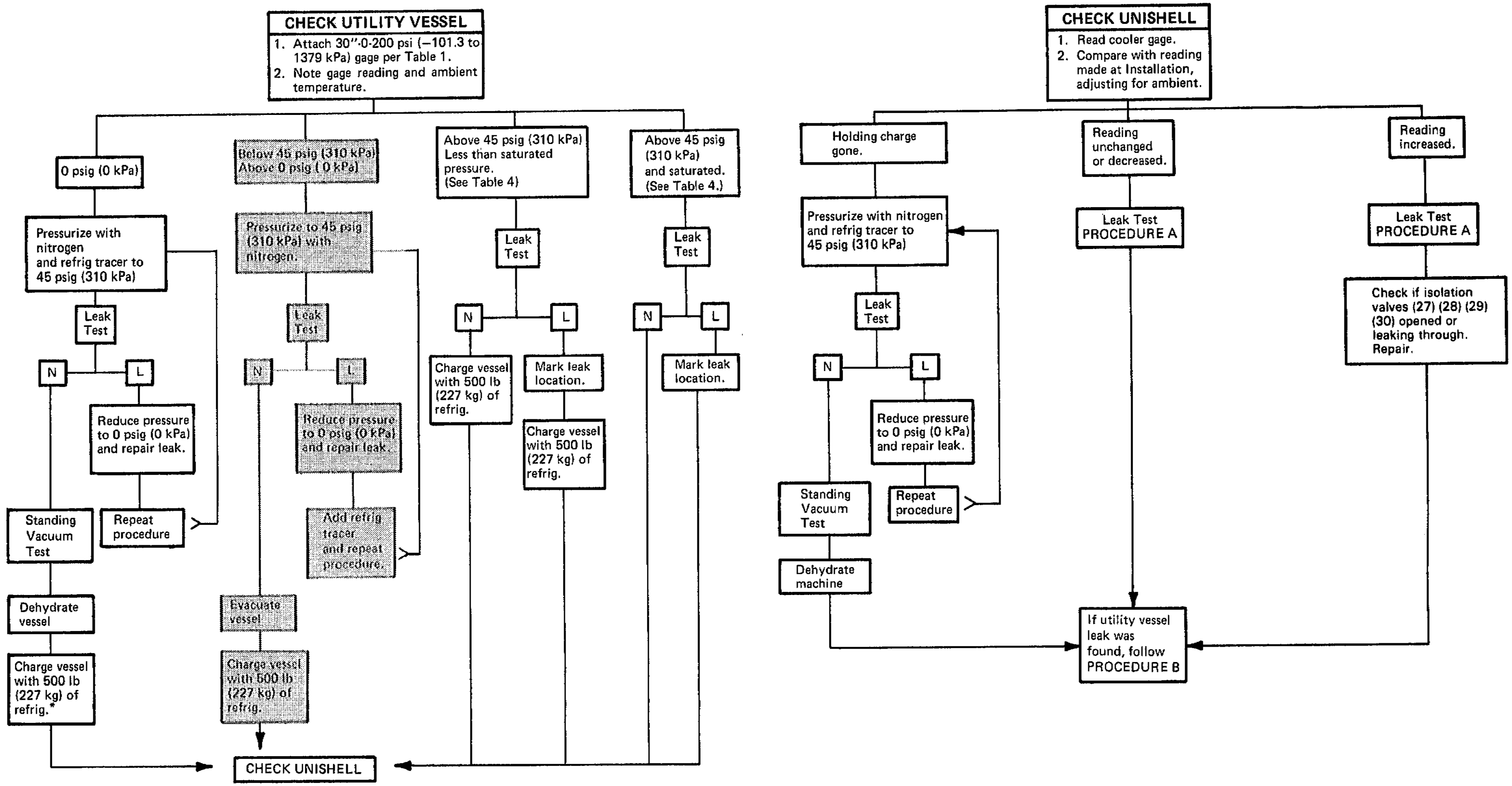
Do not start compressor or oil pump, even for a rotation check, while machine is under dehydration vacuum. Insulation breakdown and severe damage may result.

Table 5 — Gage and Pressure Connections for Pressurizing or Evacuation

TO CHECK OR SERVICE	VACUUM OR PRESSURE CONNECTIONS (See Notes 1 and 2.)			
	Indicator		Service Line	
	With Pumpout	Without Pumpout	With Pumpout	Without Pumpout
UNISHELL	Purge Valve 35.	Purge Valve 35.	Tee at valve 6.	Valve 1.
UTILITY VESSEL	Valve 26, or field-installed tee in service line.	Valve 26, or field-installed tee at valve 6.	Tee at valve 6.	Valve 6.
ENTIRE MACHINE	Purge Valve 35.	Purge Valve 35.	Valve 26, or tee at valve 6. (Open valves 27,28,29 and 30.)	Valves 1 and/or 6. (Open valves 27,28,29 and 30.)

NOTES:
1. See Fig. 1 for valve location. Valve number is same as item number in Fig. 1.
2. Connection size:

NUMBER	SIZE
1	½-in. ODS
6	½-in. male flare
26	½-in. male flare
35	⅜-in. male flare
tee	⅜-in. FPT



*This refrigerant may be used to raise unishell to saturated pressure during unishell leak test.

At ambient temperatures below 50 F (10 C) refrigerant saturation pressure may be less than 45 psig (310 kPa). Do not apply SHADED AREA procedure unless condition (over 0 psig [0 kpa] less than 45 psig [310 kPa] still exists when machine ambient is raised above 50 F [10 C]).

LEGEND

L — Leak detected

N — No leak detected

NOTES:
1. Use electronic leak detector.
2. For detailed instructions, see Refrigerant Leak Testing.

Fig. 6 — 19EB Leak Test Procedures

At low room temperatures, dehydration becomes extremely difficult and special techniques must be applied. 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 [24 L/s] or larger is recommended) to the machine as indicated in Table 5.
2. Use an absolute pressure type manometer or a wet-bulb vacuum indicator to measure vacuum. Open the shutoff valve to the vacuum indicator only when taking a reading. Then leave the valve open for 3 minutes or so to allow the indicator vacuum to equalize with machine vacuum.
3. Open isolation valves 27, 28, 29 and 30 if the entire machine is to be dehydrated.
4. With machine ambient at 60 F (15.6 C) or higher, operate the vacuum (dehydration) pump until the manometer reads 29.8 in. Hg vac (-100.6 kPa gage), ref 30-in. bar. (0.20 in. Hg abs) (0.7 kPa) or the vacuum indicator reads 35 F (1.7 C). Operate pump for 2 more hours.

   Do not apply greater vacuum than 29.82 in. Hg vac (-100.7 kPa gage), ref 30-in. bar. (0.18 in. Hg abs) (0.6 kPa) or go below 33 F (0.6 C) on wet-bulb vacuum indicator. At this temperature/pressure, isolated pockets of moisture can turn into ice. The slow rate of evaporation (sublimation) of ice at low temperature greatly retards dehydration.
5. Valve off vacuum pump; stop pump; record instrument reading.
6. After a 2-hour wait, take another instrument reading. If reading has not changed, dehydration is complete. If reading indicates vacuum loss, repeat steps 4 and 5.
7. If reading continues to change after several dehydration attempts, check for leaks by charging vessel with dry air or nitrogen and refrigerant tracer to a maximum of 140 psig (965 kPa). Locate and repair leak, and repeat dehydration.

Inspect Piping — Refer to the piping diagrams provided in the job data. Inspect piping to cooler, condenser, oil cooler, pumpout system and relief devices. Be sure that flow directions are correct and that all piping specifications are met and piping systems are installed properly, with no stress on water box nozzles or relief devices.

Water flow through cooler and condenser must meet job requirements. Measure pressure drop across cooler and condenser.

Oil cooler water must meet the specifications for cleanliness, flow rate, pressure and temperature specified in the machine Installation Instructions. If city water is used, make sure that drainage is visible. Plug valve (item 36, Fig. 1) on oil cooler is adjusted to provide proper bearing temperature after compressor start.

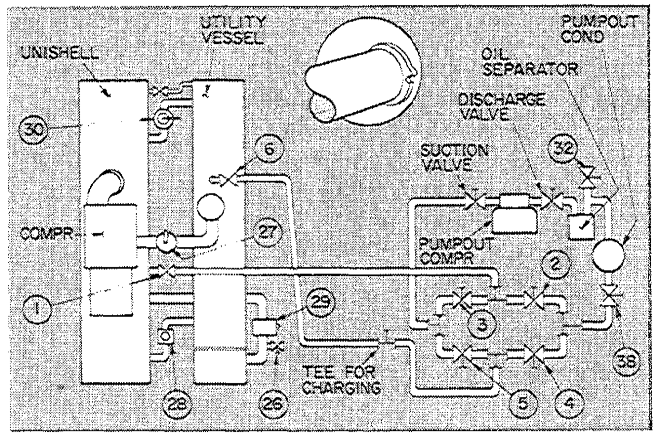


Fig. 7 — Pumpout System Piping Schematic (See Fig. 1 Legend for Item Reference)

Inspect Wiring

⚠ WARNING

Do not check high-voltage supply (over 600 v) without proper equipment and precautions. Serious injury may result. Follow power company recommendations.

1. Examine wiring for conformance to job wiring diagrams and to all applicable electrical codes.
2. On low-voltage compressors (600 v or less), connect voltmeter across power wires to compressor starter and measure voltage on each phase. Compare reading with voltage rating on compressor and starter nameplates. Readings must be within 1% of nameplate ratings; if not, correct situation or consult power company.
3. Compare ampere rating on starter nameplate with ampere (RLA) rating on motor nameplate. Motor overload relay selection must satisfy electrical code requirements.
4. Starter for centrifugal compressor motor must contain the components and terminals required for refrigeration machine control. Check job data drawings.
5. Check voltage to the following components and compare to nameplate values: oil pump starter and pumpout compressor motor starter.
6. Check 115-v supply to control center and separate 115-volt supply to oil heater.
7. Be sure that fused disconnects or circuit breakers have been supplied for oil pump, oil heater and pumpout unit.
8. Ground electrical equipment and controls in accordance with job drawings and all applicable electrical codes.

9. Make sure customer/contractor has verified proper operation of water pumps, cooling tower fan and associated auxiliary equipment. This includes ensuring that motors are properly lubricated and have proper electrical supply and proper rotation.

⚠ WARNING

Do not apply test voltage of any kind, even for a rotation check, if machine is under dehydration vacuum. Insulation breakdown and serious damage may result.

10. Test machine compressor motor and its power lead insulation resistance with a 500-volt insulation tester such as a megohmmeter. For compressor motors with nameplate voltage higher than 600 v, use a 5000-v tester; start test at 500 v and increase voltage setting after each successful testing until test voltage exceeds nameplate voltage.
    a. *Open starter main disconnect switch.*
    b. With tester connected to the motor side of the starter contactor in the starter, take 10-second and 60-second megohm reading as follows:

       Six-lead motor — Tie all 6 terminals together and test between terminal group and ground. Next, tie terminals in pairs, 1 and 4, 2 and 5, 3 and 6. Test between each pair while grounding the third pair.

       Three-lead motor — Tie terminals 1, 2 and 3 together and test between group and ground.
    c. Divide the 60-second resistance reading by the 10-second reading. The ratio, or polarization index, must be 1.15 to 1 or higher. Both the 10-second and the 60-second reading must be at least 50 megohms.

       If the readings are unsatisfactory, repeat the test at the motor with the power leads disconnected. Satisfactory readings in this second test indicate that the fault is in the power leads.

Check Starter — Before starting the 19EB chiller, *open the main disconnect* and then check starter:

1. Remove contactor arc chutes. Be sure contactors move freely and that shipping string is removed. Replace arc chutes.
2. If starter has been on jobsite for a considerable period, check contactors for dirt and rust. Clean contact magnet surfaces lightly with sandpaper. *Do not sandpaper or file silverplated contacts.* Apply a very thin coat of vaseline to magnet surfaces, then wipe it off. If starter has been in a dusty atmosphere, vacuum clean starter cabinet and wipe with a lint-free cloth.
3. Remove fluid cups from magnetic overload relays. Add dashpot oil to cups per instructions on relay nameplate. Oil is shipped in small vials usually attached to starter frame near relays. Use only the dashpot oil shipped with starter. *Do not substitute.* Overload relays are factory set for 108% of motor full load amperage.
4. Check transfer timer for proper time setting. Starter timers have adjustable ranges of 10 seconds to one minute and are factory set at 30 seconds.
5. With main disconnect switch open, manually open and close compressor start relay (1CR) to be sure it operates freely.

Oil Charge of approximately 15 gallons (57 L) is shipped in the oil reservoir. Check sight glass (item 14, Fig. 1) to be certain oil is visible. If oil must be added, it must meet Carrier's oil specification listed in the section, Change Oil and Oil Filter. Charge oil through the oil reservoir charging valve (item 19, Fig. 1). Use a hand pump to charge the oil against machine pressure.

Oil Heater — Energize the oil heater to minimize absorption of refrigerant by the oil. A light (item 16, Fig. 1) indicates when the heater is energized. Set the oil heater thermostat to maintain a temperature of 140 - 145 F (60 - 63 C) at shutdown.

Refrigerant Charge (Table 6) is shipped in the utility vessel. To prepare the machine for operation, follow the pumpout procedure Return Refrigerant to Normal Operating Conditions, page 33. If refrigerant must be added, charge it through the refrigerant charging valve (26) or the tee near valve 6 (see Fig. 1).

⚠ WARNING

At pressures below those listed in Table 7, liquid refrigerant flashes into a gas and may cause tube freeze-up. Run water pumps and charge refrigerant as a gas until cooler pressure rises above the Table 7 value.

Table 6 — Refrigerant Charging Quantity

SIZE*	WEIGHT R-12		WEIGHT R-500	
	lb	kg	lb	kg
41	2000	907	1784	809
42	2000	907	1784	809
43	2180	989	1945	882
45	2180	989	1945	882
46	2370	1075	2114	959
47	2370	1075	2114	959
51	2600	1179	2319	1052
52	2650	1202	2364	1072
53	2700	1225	2408	1092
55	3000	1361	2676	1214
57	3100	1406	2765	1254
59	3500	1588	3122	1416

*Unishell size — see machine identification plate (see Fig. 1).

Table 7 — Pressures Corresponding to 32 F (0 C) Saturation Temperature

REFRIG	PRESSURE		CHARGE AS GAS UP TO	
	psig	kPa	psig	kPa
R-500	38.04	268	45	310
R-12	30.06	207	35	241

Table 8 — Refrigerant R-12 Temperature vs Pressure (Saturated)

TEMP		PRESSURE		TEMP		PRESSURE		TEMP		PRESSURE	
F	C	psig	kPa	F	C	psig	kPa	F	C	psig	kPa
0	-18	9.15	63.0	40	4.4	36.97	255	90	32.2	99.79	688
2	-16.7	10.18	70.2	41	5.0	37.89	261	92	33.3	103.12	711
4	-15.6	11.24	77.5	42	5.6	38.82	268	94	34.4	106.52	734
6	-14.4	12.34	85.1	43	6.1	39.76	274	96	35.6	110.00	758
8	-13.3	13.47	92.9	44	6.7	40.71	281	98	36.7	113.54	783
10	-12.2	14.64	101	45	7.2	41.68	287	100	37.8	117.16	808
12	-11.1	15.84	109	46	7.8	42.66	294	102	38.9	120.9	834
14	-10.0	17.08	118	47	8.3	43.65	301	104	40.0	124.6	859
16	-8.9	18.36	127	48	8.9	44.65	308	106	41.1	128.5	886
18	-7.8	19.68	136	49	9.4	45.67	315	108	42.2	132.4	913
20	-6.7	21.04	145	50	10.0	46.70	322	110	43.3	136.4	940
21	-6.1	21.73	150	52	11.1	48.80	336	112	44.4	140.5	969
22	-5.6	22.44	155	54	12.2	50.95	351	114	45.6	144.7	998
23	-5.0	23.16	160	56	13.3	53.16	367	116	46.7	148.9	1027
24	-4.4	23.88	165	58	14.4	55.42	382	118	47.8	153.2	1056
25	-3.9	24.61	170	60	15.6	57.74	398	120	48.9	157.6	1087
26	-3.3	25.36	175	62	16.7	60.11	414	122	50.0	162.2	1118
27	-2.8	26.12	180	64	17.8	62.54	431	124	51.1	166.7	1149
28	-2.2	24.88	172	66	18.9	65.02	448	126	52.2	171.4	1182
29	-1.7	27.66	191	68	20.0	67.58	466	128	53.3	176.2	1215
30	-1.1	28.45	196	70	21.1	70.19	484	130	54.4	181.0	1248
31	-0.6	29.25	202	72	22.2	72.86	502	132	55.6	185.9	1282
32	0.0	30.06	207	74	23.3	75.60	521	134	56.7	191.0	1317
33	0.6	30.89	213	76	24.4	78.39	540	136	57.8	196.1	1352
34	1.1	31.72	219	78	25.6	81.25	560	138	58.9	201.3	1388
35	1.7	32.57	225	80	26.7	84.17	580	140	60.0	206.6	1424
36	2.2	33.42	230	82	27.8	87.16	601	142	61.1	212.0	1462
37	2.8	34.29	236	84	28.9	90.22	622	144	62.2	217.5	1500
38	3.3	35.17	242	86	30.0	93.34	644	146	63.3	223.1	1538
39	3.9	36.07	249	88	31.1	96.53	666	148	64.4	228.8	1578

Table 9 — Refrigerant R-500 Temperature vs Pressure (Saturated)

TEMP		PRESSURE		TEMP		PRESSURE		TEMP		PRESSURE	
F	C	psig	kPa	F	C	psig	kPa	F	C	psig	kPa
0	-18.0	13.26	91.4	40	4.4	46.24	319	90	32.2	121.2	836
2	-16.7	14.48	99.8	41	5.0	47.14	325	92	33.3	125.1	863
4	-15.6	15.73	108	42	5.6	48.44	334	94	34.4	129.2	891
6	-14.4	17.03	117	43	6.1	49.35	340	96	35.6	133.3	919
8	-13.3	18.36	127	44	6.7	50.69	349	98	36.7	137.6	949
10	-12.2	19.75	136	45	7.2	51.62	356	100	37.8	141.9	978
12	-11.1	21.18	146	46	7.8	53.01	365	102	38.9	146.3	1009
14	-10.0	22.65	156	47	8.3	53.95	372	104	40.0	150.9	1040
16	-8.9	24.16	167	48	8.9	55.39	382	106	41.1	155.4	1071
18	-7.8	25.72	177	49	9.4	56.34	388	108	42.2	160.1	1104
20	-6.7	27.33	188	50	10.0	57.82	399	110	43.3	164.9	1137
21	-6.1	28.10	194	52	11.1	60.32	416	112	44.4	169.8	1171
22	-5.6	28.99	200	54	12.2	62.87	433	114	45.6	174.8	1205
23	-5.0	29.75	205	56	13.3	65.52	452	116	46.7	179.9	1240
24	-4.4	30.70	212	58	14.4	68.21	470	118	47.8	185.0	1276
25	-3.9	31.47	217	60	15.6	70.96	489	120	48.9	190.3	1312
26	-3.3	32.45	224	62	16.7	73.79	509	122	50.0	195.7	1349
27	-2.8	33.24	230	64	17.8	76.69	529	124	51.1	201.2	1387
28	-2.2	34.26	236	66	18.9	79.67	549	126	52.2	206.7	1425
29	-1.7	35.07	242	68	20.0	82.71	570	128	53.3	212.4	1464
30	-1.1	36.12	249	70	21.1	85.81	592	130	54.4	218.2	1504
31	-0.6	36.94	255	72	22.2	89.01	614	132	55.6	224.1	1545
32	0.0	38.04	262	74	23.3	92.27	636	134	56.7	230.1	1586
33	0.6	38.87	268	76	24.4	95.59	659	136	57.8	236.3	1629
34	1.1	40.01	276	78	25.6	99.0	683	138	58.9	242.5	1672
35	1.7	40.86	282	80	26.7	102.5	707	140	60.0	247.74	1708
36	2.2	42.02	290	82	27.8	106.1	732	142	61.1	254.18	1753
37	2.8	42.89	296	84	28.9	109.7	756	144	62.2	260.73	1798
38	3.3	44.10	304	86	30.0	113.4	782	146	63.3	267.40	1844
39	3.9	44.99	310	88	31.1	117.3	809	148	64.4	274.19	1890

Inspect Guide Vane Linkage, as described in the General Maintenance section, Guide Vane Linkage.

Check Machine Safety Control Settings

> ⚠ **WARNING**
>
> Do not operate machine before safety control settings, configuration switch (DIP switch) settings and controls test have been satisfactorily completed. Protection by safety controls cannot be assumed until all control settings have been confirmed.

ANALOG SAFETY CONTROL SETTINGS — Analog inputs are monitored by the microprocessor to prevent machine operation outside acceptable limits. Most analog safeties have preset limits based on proper DIP switch setting. Follow procedures given in Table 1. Confirm DIP switch settings during controls test and recheck during operation if noted.

MECHANICAL SAFETY AND OPERATING CONTROL SETTINGS — With the exception of the oil heater thermostat and the flow switches, these controls are most conveniently checked with machine off and unishell pressure at 0 psig (0 kPa). If switches are checked during leak test, be sure to tag each switch with setting and date. Follow setting procedures given in Table 1.

Configure DIP Switches — Refer to Control Configuration in Controls section. Using Table 3 (Configuration Switch Settings), position DIP switches according to function and description that match the requirements or best suit the machine's operating duty. Recommended settings for multiple choice selections are identified by an asterisk (*).

Check Safety Control Operation — Check safety control status by performing a controls test. Refer to Controls Test in Controls section. Then check operation by manually tripping safety controls during a trial run condition. As the checks are made, the appropriate diagnostic code should be displayed. After each check, depress the POR pushbutton to override the 15-minute timer and initialize the 3-minute timer.

To operate the machine in a trial run condition:

1. Open disconnects to remove all power from starter and control panel.
2. Disconnect main motor leads from starter and secure. Re-energize starter and control center.
3. Manually trip and reset compressor motor overloads in starter and condenser high-pressure switch.
4. Start pumps (if not automatic) and start machine. After machine enters ramp loading (code 29), check each safety as follows and observe display for proper safety shutdown diagnostic code.
   a. Open oil pump disconnect (code 65).
   b. Manually trip condenser high-pressure switch, reset before next test (code 73).
   c. De-energize chilled water or brine pump (code 70).
   d. De-energize condenser water pump (code 71).
   e. If installed, manually trip spare safety or safeties (code 79). Reset if required.
   f. Simulate a welded starter contact condition: De-energize control center and install a temporary switch between L1 and terminal 18 in control center. Open switch and re-energize control center. Depress START pushbutton and wait until guide vane opens part way. Close switch and depress STOP pushbutton; guide vane should be driven closed, alarm should energize and diagnostic code 77 should be displayed. Oil pump, water pumps and tower fan should remain energized.
5. After compressor stops, de-energize control center, remove temporary switch and replace motor leads from starter.

INITIAL START-UP

Preparation — Before starting machine, check that:

1. Power is on to main starter, oil pump starter, water pump starters, tower fan starter, oil heater and machine control center.
2. Cooling tower water is at proper level and temperature.
3. Machine is charged with refrigerant and all refrigerant valves are in the normal operating position (see Pumpout Procedures).
4. Oil is visible in reservoir sight glass.
5. Oil reservoir temperature is 140 to 150 F (60 to 66 C).
6. Oil cooler plug valve (item 36, Fig. 1) is partially open.
7. Valves in evaporator and condenser water circuits are open. NOTE: If pumps are not automatic, make sure water is circulating properly.

> ⚠ **WARNING**
>
> Do not permit water or brine warmer than 100 F (38 C) to flow through cooler. Refrigerant overpressure may actuate relief valves and result in loss of refrigerant charge.

Start-Up — Set capacity control switch at HOLD. Depress machine START pushbutton. Compressor starts after prestart sequence is completed and oil pump has operated about 20 seconds (see Control Sequence). As compressor motor begins to turn, check for clockwise motor rotation through motor end bell sight glass. Let compressor come up to speed. Note oil differential pressure gage reading; it should be 20 to 25 psid (138 to 172 kPa).

Depress STOP pushbutton and listen for any unusual sounds from the compressor as it coasts to a stop.

If rotation is not clockwise (as viewed through sight glass), reverse power leads on any 2 of 3 phases entering the motor starter and recheck rotation.

⚠ CAUTION

Do not check motor rotation during coastdown; rotation may reverse during equalization of vessel pressures.

Calibrate Motor Current Demand

1. Place ammeter on line motor load current transformer on the motor side of power factor correction (if provided). Start compressor and establish a steady motor current value between 50% and 99% RLA by manually opening guide vane (set capacity control at INC while gradually adjusting thermostat towards cooler). Do not exceed 105% of nameplate RLA. NOTE: Above 99% RLA, display blinks because actual value cannot be shown.
2. Set capacity control at HOLD; % RLA will be displayed. Measure motor current at selected condition and calculate its percentage of RLA using nameplate RLA rating.

   $$\% \text{ RLA} = \frac{\text{Measured Current}}{\text{Nameplate RLA}} \times 100$$

3. Compare percentage calculated with percentage displayed on LCD.

   If percentage displayed does not match percentage calculated, use calibration tool provided in service packet to adjust motor current calibration potentiometer; turn clockwise to increase or counterclockwise to decrease display reading until display matches calculated percentage.

   NOTE: When adjusting motor current calibration potentiometer, allow for a time lag of several seconds caused by feedback capacitance in the motor current circuit.

4. Check the foregoing motor current calibration with machine under AUTO. control as follows:
   a. Allow machine to operate and stabilize near full load in AUTO. Set capacity control to HOLD and note percent current displayed.
   b. Close guide vane manually (capacity control at DEC) and set demand limit below value noted on display in step a.
   c. Turn capacity control to AUTO. Guide vane should stop opening at electrical demand setting in b; if not, note direction of error and repeat calibration procedure.

If control cannot be calibrated with above procedure, check voltage signal and signal resistor in starter. At 100% RLA, voltage between terminals $\boxed{23}$ and $\boxed{24}$ inside control center must be 0.5 ± .01 volts. If voltage is not within this range, check sizing of signal resistor and current transformer in starter.

Check Machine Operating Condition — Be sure machine temperatures, pressures, water flows and oil and refrigerant levels indicate that the system is functioning properly. Refer to Check Running System in the Operating Instructions section.

Trim Refrigerant Charge — To adjust the refrigerant charge to obtain optimum machine performance, refer to Trimming Refrigerant Charge in the General Maintenance section.

INSTRUCT THE CUSTOMER OPERATOR

Be sure that the operator carefully reads and understands all operating and maintenance instructions. Point out the various machine components and explain their functions.

Compressor-Motor Assembly — Guide vane, actuator motor and linkage, motor cooling system, transmission, temperature sensors.

Unishell — Cooler, condenser, isolation valves, relief valves, water circuits, vents and drains.

Utility Vessel — Float chambers, sight glasses, relief valves, charging valve.

Dehydrator — Importance of proper operation, valves and system operation, sight glasses, pressure gage.

Lubrication System — Oil pump, cooler, filter, solenoid valve, plug valve, heater, thermostat, temperature gage, oil quality, oil level and temperature.

Pumpout System — Compressor, condenser, oil separator, valve system, controls, lubrication.

Control System — LOCAL/REMOTE switch; STOP, START, RESET, RECALL and POR pushbuttons; LCD; pressure gages; safety controls, operating controls, auxiliary and optional controls.

Auxiliary Equipment — Starters and disconnects, separate electrical sources, pumps, cooling tower.

Describe Machine Cycles — Refrigerant, motor cooling, lubrication.

Review Maintenance — Scheduled, routine, extended shutdown, importance of log sheet, importance of water treatment.

Safety Devices and Procedures — Electrical disconnects, relief valve maintenance, handling refrigerant.

Check Operator Knowledge — Start, stop and shutdown procedures, safety and operating controls, refrigerant and oil charging, job safety.

Review Operating and Maintenance Instructions.

OPERATING INSTRUCTIONS

Operator Duties

1. Become familiar with refrigeration machine and related equipment before operating.
2. Prepare system for start-up; start and stop machine; place system in shutdown condition.
3. Maintain log of operating conditions and recognize abnormal readings.
4. Inspect equipment, make routine adjustments and controls tests, maintain proper levels of oil, water and refrigerant.
5. Protect system from damage during shutdown.

Prepare Machine for Start-Up — Follow all steps described under Preparation in the Initial Start-Up section.

To Start Machine

1. Start water pumps, if not automatic.
2. Allow 3-minute stop-to-start inhibit timer to expire and blank out.
3. Depress START pushbutton; machine follows start-up sequence as described in the Controls section.

Check Running System — After compressor starts, operator should monitor the display codes and observe the following indications of normal operation.

Oil reservoir temperature should be 140 - 150 F (60 - 66 C). Oil cooler water flow may require some adjustment to maintain temperature; open or close plug valve (item 36, Fig. 1) as required.

Oil cooler water should be visible at open sight drain.

Oil level should be at about 1/2 sight glass (item 14, Fig. 1).

Oil pressure should read 20 - 25 psi (138 - 172 kPa) differential at control center gage.

Bearing oil return temperature should be 150 - 175 F (66 - 78 C). If bearing thermometer (item 33, Fig. 1) reads more than 180 F (82 C) with oil pump and oil cooler water operating, *stop machine immediately and determine cause.*

Condenser temperature varies with machine design conditions; range is usually within 75 - 105 F (24 - 41 C). Check your selected design temperature.

Condenser leaving water should be above 65 F (18.3 C) for most applications; check your design data.

Cooler refrigerant temperature varies with machine design conditions; range is usually 30 - 40 F (-1.0 - +4.0 C). Check your selected design temperature.

Dehydrator pressure should be approximately midway between cooler and condenser pressures.

NOTE: The compressor may operate at full capacity for a short time after ramp loading has ended, even though the building cooling load is small. The electrical demand control can be adjusted to limit compressor IkW and avoid a high demand charge for the short period of full capacity operation.

To Stop Machine — Depress STOP pushbutton; machine follows shutdown sequence as described in the Controls section. *If machine fails to stop, in addition to action taken by the microprocessor, the operator should close guide vane and reduce machine load by turning capacity control switch to DEC (decrease); then open main disconnect. Do not attempt to stop machine by opening an isolating knife switch. High intensity arcing may occur. DO NOT restart machine until malfunction is corrected.*

After Limited Shutdown — Special preparations are unnecessary. Follow regular preliminary checks and start-up procedures.

Extended Shutdown — Pump refrigerant charge into utility vessel (see Pumpout Procedures). Leave a holding charge of approximately 10 psig (69 kPa) in the unishell. Maintain 140 - 145 F (60 - 63 C) oil temperature.

If freezing temperatures can occur in the machine area, drain the chilled water, condenser water, oil cooler and pumpout condenser water circuits to prevent freeze-up. Keep water box drains open. Clear oil cooler and pumpout condenser water lines with air.

After Extended Shutdown — Close all water system drains. Return refrigerant to normal operating condition (see Pumpout Procedures). Carefully make all regular preliminary and running system checks.

If compressor oil level appears abnormally high, the oil may have absorbed refrigerant; temporarily raise oil thermostat temperature (item 17, Fig. 1) to drive off any refrigerant. NOTE: On some machines, an oil low temperature safety will prevent compressor start unless the oil is warm.

Manual Operation — The capacity control switch permits the operator to increase leaving chilled water or brine temperature above the set point without altering the automatic temperature control settings.

Manual control is useful in checking control operation or controlling the machine in an emergency.

Turn the capacity control switch to DEC (decrease) to close the guide vanes, decrease machine capacity and *increase* chilled medium temperature. HOLD maintains guide vane position and displays the % RLA on the LCD. INC (increase) opens the guide vanes, increases machine capacity and lowers chilled medium temperature to the thermostat set point.

NOTE: The INC (increase) position overrides ramp loading during start-up. Motor current above the electrical demand setting or above motor RLA, evaporator refrigerant temperature below the set point or chilled water or brine temperature below the set point overrides the INC capacity control setting. For description and set points, refer to Capacity Overrides in the Controls section.

Refrigeration Log — The Carrier 19E log sheet provides a convenient check list for routine inspection and maintenance, and forms a continuing record of machine performance. It is an aid in scheduling routine maintenance and in diagnosing machine problems.

Keep a record of machine's pressures, temperatures and liquid levels on a sheet similar to that shown (reduced in size) in Fig. 8. Your Carrier representative can supply full size (8-1/2 x 11 in.) (215 x 280 mm) sheets. Specify the form number in the lower left corner of the sheet.

WEEKLY MAINTENANCE

Check Lubrication System — Mark oil level on reservoir sight glass (item 14, Fig. 1) and observe level each week while the machine is shut down. Record date and amount of any added oil. Add oil through the oil charging valve (item 19, Fig. 1), using a hand pump to charge against machine pressure. *Added oil must meet Carrier's specifications for centrifugal compressor usage.* (See Change Oil and Oil Filters.)

A 1500-watt oil heater and a thermostat (items 16 and 17, Fig. 1) maintain oil reservoir temperature at 140 - 145 F (60 - 63 C) during shutdown. The heater pilot lights indicate that the heater is on. If the pilot light is out but the reservoir remains warm, check the bulb and replace if necessary. If the pilot light is out and the reservoir is colder than normal, the thermostat may be set too low, thermostat may be faulty or power may be off. Check power source, reset thermostat or replace if necessary.

Do not operate machine with oil temperature less than 135 F (57 C).

Carrier Air Conditioning Company
A DIVISION OF CARRIER CORPORATION

DATE ______

REFRIGERATION LOG CARRIER 19E/F HERMETIC CENTRIFUGAL REFRIGERATION MACHINE

PLANT ______ MACHINE SERIAL NO. ______ MACHINE SIZE ______ REFRIGERANT TYPE ______

	COOLER				CONDENSER				COMPRESSOR					DEHYDRATOR				
	H_2O Press In ______ GPM ______ H_2O Press Out ______				H_2O Press In ______ GPM ______ H_2O Press Out ______					OIL			FLA. ______					
			Water Temperature				Water Temperature											
Time	Shut-down Refrigerant Level	Refrigerant Pressure	IN	OUT	Refrigerant Pressure	Refrigerant Temperature	IN	OUT	Bearing Temperature	Level	Temperature (reservoir)	Pressure (differential)	Motor Amps or Vane Position	Refrigerant Level	Condenser Pressure	Operator's Initials		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

REMARKS: Indicate shut-downs on safety controls, repairs made, oil or refrigerant added or removed, air exhausted and water drained from dehydrator. Include amounts.

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Fig. 8 — Refrigeration Log

Check Dehydrator Operation — Higher than normal dehydrator pressure indicates noncondensable gas (air) in the dehydrator chamber. If dehydrator pressure is within 10 psig (69 kPa) of condenser pressure, open vent valve (item 35, Fig. 1) and vent gas in short spurts. Stop when dehydrator gage indicates normal pressure (halfway between cooler and condenser pressures).

Water accumulation is visible in the dehydrator chamber sight glass. Drain the water, measure and record the amount removed. If water is continually being removed, obtain the services of a qualified service representative to determine the source. *If water remains in the machine, serious damage to the refrigerant side may result.*

SCHEDULED MAINTENANCE

Establish a regular maintenance schedule based on your actual machine requirements (determined by machine load, hours of operation, water quality, etc.). The time intervals listed in this section are offered as guides.

Inspect Control Center — Maintenance is normally limited to general cleaning, tightening of connections and checking of safety and operating controls. In the event of machine control malfunction, refer to Controls section and Troubleshooting Guide in this publication for control checks and adjustment procedures.

Check Safety and Operating Controls — To ensure machine protection, a controls test should be done at least once monthly and the mechanical safety controls should be checked at least once during the operating season, or at least once every 6 months if the machine is operated continuously. See Table 1 for control illustrations and setting procedures.

Pumpout System Maintenance — For compressor maintenance details, refer to the 06D,07D Installation, Start-Up and Service Instructions.

OIL CHARGE — Use oil conforming to Carrier material specification for reciprocating compressor usage. Oil requirements are as follows:

Viscosity at 100 F (38 C), SSU	150 ± 10 (29.5/33.9 mm²/sec)
Viscosity at 210 F (99 C), SSU	40 - 45 (4.2/5.7 mm²/sec)
Dielectric, minimum	25 kv
Floc point, maximum	-60 F (-51 C)
Pour point, maximum	-35 F (-37 C)
Neutralization number, maximum	.05
Flash point, minimum	330 F (166 C)
Moisture content, maximum	30 ppm (30 mg/L)

The total charge, 4.5 pints (2.1 L), consists of 3.5 pints for the compressor and an additional pint for the oil separator.

Oil should be visible in the compressor sight glass both during operation and at shutdown. Always check oil level before operating compressor. Before adding or changing oil, relieve refrigerant pressure as follows:

1. Attach a pressure gage to the gage port of the compressor suction service valve (Fig. 1).
2. Close the suction service valve and open the discharge line to storage tank or machine.
3. Operate compressor until crankcase pressure drops to 2 psig (14 kPa).
4. Stop compressor and isolate system by closing discharge service valve.
5. Slowly remove oil return line connection (item 25, Fig. 1). Add oil as required.
6. Replace connection and reopen compressor service valves.

SAFETY CONTROL SETTINGS — The pumpout unit high-pressure switch should open at 161 ± 5 psig (1110 ± 35 kPa) and should reset automatically on pressure drop to 130 (+7, -0) psig (896 [+48, -0] kPa). Check switch setting by operating the pumpout compressor and slowly throttling the pumpout condenser water.

Inspect Starting Equipment — Before working on starter:

1. Shut off machine.
2. Open disconnect switch ahead of starter.

⚠ WARNING

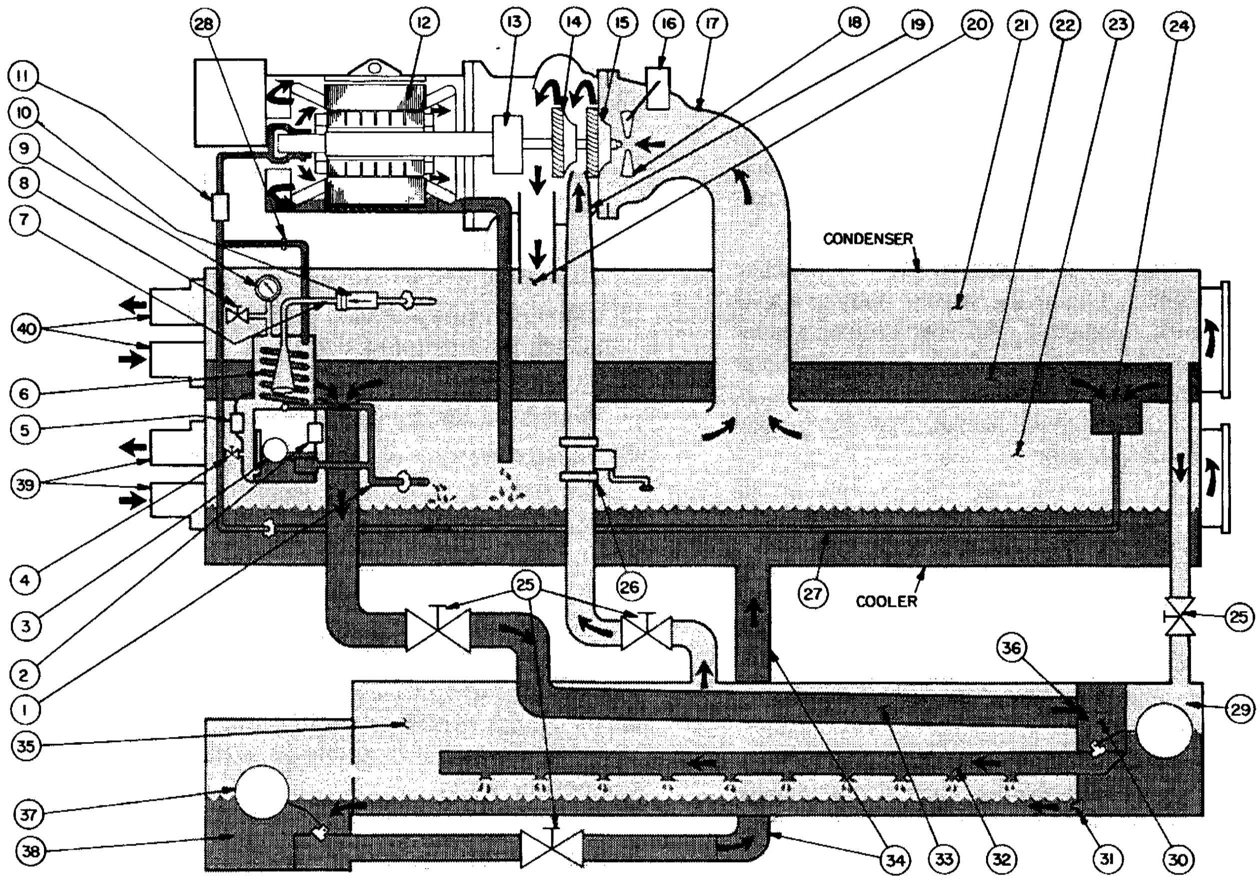
Do not open isolating knife switches while machine is running. Serious injury may result.

Inspect contact surfaces of the starter contactors for wear or pitting. Do not sandpaper or file silver-plated contacts.

Refer to starter manufacturer's instructions for contact replacement, lubrication and other maintenance requirements.

Inspect Dehydrator Yearly — A dehydrator in good repair protects the machine against corrosive mixtures and prevents damage to major components.

1. Be sure that refrigerant has been transferred from unishell to utility vessel.
2. Open dehydrator air relief valve (item 8, Fig. 9) to be sure dehydrator pressure is 0 psig (0 kPa); then remove cover from dehydrator float chamber.
3. Clean float chamber.
4. Make sure that float valve (item 3, Fig. 9) operates freely through its full travel.
5. Remove and examine float valve plunger. Replace plunger and seat assembly if there are signs of wear.
6. Reassemble components, using a new O-ring on the chamber cover.



LEGEND

1 — Dehydrator Refrigerant Return Line
2 — Liquid Level Sight Glass
3 — Dehydrator Float Valve
4 — Water Drain Valve
5 — Water Sight Glass
6 — Dehydrator Condensing Coil
7 — Dehydrator Refrigerant Sampling Line and 1/16-in. (1.6-mm) Orifice
8 — Dehydrator Air Relief Valve
9 — Dehydrator Pressure Gage
10 — Refrigerant Strainer
11 — Refrigerant Filter
12 — Compressor Motor
13 — Transmission
14 — Second-Stage Impeller
15 — First-Stage Impeller
16 — Guide Vane Actuator
17 — Compressor Suction Elbow
18 — Variable Guide Vanes
19 — Flash Economizer Gas Line
20 — Compressor Discharge
21 — Condenser
22 — Thermal Economizer
23 — Cooler
24 — Sump
25 — Isolation Valves (4)
26 — Economizer Gas Damper Valve
27 — Motor Cooling and Dehydrator Supply Line
28 — Orifice, 1/8 in. (3.2 mm)
29 — High-Side Float Chamber
30 — High-Side Valve Chamber
31 — Refrigerant Orifice and Screen
32 — Flash Economizer Spray Pipe
33 — Condenser Refrigerant Drain Line
34 — Refrigerant Supply Line to Cooler
35 — Utility Vessel
36 — Refrigerant Screen
37 — Low-Side Float Valve
38 — Low-Side Float Chamber
39 — Chilled Water (Brine) Connections
40 — Condenser Water Connections

Fig. 9 — Refrigeration Cycle

7. Check the 1/16-in. (1.6-mm) orifice in the dehydrator sampling line (item 7, Fig. 9). Replace the strainer ahead of the orifice.

Check Unishell Tubes

COOLER — Inspect and clean these tubes at end of first operating season. Tube condition at this time will indicate the required frequency of cleaning, and whether water treatment is needed in the chilled water circuit.

CONDENSER — Since this water circuit is usually an open system, the tubes may be subject to contamination by foreign matter, scale, etc. Clean the condenser tubes at least once a year, or more often if the water is contaminated.

Higher than normal condenser pressure, together with an inability to reach full refrigeration load, usually indicates dirty tubes or air in the machine. Check for air as described in Check Dehydrator Operation. If abnormal condition persists after this check, the tubes should be cleaned. A properly maintained refrigeration log quickly shows any rise above normal condenser pressure and any change in water temperatures indicative of dirty tubes or air in the system.

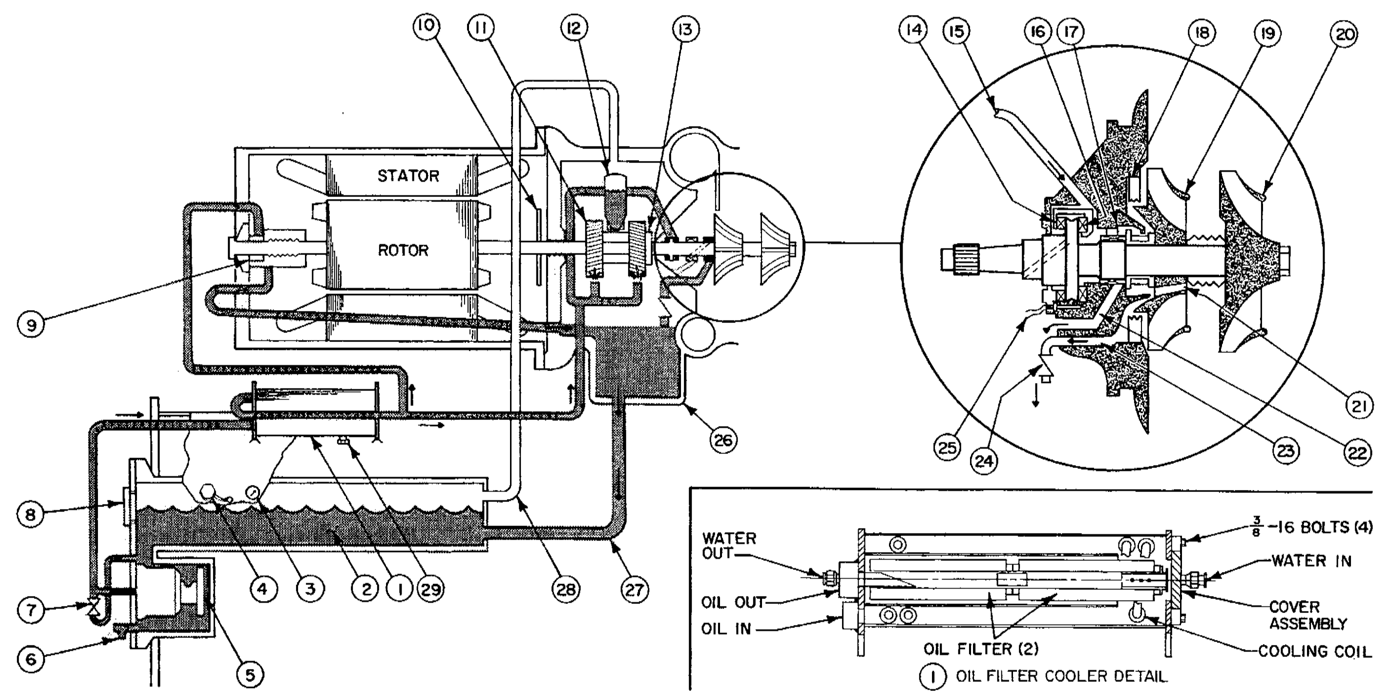
Tube cleaning brushes, especially designed to prevent scraping or scratching of tube walls, are available. Hard scale may require chemical treatment for its prevention or removal. Consult a water treatment specialist for the proper treatment.

Inspect Refrigerant Float System — Transfer all refrigerant into the unishell. Remove access covers at each end of utility vessel. Clean the float chambers (item 29 and 38, Fig. 9), refrigerant orifice (item 31, Fig. 9) and screen (item 36, Fig. 9).

Be sure that the float valves move freely and that linkage is tight.

Change Oil and Oil Filters yearly or if machine is opened for repairs.

1. Transfer the refrigerant to the utility vessel.
2. Turn off oil heater.
3. When unishell pressure drops to approximately 5 psig (35 kPa), drain the oil from the reservoir through the charging valve (item 6, Fig. 10), and from the filter cooler by removing the drain plug (item 29, Fig. 10).
4. When unishell pressure reaches 0 psig (0 kPa), remove the oil cooler cover and replace the 2 oil filters (item 1, Fig. 10).
5. Replace the oil cooler cover, using a new O-ring. Add oil through the charging valve. Approximately 15 gallons (57 L) brings the oil level to 1/3 sight glass (item 8, Fig. 10).



LEGEND

1 — Oil Filter Cooler
2 — Oil Reservoir
3 — Oil Reservoir Temperature Gage
4 — Oil Heater and Thermostat
5 — Oil Pump and Motor
6 — Oil Charging and Drain Valve
7 — Oil-Pressure Regulating Valve
8 — Oil Reservoir Sight Glass
9 — Compressor Motor End Bearing
10 — Centrifugal Demister Exhaust
11 — Compressor Transmission
12 — Coastdown Oil Reservoir
13 — Centrifugal Demister Intake
14 — Counterthrust Bearing
15 — Oil Supply Line
16 — Thrust Bearing
17 — Journal Bearing
18 — Labyrinth
19 — Second-Stage Impeller
20 — First-Stage Impeller
21 — Gas Vent Line
22 — Journal Bearing and Seal Overflow Drain Line
23 — Seal Leakage Drain Line
24 — Seal Oil Check Valve
25 — Bearing High-Temperature Sensor
26 — Compressor Oil Return Sump
27 — Oil Return Line
28 — Reservoir Vent Line
29 — Filter Cooler Drain Plug

Fig. 10 — 19EB Lubrication Cycle

6. Turn on oil heater and warm oil to 140 - 145 F (60 - 63 C). Operate oil pump for 2 minutes and add oil, if required, to maintain level. Oil should be visible in the reservoir sight glass during all operating and shutdown conditions.

OIL SPECIFICATION — Use only high grade oil conforming to the following specification:

Viscosity at 100 F	300 ± 25 SSU
(at 38 C)	(48.4/70.1 mm^2/sec)
Viscosity at 210 F	50 to 55 SSU
(at 99 C)	(7.3/8.8 mm^2/sec)
Viscosity index (minimum)	95
Pour point (maximum)	-5 F (-21 C)
Flash point (minimum)	400 F (204 C)

Rust inhibiting characteristics: material passes ASTM Rust Test D665, latest revision. Use Procedure A with 24-hour test period.

Oxidation resistance: material passes ASTM Oxidation Test D943, latest revision, for a minimum of 2000 hours. Acid number at end of test does not exceed 2.0 mg, KOH per gram.

Compressor Bearing Maintenance — Proper lubrication is the key to good bearing maintenance. Use the proper oil grade, maintained at recommended quantity, temperature and pressure. Inspect lubrication system regularly and thoroughly.

With unishell pressure at 0 psig (0 kPa), bearings should be examined for signs of wear. *Only a trained service mechanic should remove and examine bearings.* The first examination should be done after first year of operation. Thereafter, determine frequency of scheduled examinations by the hours of machine operation, type of load and condition of the lubrication system.

Excessive bearing wear can sometimes be detected through increased vibration or increased bearing temperature. If these symptoms appear, contact an experienced and responsible service organization for assistance.

Check Economizer Damper — Machine is equipped with a damper (item 9, Fig. 1). Check the assembly yearly or when machine is opened for repair.

With unishell/compressor pressure at 0 psig (0 kPa), remove the spring housing from the damper valve (Fig. 11).

Exercise care in removing cover against force of valve spring (approximately 50 lb [23 kg]).

Check the valve, damper blade and linkage for free travel and clean the assembly thoroughly. Replace the valve packing and the housing O-ring gasket (Fig. 11) if necessary. Damper valve operates at a pressure differential between cooler and economizer. The valve starts to open at 8 to 12 psid (55.16 to 82.74 kPad) and is fully open at 17 to 23 psid (117.22 to 158.59 kPad).

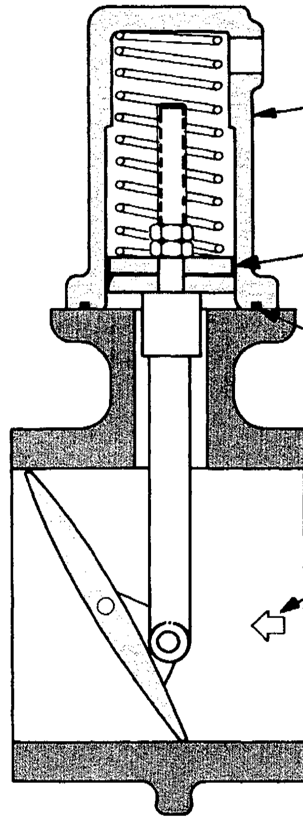


Fig. 11 — Economizer Gas Line Damper

Change Refrigerant Filter — With unishell pressure at 0 psig (0 kPa), change refrigerant filter (items 10 and 11, Fig. 9) yearly, or more often if filter condition indicates a need for more frequent replacement.

Inspect Relief Valves and Piping — *The relief valves on this machine protect the system against the potentially dangerous effects of overpressure. To insure against damage to the equipment and possible injury to personnel, these devices must be kept in peak operating condition.*

As a minimum, the following maintenance is required:

1. At least once a year, disconnect the vent piping at the valve outlet and carefully inspect the valve body and mechanism for any evidence of internal corrosion or foreign material (rust, dirt, scale, etc.).
2. If corrosion or foreign material is found, do not attempt repair or reconditioning. Replace the valve.
3. If machine is installed in a corrosive atmosphere or relief valves vent into a corrosive atmosphere, make valve inspection at more frequent intervals.

Ordering Replacement Parts — Always supply the following information with order:

1. Machine model number and serial number.
2. Name, quantity and part number of part required.
3. Delivery address and mode of shipment.

GENERAL MAINTENANCE

Refrigerant Properties — At normal atmospheric pressure:

Refrigerant 12 boils at approximately -20 F (-29.0 C).

Refrigerant 500 boils at approximately -28 F (-33.4 C).

They must, therefore, be kept in pressurized containers.

The refrigerant is practically odorless when mixed with air, and is noncombustible and nontoxic (except in open flame). It will, however, dissolve oil, dry the skin and, in heavy concentration, *may displace enough oxygen to cause asphyxiation.* When handling this refrigerant, protect hands and eyes, provide adequate ventilation and avoid breathing fumes.

Charging Refrigerant — The 19EB chiller is shipped with a full charge of refrigerant. Additional refrigerant may be required, however, to replace losses incurred in the operation of pumpout unit, dehydrator or relief valves, or from leakage.

⚠ WARNING

Always run evaporator pump and charge or transfer refrigerant as a gas when unishell pressure is less than:

R-12	35 psig (241 kPa)
R-500	45 psig (310 kPa)

Below this pressure, liquid refrigerant flashes into gas at extremely low temperature. This can cause tube freeze-up and serious damage.

Connect the refrigerant container to valve (26) or to the charging connection near valve 6 (Fig. 7). Charge refrigerant *as a gas* until system pressure exceeds 35 psig (241 kPa) for R-12, 45 psig (310 kPa) for R-500. Then charge as a liquid until 2/3 of full charge (Table 7) is in machine. Open isolation valves (27), (28), (29), and (30). Machine valve condition should be as indicated at the final step of Pumpout Procedure, Return Refrigerant to Normal Operating Condition. Start machine and complete the charging process.

Trimming Refrigerant Charge — When machine design load is available, check the difference between leaving chilled water temperature and cooler refrigerant temperature. If required, add or remove refrigerant slowly until the temperature difference reaches design conditions or becomes a minimum. *Do not overcharge.*

Shut the machine down and allow the refrigerant level to equalize between vessels. Using the level scale located inside the float chamber, record the shutdown refrigerant level near the sight glasses.

Refrigerant Leak Testing — Because Refrigerant 12 and 500 are above atmospheric pressure at room temperatures, leak testing can be performed with refrigerant in the machine. Be sure that the room is well ventilated and free from concentrations of refrigerant.

Before making repairs, however, transfer all refrigerant liquid and as much refrigerant gas as possible from the leaking vessel.

If all refrigerant has been lost:

→ CHECK UNISHELL (see Fig. 1 and 7 for item reference). Isolate unishell from utility vessel by closing valves (27), (28), (29) and (30). *Operate cooler and condenser water pumps.*

Add approximately 20 lbs (9 kg) of HCFC or HFC refrigerant tracer and raise vessel pressure to 5 psig (35 kPa) with nitrogen as follows:

1. Attach gas hose or tubing to charging tee near valve 6.
2. Close valves 2, 4 and 6.
3. Open valves 3 and 5.
4. Open valve 1 and then container valve to feed tracer, then dry gas or nitrogen into unishell.

Leak test with electronic leak detector. If leak is undetected at 5 psig (35 kPa), continue pressurizing to 30 psig (207 kPa) and retest.

CHECK UTILITY VESSEL

1. Open valves 1, 3 and 5.
2. Open valve 6 and allow gas and tracer from unishell to enter utility vessel.
3. Close valve 1 and add additional gas and tracer through charging tee as required to reach 5 psig (35 kPa).

Leak test with electronic leak detector. If leak is not apparent at 5 psig (35 kPa), pressurize to 30 psig (207 kPa) and retest.

EVACUATE VESSELS — After repair, evacuate vessels and then charge with 400 lb (181 kg) of Refrigerant 12 or 500. If vessels remain leak tight, charge to normal operating levels. Table 7 lists nominal machine charges.

Guide Vane Linkage — The guide vane and linkage assembly is adjusted and set at the factory.

When the machine is off, the guide vanes are closed and the vane motor operator is stopped by a limit switch at the position shown in Fig. 12.

19EB4 (11-49 SIZE) COMPRESSOR (Fig. 12) — If the motor crank arm is in the proper position at machine shutdown but the vane crank arm is not, the vanes are not fully closed. Loosen the linkage connector at the vane crank arm, close the vanes tightly by hand and reconnect the linkage.

If the motor crank arm is not in the proper position, the motor operator may be faulty. Do not attempt adjustment or repair. Contact your service representative for assistance.

19EB5 (51-89 SIZE) COMPRESSOR (Fig. 12) — If slack develops in the drive train, eliminate backlash as follows:

1. With machine shut down (guide vanes closed), remove chain guard, loosen actuator holddown bolts.
2. Loosen guide vane bolts so that sprocket wheel rotates on hub. Heating may be required to break down Loctite.
3. With bolts still loose, replace chain and move vane actuator to the right until all chain slack is taken up.
4. Tighten vane actuator holddown bolts and retighten vane sprocket bolts in new position (31 lb/ft torque) (42 N • m). Apply drop of Loctite to hub, sprocket and bolt connection.
5. Realign chain guard to clear chain, if required.
6. Observe vane operation from start-up (closed) position to full load (full open) position. Guide vane sprocket should rotate 110 degrees.

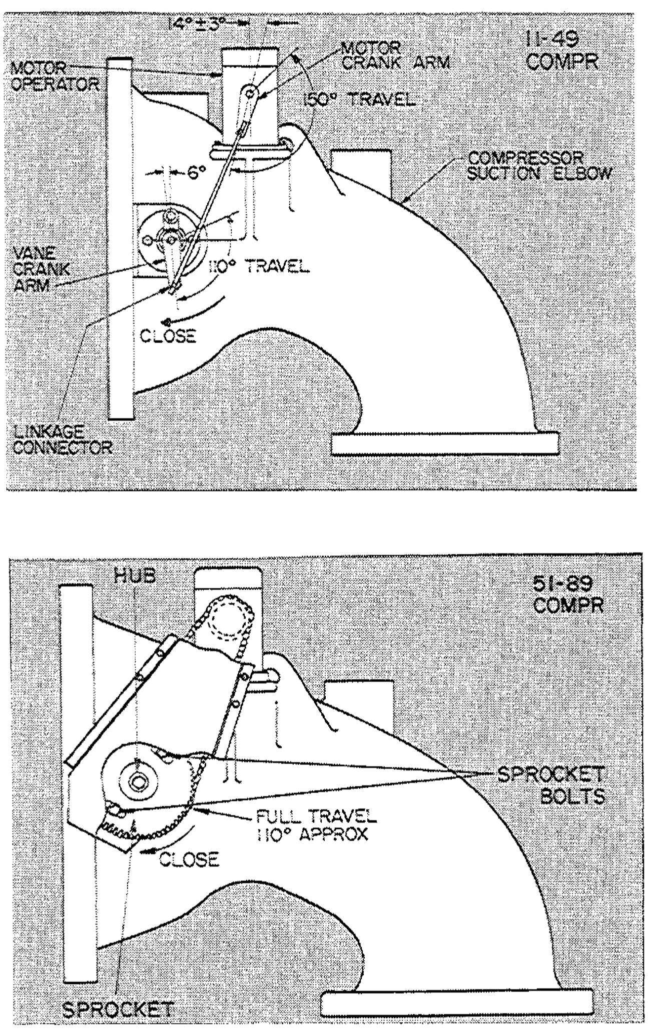


Fig. 12 — Vane Motor Crank Angle

Sensor Test Procedure — Out-of-range sensors (open or shorted) can be detected by the microprocessor. Check sensor accuracy as follows: The thrust bearing, compressor discharge, evaporator refrigerant, leaving chilled medium and motor winding temperature sensors are connected to the processor board in the machine control center. Turn off control power and disconnect terminal plug 1J1 from the processor board. Determine sensor temperature and measure sensor resistance between receptacles designated by wiring diagram with a digital ohmmeter. Compare readings to be sure they agree with Table 10.

Pumpout Procedures — If the machine is equipped with a pumpout unit, use the following procedures for refrigerant transfer or vessel evacuation.

⚠ CAUTION

Before using pumpout unit, read the Isolation Valve Operation section. Improper closing of isolation valve can cause valve damage and refrigerant loss.

Throughout the procedures, valves are identified by the item numbers used in Fig. 1. (See Fig. 7 for a schematic representation of items identified in Fig. 1.) The letter C in the valve condition diagrams indicates a closed valve. For gage and pressure connections, see Table 1.

Isolation Valve Operation — *The compressor must be off and vessel pressures equalized* (see Return Refrigerant to Normal Operating Conditions, page 33) *when opening the isolation valves (27), (28), (29) and (30).* Refer to Fig. 1 for valve number and location.

Isolation valves (28), (29) (and [27] on some machines) are box type valves that should be opened and closed in the following manner:

OPENING

1. Loosen packing nut 1/2 to 1 turn so that valve stem will rotate in packing.
2. *Hold stem in against line pressure* and rotate stem counterclockwise until it slides easily.
3. Slide stem out of body.
4. Rotate stem clockwise in the out position until snug.
5. Tighten the packing nut.

OPERATING THE PUMPOUT COMPRESSOR — During operation, be sure that both the suction and the discharge service valves are open (backseated) by rotating the valve stem fully counterclockwise. Frontseating the valve closes off the refrigerant line and opens the gage port to compressor pressure.

Loosen the compressor holddown bolts sufficiently to allow free spring travel.

Table 10 — Sensor Resistance and Temperature

TEMPERATURE		RESISTANCE	TEMPERATURE		RESISTANCE	TEMPERATURE		RESISTANCE	TEMPERATURE		RESISTANCE
C	F	Ohms	C	F	Ohms	C	F	Ohms	C	F	Ohms
-40	-40	168,230	**2**	35.6	14,749	**44**	111.2	2,271.6	**86**	186.8	518.25
-39	-38.2	157,440	**3**	37.4	14,026	**45**	113	2,184.2	**87**	188.6	502.30
-38	-39	147,410	**4**	39	13,342	**46**	114.8	2,100.7	**88**	190.4	486.89
-37	-34.6	138,090	**5**	41	12,696	**47**	116.6	2,020.8	**89**	192.2	472.04
-36	-32.8	129,410	**6**	43	12,085	**48**	118.4	1,944.4	**90**	194	457.72
-35	-31	121,330	**7**	44.6	11,506	**49**	120.2	1,871.2	**91**	195.8	443.91
-34	-30	113,810	**8**	46.4	10,959	**50**	122	1,801.2	**92**	197.6	430.57
-33	-27.4	106,880	**9**	48.2	10,441	**51**	123.8	1,734.2	**93**	199.4	417.71
-32	-25.6	100,260	**10**	50	9,949.5	**52**	125.6	1,670.0	**94**	201.2	405.30
-31	-23.8	94,165	**11**	52	9,485.0	**53**	127.4	1,608.5	**95**	203	393.32
-30	-22	88,480	**12**	53.6	9,044.5	**54**	129.2	1,549.5	**96**	204.3	381.75
-29	-20	83,170	**13**	55.4	8,627.0	**55**	131	1,493.1	**97**	206.6	370.58
-28	-18.4	78,215	**14**	57.2	8,231.0	**56**	132.8	1,439.0	**98**	208.4	359.79
-27	-16.6	73,580	**15**	59	7,855.5	**57**	134.6	1,387.1	**99**	210.2	349.36
-26	-14.8	69,250	**16**	61	7,499.0	**58**	136.4	1,337.4	**100**	212	339.30
-25	-13	65,205	**17**	62.6	7,161.0	**59**	138.2	1,289.7	**101**	213.8	329.56
-24	-11.2	61,420	**18**	64.4	6,840.0	**60**	140	1,243.9	**102**	215.6	320.17
-23	-10	57,875	**19**	66.2	6,535.8	**61**	141.8	1,200.0	**103**	217.4	311.07
-22	- 7.6	54,555	**20**	68	6,246.0	**62**	143.6	1,157.9	**104**	219.2	302.30
-21	- 5.8	51,450	**21**	69.8	5,971.0	**63**	145.4	1,117.5	**105**	221	293.79
-20	- 4	48,536	**22**	71.6	5,709.5	**64**	147.2	1,078.6	**106**	222.8	285.58
-19	- 2.2	45,807	**23**	73.4	5,461.0	**65**	149	1,041.4	**107**	224.6	277.65
-18	0.4	43,247	**24**	75.2	5,225.0	**66**	150.8	1,005.6	**108**	226.4	269.95
-17	1.4	40,845	**25**	77	5,000.0	**67**	152.6	970.70	**109**	228.2	262.51
-16	3	38,592	**26**	78.8	4,786.1	**68**	154.4	938.10	**110**	230	255.30
-15	5	36,476	**27**	80.6	4,582.5	**69**	156.2	906.35	**111**	231.8	248.35
-14	7	34,489	**28**	82.4	4,388.7	**70**	158	875.80	**112**	233.6	241.60
-13	8.6	32,621	**29**	84.2	4,204.2	**71**	159.8	846.40	**113**	235.4	235.08
-12	10.4	30,866	**30**	86	4,028.4	**72**	161.6	818.10	**114**	237.2	228.75
-11	12	29,216	**31**	87.8	3,860.9	**73**	163.4	790.95	**115**	239	222.62
-10	14	27,663	**32**	89.6	3,701.3	**74**	165.2	764.80	**116**	240.8	216.69
- 9	15.8	26,202	**33**	91.4	3,549.2	**75**	167	739.65	**117**	242.6	210.97
- 8	17.6	24,827	**34**	93.2	3,404.1	**76**	168.8	715.50	**118**	244.4	205.39
- 7	19.4	23,532	**35**	95	3,265.7	**77**	170.6	692.25	**119**	246.2	200.00
- 6	21	22,313	**36**	96.8	3,133.8	**78**	172.4	669.85	**120**	248	194.78
- 5	23	21,163	**37**	98.6	3,007.8	**79**	174.2	648.30	**121**	249.8	189.72
- 4	25	20,079	**38**	100.4	2,887.6	**80**	176	627.60	**122**	251.6	184.82
- 3	26.6	19,058	**39**	105.8	2,772.8	**81**	177.8	607.60	**123**	253.4	180.04
- 2	28.4	18,094	**40**	107.6	2,663.2	**82**	179.6	588.35	**124**	255.2	175.45
- 1	30	17,184	**41**	109.4	2,558.5	**83**	181.4	569.85	**125**	257	170.96
0	32	16,325	**42**	107.6	2,458.5	**84**	183.2	552.00	**126**	258.8	166.61
1	34	15,515	**43**	109.4	2,362.9	**85**	185	534.85			

Open the pumpout condenser discharge valve (item 38, Fig. 1).

Oil should be visible in the compressor sight glass under all conditions of operation and at shutdown. Normal oil level is 1/3 to 1/2 sight glass at shutdown. If oil is low, add as described under Pumpout System Maintenance.

The Pumpout Unit Controls section (page 7) shows a pumpout unit control wiring schematic.

PRESSURE AND VACUUM CONNECTIONS are listed in Table 5. The cooler gage on the machine control center is suitable for determining pressure or low (soft) vacuum in the unishell or the entire machine. A separate gage must be used for checking the utility vessel. *For standing vacuum test or dehydration, use a high quality vacuum indicator or manometer to obtain the desired range and accuracy.*

■ TRANSFER REFRIGERANT FROM UTILITY VESSEL TO UNISHELL when chiller is in normal operating condition. (See Fig. 1 and 7.)

VALVE NO.	1	2	3	4	5	6	26	27	28	29	30	32
CONDITION	C	C	C	C	C	C	C					C

1. Attach a pressure gage to the utility vessel (see Table 1).
2. Close isolation valves (27), (28) and (30).
3. Open valves 1, 3, 4, 6, and (26) if connected to gage.

VALVE NO.	1	2	3	4	5	6	26	27	28	29	30	32
CONDITION		C			C			C	C		C	C

4. Be sure that pumpout condenser water is off.
5. Run pumpout compressor until liquid is out of utility vessel.

6. Close isolation valve (29). (See Fig. 1.)
7. Turn off pumpout compressor.
8. Close valves 3 and 4.
9. Open valves 2 and 5.

VALVE NO.	1	2	3	4	5	6	26	27	28	29	30	32
CONDITION			C	C				C	C	C	C	C

10. Turn on pumpout condenser water.
11. Run pumpout compressor until utility vessel pressure reaches 22 in. Hg vac ref 30-in. bar. (–74 kPa) (4 psia) (28 kpa).
12. Turn off pumpout compressor.
13. Close valves 1, 2, 5, 6 and (26).
14. Turn off pumpout condenser water.

VALVE NO.	1	2	3	4	5	6	26	27	28	29	30	32
CONDITION	C	C	C	C	C	C	C	C	C	C	C	C

■ TRANSFER REFRIGERANT FROM UNISHELL TO UTILITY VESSEL when chiller is in normal operating condition. (See Fig. 1 and 7.)

VALVE NO.	1	2	3	4	5	6	26	27	28	29	30	32
CONDITION	C	C	C	C	C	C	C					C

1. Turn off cooler and condenser water pumps.

VALVE NO.	1	2	3	4	5	6	26	27	28	29	30	32
CONDITION	C	C	C	C	C	C	C					C

2. Wait 10 minutes; close isolation valves (27) and (30).
3. Open valves 1, 2, 5, 6.

VALVE NO.	1	2	3	4	5	6	26	27	28	29	30	32
CONDITION			C	C			C	C			C	C

4. Be sure that pumpout condenser water is off.
5. Run pumpout compressor for 10 minutes; then close isolation valve (28). (See Fig. 1.)

VALVE NO.	1	2	3	4	5	6	26	27	28	29	30	32
CONDITION			C	C			C	C	C		C	C

6. Run pumpout compressor for 20 minutes or until bubbles are visible in sight glasses (23), (24) and (25); then close isolation valve (29). (See Fig. 1.)

VALVE NO.	1	2	3	4	5	6	26	27	28	29	30	32
CONDITION			C	C			C	C	C	C	C	C

7. Turn off pumpout compressor.
8. Close valves 2 and 5.
9. Open valves 3 and 4.

VALVE NO.	1	2	3	4	5	6	26	27	28	29	30	32
CONDITION		C			C		C	C	C	C	C	C

10. *Turn on cooler and condenser pumps and pumpout condenser water.*
11. Run pumpout compressor until unishell pressure reaches 35 psig (241 kPa) for R-12 and 45 psig (310 kPa) for R-500, and then shut it off for 30 minutes. If any liquid refrigerant is trapped in the unishell, it will now boil off from the heat of the cooler and condenser water and the unishell pressure will go above 35 psig (241 kPa) for R-12 and 45 psig (310 kPa) for R-500.
12. Let pressure build up to about 40 psig (396 kPa) for R-12 and 50 psig (345 kPa) for R-500, and turn on pumpout compressor.
13. Repeat steps 11 and 12 until pressure stops rising.
14. Run pumpout compressor until unishell pressure reaches 22 in. Hg vac ref 30-in. bar. (–74 kPa) (4 psia) (28 kPa).
15. Turn off pumpout compressor.
16. Close valves 1, 3, 4 and 6. Turn off cooler and condenser pumps and pumpout condenser water.

VALVE NO.	1	2	3	4	5	6	26	27	28	29	30	32
CONDITION	C	C	C	C	C	C	C	C	C	C	C	C

■ UTILITY VESSEL EVACUATING PROCEDURE (See Fig. 1 and 7.)

VALVE NO.	1	2	3	4	5	6	26	27	28	29	30	32
CONDITION	C	C	C	C	C	C	C	C	C	C	C	C

1. Open valves 5, 6 and (26) if connected to gage.

VALVE NO.	1	2	3	4	5	6	26	27	28	29	30	32
CONDITION	C	C	C	C				C	C	C	C	C

2. Turn on pumpout condenser water.
3. → Remove flare cap, add temporary line from vent valve (32) to either vessel, and crack open vent valve (32). *Vent refrigerant slowly to avoid freeze-up of pumpout condenser tubes.*

VALVE NO.	1	2	3	4	5	6	26	27	28	29	30	32
CONDITION	C	C	C	C				C	C	C	C	

4. Turn off pumpout condenser water.
5. Operate pumpout compressor until indicator reads 22 in. Hg vac ref 30-in. bar. (–74 kPa) (4 psia) (28 kPa).
6. Close valves 5, 6, 7, 8 and (26).
7. Shut off pumpout compressor.
8. Close vent valve (32) and replace flare cap.

VALVE NO.	1	2	3	4	5	6	26	27	28	29	30	32
CONDITION	C	C	C	C	C	C	C	C	C	C	C	C

UNISHELL EVACUATING PROCEDURE (See Fig. 1 and 7.)

VALVE NO.	1	2	3	4	5	6	26	27	28	29	30	32
CONDITION	C	C	C	C	C	C	C	C	C	C	C	C

1. Open valves 1 and 3.

VALVE NO.	1	2	3	4	5	6	26	27	28	29	30	32
CONDITION		C		C	C	C	C	C	C	C	C	C

2. Turn on pumpout condenser water.
3. Remove flare cap, add temporary line from vent valve (32) to either vessel, and crack open vent valve (32). *Vent refrigerant slowly to avoid freeze-up of pumpout condenser tubes.*

VALVE NO.	1	2	3	4	5	6	26	27	28	29	30	32
CONDITION		C		C	C	C	C	C	C	C	C	

4. Turn off pumpout condenser water.
5. Operate pumpout compressor until indicator reads 22 in. Hg vac ref 30-in. bar. (-74 kPa) (4 psia) (28 kPa).
6. Close valves 1 and 3.
7. Shut off pumpout compressor.
8. Close vent valve (32) and replace flare cap.

VALVE NO.	1	2	3	4	5	6	26	27	28	29	30	32
CONDITION	C	C	C	C	C	C	C	C	C	C	C	C

RETURN REFRIGERANT TO NORMAL OPERATING CONDITIONS (See Fig. 1 and 7.)

1. Be sure that opened vessel has been evacuated. If unishell or utility vessel evacuated:

VALVE NO.	1	2	3	4	5	6	26	27	28	29	30	32
CONDITION	C	C	C	C	C	C	C	C	C	C	C	C

2. Open valves 1, 3, and 6.
3. Run water pumps.

VALVE NO.	1	2	3	4	5	6	26	27	28	29	30	32
CONDITION		C		C	C		C	C	C	C	C	C

4. a. *If unishell has been evacuated* — Crack open valve 5, gradually increasing pressure in unishell to 35 psig (241 kPa) for R-12 and 45 psig (310 kPa) for R-500. Feed refrigerant slowly to prevent tube freeze-up.

   b. *If utility vessel has been evacuated* — Crack open valve 5 to slowly equalize unishell and utility vessel pressures. To avoid tube freeze-up, be sure that unishell pressure does not drop below 35 psig (241 kPa) for R-12 and 45 psig (310 kPa) for R-500.
5. Open valve 5 fully.

VALVE NO.	1	2	3	4	5	6	26	27	28	29	30	32
CONDITION		C		C			C	C	C	C	C	C

6. Open valve (29) to equalize the liquid refrigerant levels between vessels.
7. Close valves 1, 3, 5, 6.
8. Open isolation valves (27), (28) and (30).

VALVE NO.	1	2	3	4	5	6	26	27	28	29	30	32
CONDITION	C	C	C	C	C	C	C					C

→ **Machines Without Pumpout Systems** — Contact your local Carrier office for refrigerant transfer procedure. A portable pumpout system must be attached to the machine. Arrange pumpout connections, tubing, and machine valves to perform the same transfer operations used on machines with a pumpout system. To accomplish this:

1. Follow the procedures outlined in the Transfer Refrigerant from Utility Vessel to Unishell section on page 31.
2. Follow the procedures outlined in the Transfer Refrigerant from Unishell to Utility Vessel section on page 32.

UTILITY VESSEL EVACUATION PROCEDURE (See Fig. 1.)

VALVE NO.	1	6				26	27	28	29	30
CONDITION	C	C				C	C	C	C	C

1. Connect vacuum pump and indicator as noted in Table 5.
2. Open valves to pump and indicator.
3. Reduce utility vessel pressure to 26 in. Hg vac ref 30-in. bar. (-88 kPa) (2 psia) (14 kPa).
4. Close valves to pump and indicator.
5. Shut off vacuum pump.

UNISHELL EVACUATION PROCEDURE (See Fig. 1.)

VALVE NO.	1	6				26	27	28	29	30
CONDITION	C	C				C	C	C	C	C

1. Connect vacuum pump and indicator as noted in Table 5.
2. Open valves to pump and indicator.
3. Reduce unishell pressure to 26 in. Hg vac ref 30-in. bar. (-88 kPa) (2 psia) (14 kPa).
4. Close valves to pump and indicator.
5. Shut off vacuum pump.

GENERAL DATA

Machine Nameplate is on the unishell end flange at the suction end of the machine. Always give machine model, serial number and name of owner when corresponding with Carrier.

Compressor Nameplate is on the compressor discharge at the right of the control center.

System Components include unishell cooler-condenser, motor-compressor, utility vessel, oil pump, dehydrator and control center. Use a pump-out unit for transferring refrigerant during services and shutdown.

COOLER, in the bottom portion of unishell, allows refrigerant to pick up heat from and, therefore, chill water flowing through its tubes.

MOTOR-COMPRESSOR maintains system pressure differences and moves heat-carrying refrigerant from cooler to condenser.

CONDENSER, in the unishell upper portion, removes heat from compressed refrigerant and passes heat out of the system.

UTILITY VESSEL, during normal operation, functions as an economizer, returning flash gas to the compressor and increasing the efficiency of the refrigeration cycle. During periods of shutdown and service, the utility vessel serves as a storage tank.

DEHYDRATOR purifies the refrigerant by removing water and air.

CONTROL CENTER controls machine capacity as required, contains machine safety devices, indicates cooler, condenser and oil pressures, records machine operating hours and indicates operating status or shutdown codes.

REFRIGERATION CYCLE

The machine compressor continuously draws large quantities of refrigerant vapor from the cooler, at a rate determined by the amount of guide vane opening. This compressor suction reduces the pressure within the cooler, allowing the liquid refrigerant to boil vigorously at a fairly low temperature (typically 30 to 35 F) (-1.0 to +1.7 C).

The liquid refrigerant obtains the energy needed to vaporize by removing heat from the water or brine in the cooler tubes. The cold water or brine can then be used in an air conditioning or other process.

After removing heat from the water or brine, the refrigerant vapor enters the first stage of the compressor, is compressed and flows into the compressor second stage. Here it is mixed with flash-economizer gas and is further compressed.

Compression raises the refrigerant temperature above that of the water flowing through the condenser tubes. When the warm (typically 100 to 105 F [38 to 41 C]) refrigerant vapor comes into contact with the condenser tubes, the relatively cool condensing water (typically 85 to 95 F [29 to 35 C]) removes some of the heat and the vapor condenses into a liquid.

Further heat removal occurs in the group of condenser tubes that form the thermal economizer. Here the condensed liquid refrigerant is subcooled by contact with the coolest (entering water) condenser tubes.

The subcooled liquid refrigerant drains into a high-side valve chamber which maintains the proper fluid level in the thermal economizer and meters the refrigerant liquid into a flash economizer chamber. Pressure in this chamber is intermediate between condenser and cooler pressures. At this lower pressure, some of the liquid refrigerant flashes to gas, cooling the remaining liquid. The flash gas, having absorbed heat, is returned directly to the compressor second stage. Here it is mixed with discharge gas already compressed by the first-stage impeller. Since the flash gas has to pass through only half the compression cycle, to reach condenser pressure, there is a savings in power.

The cooled liquid refrigerant in the economizer is metered through the low-side valve chamber into the cooler. Because pressure in the cooler is lower than economizer pressure, some of the liquid flashes and cools the remainder to evaporator (cooler) temperature. The cycle is now complete.

MOTOR COOLING CYCLE

Passage through the motor cooling and dehydrator supply line (item 27, Fig. 9) subcools liquid refrigerant from condenser sump (item 24, Fig. 9). The refrigerant then flows externally through a strainer and variable orifice (item 11, Fig. 9) and enters the compressor motor end. Here it sprays on, and cools the compressor rotor and stator. It then collects in the base of the motor casing, and drains into the cooler. Differential pressure between condenser and cooler maintains the refrigerant flow.

DEHYDRATOR CYCLE

The dehydrator removes water and noncondensable gases, and indicates any water leakage into the refrigerant.

The system includes a refrigerant condensing coil and chamber, water drain valve, purging valve, pressure gage, refrigerant float valve and refrigerant piping.

The dehydrator sampling line continuously picks up refrigerant vapor, and contaminants, if any, from the condenser. The dehydrator condensing coil condenses vapor into liquid. Water, if present, separates from and floats on the refrigerant liquid. The water level can be observed through a sight glass, and water may be withdrawn manually at the water drain valve. Air or other noncondensable gases collects in the upper portion of the dehydrator condensing chamber. The dehydrator gage indicates presence of air or other gases through a rise in pressure. Vent these gases manually through the purging valve.

The float valve maintains a refrigerant liquid level and pressure difference necessary for the refrigerant condensing action. The purified refrigerant is returned to the cooler from the dehydrator float chamber.

LUBRICATION CYCLE

Summary — The unishell contains the oil pump and oil reservoir. Oil is pumped through an oil filter cooler which removes heat and any foreign particles. A portion of the oil is then fed to the compressor motor-end bearings and seal. The remaining oil lubricates the compressor transmission, compressor thrust and journal bearings and seal. Oil is then returned to the reservoir to complete the cycle.

Details (see Fig. 10 for numbered references) — Oil is charged into the oil reservoir (2) through a hand valve (6). A sight glass (8) permits observation of the oil level. The motor-driven pump (5) discharges oil through a pressure regulating valve (7) at a differential pressure of 20 - 25 psi (138 - 172 kPa). Read the pressure directly on the oil gage at the machine control center.

The oil is pumped through a filter cooler (1). Manually adjust the oil cooler water flow by a plug cock to ensure the proper oil temperature (140 - 150 F [60 - 66 C]) for compressor lubrication. Oil leaving the filter cooler is separated into a line supplying the motor-end bearing (9) and seal, and a line supplying the transmission (11), compressor thrust and journal bearings (16) and (17) and seal. A portion of the oil fills a reservoir (12) which supplies oil to the compressor during coastdown in the event of a power failure.

Any oil which passes across the seal face (compressor end) enters the drain line (23) and returns to the compressor sump (26) through the seal oil check valve (24).

A demister (10 and 13) draws gas from the transmission area into the motor shell by centrifugal action. The resulting pressure difference prevents oil in the transmission cavity from leaking into the motor shell.

A gage, on the compressor casing, shows the temperature of the oil leaving the thrust bearings of the compressor. The return oil (22 and 27) re-enters the main oil reservoir and the cycle is repeated.

CONTROL TROUBLESHOOTING

The microprocessor control system used in this unit contains extensive diagnostic capabilities. Diagnostic information is displayed on the 2-digit LCD in code form. Diagnostic codes should be used in conjunction with Table 12, Diagnostic Codes and Troubleshooting Guide, to resolve most control problems.

If a problem is suspected, use the following procedures:

1. Check display for diagnostic code and refer to Table 12.
2. Recall and record stored codes before turning off control center power or depressing the POR pushbutton.

IMPORTANT: Displayed and stored diagnostic codes will be lost if power is turned off or a POR is performed.

3. Compare displayed code with recalled code(s) for a pattern or similarities.
4. If control center is energized and there is no diagnostic code and no stored code(s), inquire about power loss.
5. If control center is not energized or controls test malfunctions, check for loose ribbon cable connection or blown fuses, and check control center transformer as follows:
   a. De-energize control center and remove terminal plug 1J4 from the processor board. Re-energize control center transformer.
   b. Check for 19 vac ± 15% between transformer orange and blue leads (terminals 1 and 3). Replace transformer if voltage is outside these limits.
   c. Check for 18 vac ± 15% between transformer brown and red leads (terminals 5 and 6). Replace transformer if voltage is outside these limits. De-energize control center. Reconnect terminal plug 1J4 and re-energize control center.
6. Perform controls test and make visual inspection of machine and starter. If everything is correct, start machine and monitor closely. If not correct, check processor, I/O and S/D boards to determine if replacement is required.

Table 11 — Compressor Assembly Torques (lb-ft) (N•m)

ITEM*	DESCRIPTION	TORQUE Compressor Size 11-49 lb-ft	11-49 N·m	51-89 lb-ft	51-89 N·m
A	Main Motor Terminal	10	14	10	14
B	Impeller Locknut	200	271	250	339
C	Gear and Motor Shaft Nut	300	407	300	407
D	Transmission Bearing Holddown Bolt	60	81	60	81
E	Impeller Displacement Detector Locknut	10	14	10	14

*See Fig. 13 for item callout.

COMPRESSOR FITS AND CLEARANCES
(See Fig. 13 for item callout)

Service and repair of Carrier centrifugal compressors should be performed only by fully trained and qualified service personnel. The information in this section is included as a reference for such personnel only.

ITEM	DESCRIPTION	MEASUREMENT	DIMENSION 19EB4 in.	19EB4 mm	19EB5 in.	19EB5 mm
1	1st-stage impeller to diaphragm	Axial	See tabulation.			
2	2nd-stage impeller to discharge wall	Axial	See tabulation.			
3	1st-stage labyrinth	Diametral	.016/.020	0.41/0.51	.016/.020	0.41/0.51
4	Interstage labyrinth	Diametral	.012/.016	0.30/0.41	.012/.016	0.30/0.41
5	2nd-stage labyrinth	Diametral	.008/.012	0.20/0.30	.008/.012	0.20/0.30
6	Balancing piston labyrinth	Diametral	.008/.012	0.20/0.30	.008/.012	0.20/0.30
7	Impeller shaft journal bearing	Diametral	.0020/.0035	0.051/0.089	.0030/.0045	.076/0.114
8	Thrust-end float	Axial	.008/.014	0.20/0.36	.010/.015	0.25/0.38
9	Counterthrust bearing seal ring	Diametral	.002/.004	0.051/0.102	.002/.004	0.051/0.102
10	Gear bearing to gear	Diametral	.0040/.0055	0.102/0.140	.0040/.0055	0.102/0.140
11	Gear bearing to bearing housing	Diametral	.0025/.0045	0.064/0.115	.0005/.0025	0.013/0.064
12	Pinion bearing to pinion	Diametral	.0030/.0045	0.076/0.114	.0030/.0045	0.076/0.114
13	Pinion bearing to bearing housing	Diametral	.002/.004	0.051/0.102	.001/.003	0.025/0.076
14	Transmission labyrinth	Diametral	.006/.010	0.15/0.25	.006/.010	0.15/0.25
15	Motor-end labyrinth	Diametral	.005/.008	0.127/0.203	.005/.008	0.127/0.203
16	Motor-end bearing to shaft	Diametral	.004/.005	0.102/0.127	.004/.005	0.102/0.127
17	Motor-end bearing to bearing housing	Diametral	.0005/.0020	0.013/0.05	.0005/.0020	0.013/0.05
18	Impeller displacement switch to impeller shroud (impeller in thrust position)	Axial	.057/.072	1.45/1.83	.057/.072	1.45/1.83

TABULATION — IMPELLER CLEARANCES (in.) (mm)

COMPRESSOR SIZE		IMPELLER DIAMETER		DIMENSION* (Item 1)		DIMENSION* (Item 2)	
New	Old	in.	mm	in.	mm	in.	mm
11	431	9.10	231	.701	17.8	.548	13.9
13	433	9.40	239	.671	17.0	.508	12.9
15	435	9.70	246	.641	16.3	.488	12.4
17	437	10.00	254	.611	15.5	.468	11.9
19	439	10.40	264	.596	15.1	.458	11.6
21	441	9.10	231	.811	20.6	.628	16.0
23	443	9.40	239	.781	19.8	.578	14.7
25	445	9.70	246	.741	18.8	.558	14.2
27	447	10.00	254	.711	18.1	.528	13.4
29	449	10.40	264	.686	17.4	.518	13.2
31	451	9.10	231	.921	23.4	.708	18.0
33	453	9.40	239	.881	22.4	.668	17.0
35	455	9.70	246	.841	21.4	.638	16.2
37	457	10.00	254	.801	20.4	.598	15.2
39	459	10.40	264	.776	19.7	.578	14.7
41	461	9.10	231	1.041	26.4	.798	20.3
43	463	9.40	239	.991	25.2	.758	19.3
45	465	9.70	246	.951	24.2	.718	18.2
47	467	10.00	254	.901	22.9	.668	17.0
49	469	10.40	264	.866	22.0	.648	16.5
51	531	12.00	305	.837	21.3	.638	16.2
53	533	12.38	315	.797	20.2	.609	15.5
55	535	12.75	324	.757	19.2	.579	14.7
57	537	13.25	337	.717	18.2	.541	13.7
59	539	13.75	349	.690	17.5	.541	13.7
61	541	12.00	305	.977	24.8	.760	19.3
63	543	12.38	315	.937	23.8	.726	18.4
65	545	12.75	324	.897	22.8	.688	17.5
67	547	13.25	337	.837	21.3	.639	16.2
69	549	13.75	349	.810	20.6	.632	16.1
71	551	12.00	305	1.177	29.9	.895	22.7
73	553	12.38	315	1.137	28.9	.852	21.6
75	555	12.75	324	1.077	27.4	.809	20.6
77	557	13.25	337	1.017	25.8	.750	19.6
79	559	13.75	349	.970	24.6	.731	18.6
81	561	12.00	305	1.297	32.9	.972	24.7
83	563	12.38	315	1.237	31.4	.928	23.6
85	565	12.75	324	1.177	29.9	.880	22.4
87	567	13.25	337	1.097	27.9	.817	20.8
89	569	13.75	349	1.050	26.7	.796	20.2

*Measured with shaft in thrust position; tol = ± 0.005.

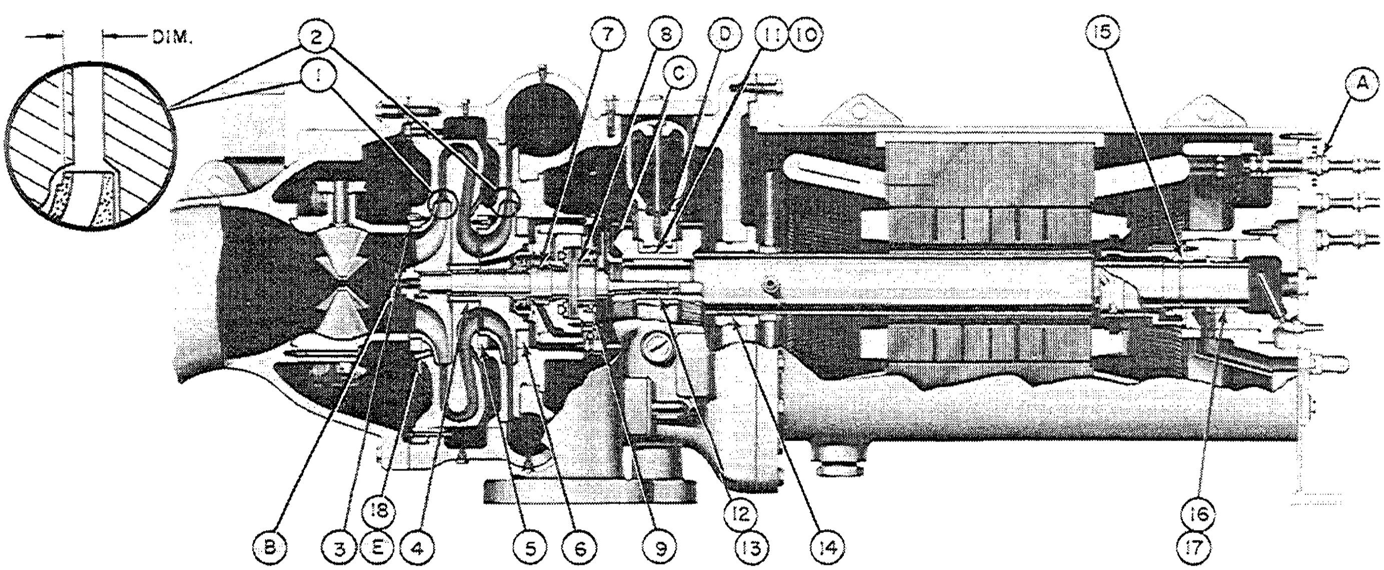


Fig. 13 — Compressor Fits and Clearances

Test Points — When checking the 3 boards to determine if replacement is required, use reference voltages given at certain test points. These test points are labeled on the particular board as TP"X", where X is the number of the test point. The voltages are listed in the following sections on board replacement. When taking readings at test points, connect ground side of DVM to negative side of large capacitor on processor board or to terminal plug 1J3-1.

Processor Board Replacement — The processor board should be replaced if one or more of the following abnormalities exist with proper power supply from the control center transformer and with terminal plugs 1J1 and 1J2 disconnected.

1. The voltage at terminal pin 1J3-7 exceeds −10 ± 1 vdc; the voltage at terminal pin 1J3-6 exceeds ±10 ± 1 vdc; or the voltage at any of the following test points is exceeded.

   TP1 +5 ± .2 vdc
   TP2 +5 ± .2 vdc
   TP4 +5 ± .2 vdc
   TP8 −5 ± .2 vdc
   TP9 +10 ± 1 vdc
   TP15 +12 ± .5 vdc
2. Both types of inputs (analog and digital) malfunction or indicate faulty during the controls test.
3. The display on the S/D board and outputs from the I/O board malfunction at the same time during the controls test.
4. The control sequence is not followed.
5. An out-of-range sensor reading is displayed but sensor resistance is within limits.
6. The circuit board or any component on the circuit board has been damaged.

Input/Output Board Replacement — The I/O board should be replaced if one of the following abnormalities exist and the processor board has been checked and is functioning properly.

1. The voltage at TP1 exceeds -5 ± .2 vdc; the voltage at TP2 exceeds +5 ± .2 vdc; or the voltage at TP4 exceeds +5 ± .2 vdc.
2. An input channel from a peripheral device malfunctions during a controls test when the signal from the device is correct. (Example: Microprocessor indicates flow switch open when flow switch is closed and voltage is at the input channel.)
3. An output channel to a peripheral device malfunctions during a controls test when the LCD indicates that the command is being executed. (Example: Microprocessor indicates water pump relay is energized but no power is on relay.)
4. A safety trip occurs due to a high, low or loss of power indication when the power supply is within limits.
5. A 110-vac open or close signal is applied to the guide vane actuator when the DIP switches are properly configured.
6. The circuit board or any component on the circuit board has been damaged.

Set Point/Display Board Replacement — The S/D board should be replaced if the following abnormalities exist and the processor board has been checked and is functioning properly.

1. The voltage at the center terminal on the START or STOP pushbutton exceeds +5 ± .2 vdc.
2. An 88 is not displayed on the LCD during the first-step results of the control test.
3. The demand limit or leaving chilled medium set point potentiometer status indicates faulty.

Table 12 — Diagnostic Codes and Troubleshooting Guide

TYPE	CODE NO.	DESCRIPTION/MALFUNCTION	PROBABLE CAUSE/REMEDY
TIMER	00-15	Time Remaining Until Restart (Decreases at one-minute intervals)	15-minute or 3-minute start inhibit timers not expired.
START STATUS	25	Recycle Restart Pending	Leaving chilled water or brine temperature too low for recycle start-up (⩽ 5 F [2.8 C] above set point).
	26	Start-Up in Progress	Prestart checks being performed, water flows and oil pressure being established.
RUN STATUS	28	Temperature Capacity Control	Machine operating normally under temperature control.
	29	Ramp Loading Capacity Control	Leaving temperature pulldown rate being limited by ramp loading.
	30	Demand Limit Capacity Control	Compressor motor current > demand limit set point — check motor current calibration.
	35	Motor Temperature Override	Motor temperature > 200 F (93.3 C) — check motor temperature immediately, check sensor resistance.
	36	Refrigerant Temperature Override	Refrigerant temperature ⩽ 1°F (0.56 C) above trip limit — check refrigerant temperature, check sensor resistance, check refrigerant charge.
PRESTART FAILURE STATUS	40	Motor Winding Temperature Too High to Start	Motor temperature > 190 F (87.8 C) — check motor temperature, reset when < 190 F (87.8 C), check sensor resistance.
	41	More Than 3 Starts in Past 12 Hours	Start inhibited by 3 Starts/12-Hour counter. Depress reset pushbutton if additional start is required.

Table 12 — Diagnostic Codes and Troubleshooting Guide (cont)

TYPE	CODE NO.	DESCRIPTION/MALFUNCTION	PROBABLE CAUSE/REMEDY
PRESTART FAILURE STATUS (cont)	42	Failure of Condenser Pump to Establish Flow	Check pump operation, check power supply and pilot relay, check flow switch, check water valves, check for air in water lines.
	43	Failure of Evaporator Pump to Establish Flow	Check pump operation, check power supply and pilot relay, check flow switch, check water valves, check for air in water lines.
	44	Defective Oil Pump Pressure Switch	Oil pressure switch contact closed with pump de-energized; check contacts. Check setting.
	45	Out-of-Range Sensor Readings	Perform controls test to check for defective set point potentiometer(s) or open or shorted sensors; check sensor resistance.
	46	Oil Pressure Switch Not Closed Within 15 Seconds After Pump is Energized (Failure to develop pressure)	Check power to pump, check oil level, check oil pressure switch setting, check for dirty oil filters.
	47	Impeller Displacement Contacts Open	Check switch and wiring for continuity. If open, check thrust clearance. If necessary, correct clearance and replace switch.
	48	Low/High Line Voltage	Control center voltage supply < 94.3 VAC or > 135.7 VAC for one minute. Check voltage supply. Check control center transformer, check circuit loading, consult power utility if line voltage is low. See I/O Board Replacement.
SHUTDOWN STATUS	60	Compressor Discharge Temperature > 220 F (104 C)	Check discharge temperature immediately, check sensor resistance, check for proper condenser water flow and temperature, check oil reservoir temperature, check condenser for air or water leaks.
	61	Evaporator Refrigerant Temperature < Limit	Check refrigerant temperature, check sensor resistance, check refrigerant charge.
	62	Motor Winding Temperature > 220 F (104 C)	Check motor temperature immediately, check sensor resistance and connections at compressor junction box, check motor cooling system for restrictions.
	63	Thrust Bearing Temperature > 220 F (104 C)	Check oil reservoir temperature, check oil cooler water flow and solenoid, check oil heater thermostat setting, check sensor resistance and connections at compressor junction box, check journal and thrust bearings if other checks OK.
	64	Sensor Out-of-Range	Perform controls test to check for defective set point potentiometer(s) or open or shorted sensors; check sensor resistance.
	65	Oil Pressure < Limit	Check power to pump, check oil level, check oil pressure switch setting, check for dirty oil filters, check for oil foaming at start-up, reduce ramp loading rate if oil foaming is noted.
	66	Motor Overload Trip	Check motor overload dashpots and setting (do not attempt field calibration), check motor current demand calibration. Check optional compressor motor starter protective devices (e.g., phase loss, ground fault, etc.).
	67	Temporary Loss of Line Voltage	Control center voltage < 57.5 VAC for one cycle — depress reset pushbutton and restart.
	68	Low-Line Voltage	Control center voltage < 94.3 VAC for one minute; check control center voltage, check control center transformer, check circuit loading, consult power.
	69	High-Line Voltage	Control center voltage > 135.7 VAC for one minute. Check control center voltage, check control center transformer, check power company.
	70	Loss of Chilled Water Flow	Check pilot relay, check power to pump, check flow switch, check water valves.
	71	Loss of Condenser Water Flow	Check pilot relay, check power to pump, check flow switch, check water valves.
	72	Excessive Impeller Displacement	Check switch for continuity, if open check thrust clearance — correct, replace switch.
	73	High Condenser Pressure	Check high condenser pressure switch setting, check for proper condenser water flow and temperature, check for fouled tubes.
	74	Failure of Starter to Complete Transition	Check starter, check run contact, check DIP switch configuration for proper starter type.
	75	Excessive Motor Acceleration Time	Check to ensure guide vane is closed at start-up, check starter transfer time, check guide vane linkage. Check DIP switch configuration for proper starter type.
	76	Illegal Configuration	Check for proper unit configuration.
	77	Run/Transition Contacts Failed to Deactivate On Shutdown	Check run contact, check 1CR relay, check starter for welded contacts.
	78	Manual Override Shutdown	Stop pushbutton depressed with L/R switch in remote position — reset.
	79	Spare Safety Limit Exceeded	Check spare safety contact(s), check spare safety operation.

Table 12 — Diagnostic Codes and Troubleshooting Guide (cont)

TYPE	CODE NO	DESCRIPTION/MALFUNCTION	PROBABLE CAUSE/REMEDY
SHUTDOWN STATUS (cont)	80	**Recycle with Motor Current > 50% of RLA**	Check for proper cooler and condenser water flows and temperatures, check leaving chilled water/brine sensor resistance, check motor current calibration, check guide vane actuator and linkage.
—	—	**Chilled Water Temperature Too High (Machine running)**	THERMOSTAT SET TOO HIGH — Return thermostat to proper setting.
			CAPACITY OVERRIDE OR EXCESSIVE COOLING LOAD (Machine at Capacity) — Check for diagnostic code, check for infiltration of outside air into conditioned spaces.
			CONDENSER TEMPERATURE TOO HIGH — Check condensing water flow. Check condensing water temperature; examine cooling tower operation. Check for air and water leaks, check for fouled tubes.
			REFRIGERANT LEVEL LOW — Check for leak; repair. Add refrigerant and trim charge.
			LIQUID BYPASS IN WATER BOX — Examine division plates and gaskets for leaks.
			GUIDE VANE FAILS TO OPEN — Check for defective actuator — replace.
			GUIDE VANES FAIL TO OPEN FULLY — Be sure that capacity control switch is in *AUTO.* position. If vanes will not open with switch at *INC*, check for excessive cooling load (see above). Check chilled water or brine sensor resistance. Check guide vane linkage. Check limit switch in actuator, check that sensor is connected to proper terminals.
		Chilled Water or Brine Temperature Too Low (Machine running)	THERMOSTAT SET TOO LOW — Return thermostat to proper setting.
			GUIDE VANES FAIL TO CLOSE — Be sure that capacity control switch is in *AUTO.* position. Check chilled water sensor resistance, check guide vane linkage. Check for defective actuator — replace, check that sensor is connected to proper terminals.
			DEFECTIVE SENSOR — Check sensor resistance.
			EVAPORATOR REFRIGERANT TEMPERATURE SET POINT IMPROPERLY SET (Brine Chilling Only) — Check refrigerant temperature set point.
		Chilled Water Temperature Fluctuates; Vanes Hunt	DEADBAND TOO NARROW (Erratic Flow or Temperature) — Configure DIP switch for 2 F (1°C) deadband.
			PROPORTIONAL BAND TOO NARROW (Erratic Flow or Temperature) — Configure DIP switch for 15 F (8.3 C) proportional band.
			LOOSE GUIDE VANE LINKAGE — Adjust guide vane linkage.
			DEFECTIVE VANE ACTUATOR — Replace actuator.
			DEFECTIVE SENSOR — Check sensor resistance.
—	—	**Oil Reservoir Temperature Too Low**	OIL COOLER WATER FLOW TOO HIGH — Throttle water to reduce flow.
			THERMOSTAT IMPROPERLY SET OR DEFECTIVE — Check voltage across thermostat while adjusting; if contacts do not close, replace thermostat.
			OIL HEATER DEFECTIVE — If light indicates power but unit does not heat, check unit for open or short. Replace unit if required.
		Oil Reservoir Temperature Too High	THERMOSTAT IMPROPERLY SET — Adjust thermostat.
			OIL COOLER WATER FLOW TOO LOW — Open plug valve.
			OIL COOLER SOLENOID VALVE OPERATING IMPROPERLY — Check electrical operation of solenoid. Inspect valve; if screen is fouled, clean and install a 20-mesh strainer ahead of valve.
			OIL COOLER COIL FOULED — Clean coil; replace cooler if required.

For replacement items use Carrier Specified Parts.

Manufacturer reserves the right to discontinue, or change at any time, specifications or designs without notice and without incurring obligations.

Book 2 | Tab 5a   Form 19EB-3SSM Supersedes 19EB-2SSM   Printed in U.S.A.   295   11-84   PC 201   Catalog No. 531-910