Number One Air Conditioning Maker

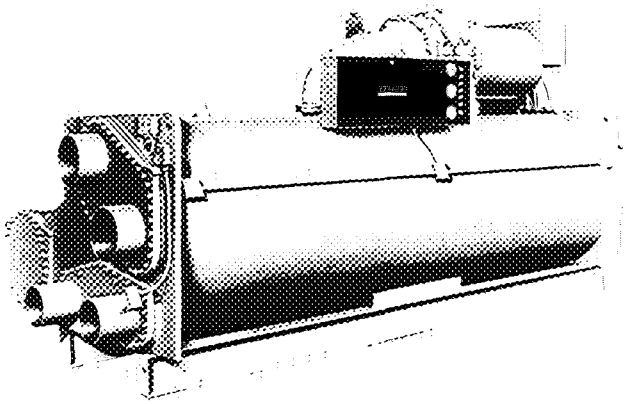
Carrier

Division of Carrier Corporation

Carrier Parkway • Syracuse N Y 13221

Start-up, Operation and Maintenance Instructions 19EA

Hermetic Centrifugal Liquid Chillers



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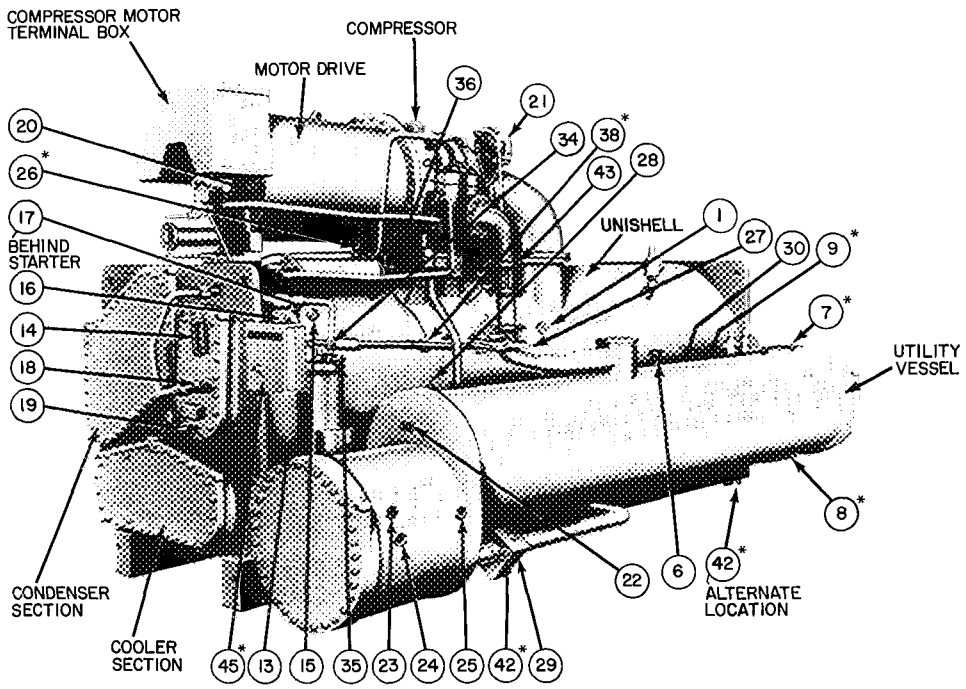
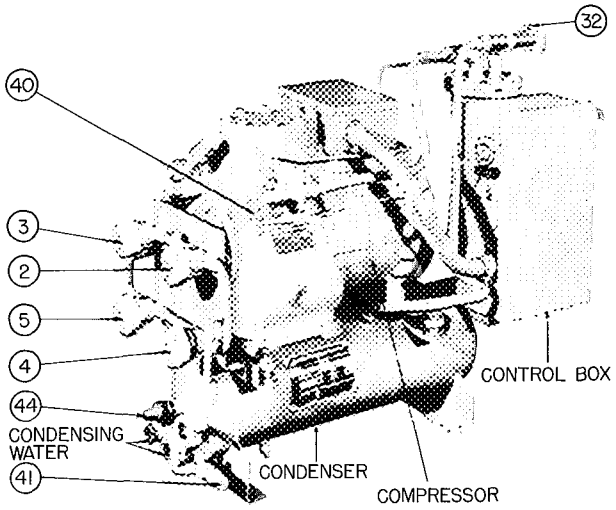
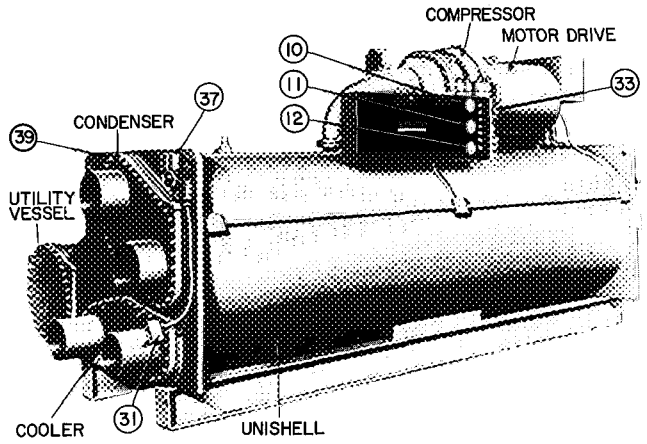




PUMPOUT UNIT



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 – Pumpout Service Valve 7*
8 – Pumpout Service Valve 8*
9 – Service Valve 9 (hidden between unishell and utility vessel)*
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 – Sight Glass – Liquid Level
23 – Sight Glass – Liquid Level
24 – Sight Glass – Liquid Level
25 – Sight Glass – Liquid Level
26 – Refrigerant Drain Valve*
27 – Isolation Valve
28 – Isolation Valve (hidden)
29 – Isolation Valve
30 – Isolation Valve – ball valve between unishell and utility vessel (hidden)
31 – Chilled Water Control Element
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 – Chilled Water Low-Temperature Cutout
38 – Oil Low-Temperature Switch*
39 – Machine Identification Plate
40 – Oil Return Line Connection
41 – Pumpout Condenser Discharge Valve
42 – Refrigerant Drain and Charging Valve*
43 – Economizer Damper Valve
44 – Frangible Plug
45 – Oil Pump Starter*

*On some machines

→ **Fig. 1 — Machine Components**

INTRODUCTION

All persons involved in the start-up and maintenance of the 19EA machine should be thoroughly familiar with these instructions and other necessary job data before initial start-up. Procedures in this book are arranged in the sequence required for proper machine operation.

BEFORE INITIAL START-UP

Job Data Required

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

Equipment Required

1. Mechanic's tools
2. Volt-ohmmeter and clamp-on ammeter
3. Leak detector, electronic or halide type
4. Absolute pressure manometer or wet-bulb vacuum indicator
5. Vacuum pump – at least 5 to 7.5 cfm capacity

Isolation Valve Operation – *The compressor must be off and vessel pressures equalized* (see RETURN REFRIGERANT TO NORMAL OPERATING CONDITIONS) *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.

CLOSING

→ After closing valve (28) and (29), bleed some refrigerant thru the packing gland to ensure a gas pocket in the valve body. Trapped liquid refrigerant can expand to damage the valve and cause refrigerant loss.

1. Loosen the packing nut 1/2 to 1 turn so that valve stem can rotate in packing.
2. Rotate stem counterclockwise until stem slides easily.
3. Slide stem into valve until it bottoms.
4. *While holding stem in,* rotate it clockwise until tight (25 lb-ft approx).
5. Tighten the packing nut.

→ **Check Machine Tightness** – The 19EA chiller is shipped with the refrigerant charge in the utility vessel (Fig. 1) and a holding charge of 10 psig 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. 2. For refrigerant transfer and vessel evacuation, see Pumpout Procedures. Standing vacuum test and machine dehydration procedures are described in sections following. *Retighten all gasketed joints after 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

To determine utility vessel pressure, attach an accurate 30"-0-200 psi gage or other indicator at one of the locations listed in Table 1.

Unishell/compressor pressure can be read at the cooler gage on the machine control center (Fig. 1).

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

→ **Table 1 – Gage and Pressure Connections for Pressurizing or Evacuation**

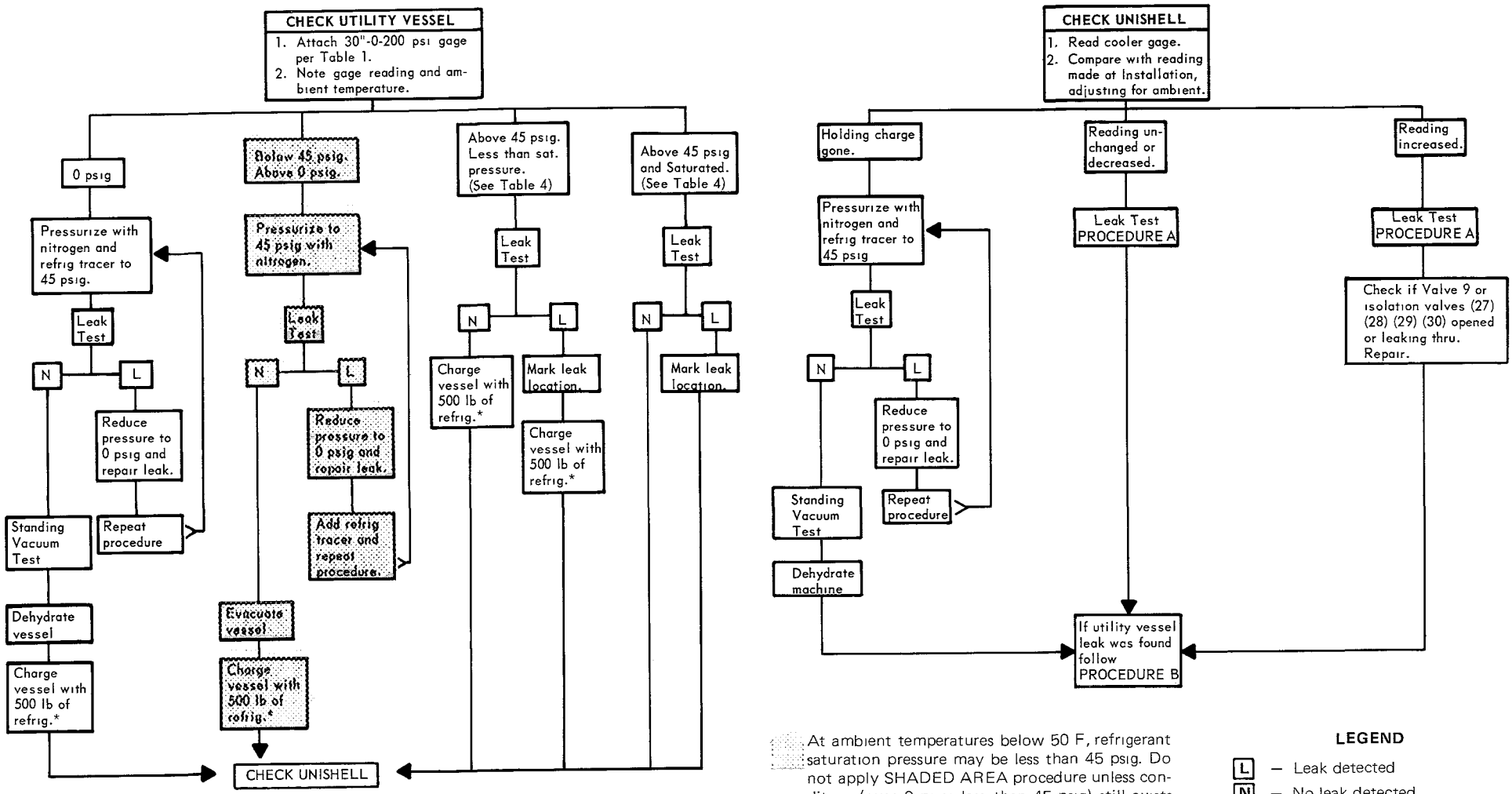
TO CHECK OR SERVICE	VACUUM OR PRESSURE CONNECTIONS (See Notes 1 and 2)			
	Indicator		Service Line	
	With Pumpout	Without Pumpout	With Pumpout	Without Pumpout
UNISHELL	Purge Valve 35	Purge Valve 35	Tee at valve 6	Valve 1
UTILITY VESSEL	Valve 42, or field-installed tee in service line.	Valve 42, or field-installed tee at valve 6	Tee at valve 6	Valve 6
ENTIRE MACHINE	Purge Valve 35	Purge Valve 35	Valve 42, or tee at valve 6. (Open valves 27, 28, 29 and 30)	Valves 1 and/or 6. (Open valves 27, 28, 29 and 30)

NOTE:

1 See Fig 1 for valve location Valve number is same as item number in Fig 1.

2 Connection size:

NUMBER	SIZE
1	1/2-in ODS
6	1/2-in. male flare
35	3/8-in male flare
42	1/2-in male flare
tee	3/8-in FPT



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

Fig. 2 – 19EA Leak Test Procedures

Make all leak tests with a halide or electronic leak detector.

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

CHECK SAFETY CONTROL SETTINGS – During leak testing, unishell pressure is sometimes reduced to 0 psig during the testing process. This may be a convenient time to check the following safety controls as described in Table 3: oil low pressure cutout, econ-cooler differential pressure switch (on some machines), condenser high pressure cutout and cooler low pressure cutout.

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

LEAK TEST THE MACHINE

Follow the sequence and procedures given in Fig. 2. Valve numbers and locations are shown in Fig. 1 and Fig. 8.

On some machine models, one or more of the following valves may not be present; 7, 8, 9, 26 or 42. This will not in any way affect the leak test and pumpout procedures which follow. Merely ignore the reference to the missing valve(s) when following the procedure.

PROCEDURE A – Test Unishell Side (as specified in Fig. 2)

1. Raise Unishell pressure to 45 psig, following steps 1 thru 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, 41 and pumpout compressor service valves.

VALVE NO.	1	2	3	4	5	6	7	8	9	26	27	28	29	30	32	42
CONDITION		C			C		C	C	C	C	C	C	C	C	C	C

   c. Run pumpout compressor until machine pressure is reduced to 0 psig.
   d. Repair leak and repeat procedure to ensure repair. If machine is opened to atmosphere for an extended period, it must be evacuated before repeating procedure.

PROCEDURE B – Retest Utility Vessel (as specified in Fig. 2).

1. Following the pumpout procedure TRANSFER REFRIGERANT FROM UTILITY VESSEL TO UNISHELL, reduce utility vessel pressure to 0 psig.
2. Repair utility vessel leak. If tank is opened for an extended period, it must be evacuated before proceeding.
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	7	8	9	26	27	28	29	30	32	42
CONDITION		C		C					C	C	C	C	C	C	C	C

4. When utility vessel pressure reaches 45 psig, 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 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 1. 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, ref 30-in. bar. (4.0 psia), using vacuum pump or pumpout unit.
3. Valve off pump to hold vacuum and record the manometer or indicator reading.
4. If the leakage rate is less than 0.05 in. Hg in 24 hours, the vessel is sufficiently tight.
5. If the leakage rate exceeds 0.05 in. Hg in 24 hours, repressurize the vessel and test for leaks. If refrigerant is available in the other vessel, pressurize by following steps 1 thru 6 of RETURN REFRIGERANT TO NORMAL OPERATING CONDITIONS. If not, use nitrogen and refrigerant tracer. Raise the vessel pressure in increments until leak is detected. If refrigerant is used, the maximum gas pressure is approximately 70 psig at normal ambient temperature; with nitrogen, limit the leak test pressure to 140 psig 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.

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 or larger is recommended) to the machine as indicated in Table 1.
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 or higher, operate the vacuum (dehydration) pump until the manometer reads 29.8 in. Hg vac ref 30-in. bar. (0.20 in. Hg abs) or the vacuum indicator reads 35 F. Operate pump for 2 more hours.

   Do not apply greater vacuum than 29.82 in. Hg vac, ref 30-in. bar. (0.18 in. Hg abs) or go below 33 F 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 the dehydration process.
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. 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.

Piping systems must be properly vented, with no stress on water box nozzles or covers.

Water flow thru cooler and condenser must meet job requirements. Measure pressure drop across cooler and condenser or across the pumps.

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.

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. Compare reading with voltage rating on compressor and starter nameplates.
3. Compare ampere rating on starter nameplate with ampere 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, pumpout compressor motor starter, water pumps and tower fan.
6. Check separate 115-volt supply to oil heater.
7. Be sure that fused disconnects have been supplied for oil pump, oil heater, pumpout unit, water pumps and fan motor.
8. Check that electrical equipment and controls are properly grounded in accordance with job drawings and all applicable electrical codes.
9. After ensuring that motors are properly lubricated, momentarily energize each (except machine compressor) to determine direction of rotation. Correct as required.

   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.
    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 readings 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 19EA 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 1 minute and are factory set at 30 seconds.
5. With main disconnect switch open, manually open and close main control relay (1CR) to be sure it operates freely.

Oil Charge of approximately 15 gallons is shipped in the oil reservoir. Check sight glass (14) 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 thru the oil reservoir charging valve (19). 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 (16) indicates when the heater is energized. Set the oil heater thermostat to maintain a temperature of 140-145 F at shutdown.

Refrigerant Charge (Table 2) is shipped in the utility vessel. To prepare the machine for operation, follow the pumpout procedure RETURN REFRIGERANT TO NORMAL OPERATING CONDITIONS, page 21. If refrigerant must be added, charge it thru the refrigerant charging valve (42) or the tee near valve 6.

WARNING: Never charge liquid refrigerant into the unishell if the pressure is below 35 psig. Below 35 psig, R-12 will flash to a gas at a temperature below the freezing point of water. With cooler and condenser water flowing, charge the refrigerant as a gas until the vessel pressure is above 35 psig.

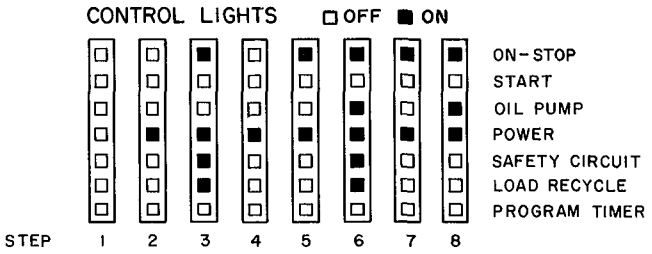
Refer to Trim Refrigerant Charge for full load adjustment.

Table 2 — Refrigerant Charging Quantity

SIZE*	WEIGHT (lb R-12)	SIZE*	WEIGHT (lb R-12)	SIZE*	WEIGHT (lb R-12)
19EA41	2000	19EA46	2375	19EA53	2700
19EA42	2000	19EA47	2375	19EA55	3000
19EA43	2175	19EA51	2600	19EA57	3100
19EA45	2175	19EA52	2650	19EA59	3500

*Unishell size — See machine identification plate (item 39, Fig 1)

Check Safety Control Operation — As the checks are made, control center lights should appear as indicated.



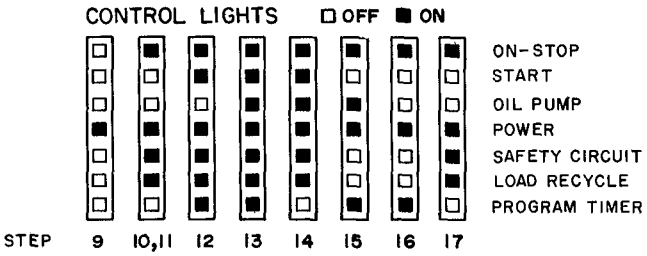
Some machines are equipped with bearing and motor high-temperature circuit breakers CB-1 and CB-2 (see Control Design 1, Fig. 3), and an oil temperature safety switch. Check the machine control wiring schematic on your control center door for these items (CB-1, CB-2, OIL TEMP).

1. Open main disconnect and remove all power from starters and controls. Then disconnect main motor leads in starter.
2. Provide power for control circuit and oil pump.
3. Press ON-STOP button (light goes on). If SAFETY CIRCUIT light does not go on, check resets on condenser high-pressure safety, low refrigerant safety, bearing and motor high-temperature circuit breakers (on some machines), and compressor overloads in starter. If machine has an oil temperature safety switch, switch will be open and machine will not start unless oil temperature is 120 F or higher. Check 3-amp fuse in relay module (Fig. 3).

   If SAFETY CIRCUIT light goes on but LOAD RECYCLE light stays off, check the chilled water recycle switch (auto-reset).

   If both lights go on, manually trip and reset motor and bearing high-temperature circuit breakers (Control Design 1, Fig. 3), compressor motor overloads in starter, low-refrigerant pressure safety and condenser high-pressure safety. Tripping the chilled water recycle switch will cut off the LOAD RECYCLE light only.
4. Press ON-STOP button (light goes out). Detach and tag end of wire running from terminal (17) to terminal [17] (or oil temperature safety on some machines).
5. Start chilled water and condenser water pumps. Press ON-STOP button (light goes on).
6. Press OIL PUMP button for several seconds. Pump should raise oil pressure to 20 - 25 psi differential between pump discharge pressure and oil reservoir pressure. Read differential on control center gage (item 10, Fig. 1). SAFETY CIRCUIT and LOAD RECYCLE lights should go on. If pump starts, but there is no pressure, reverse any 2 of 3 power leads to reverse the pump rotation.
7. Release OIL PUMP button. SAFETY CIRCUIT and LOAD RECYCLE lights should go out.
8. With OIL PUMP button depressed, alternately stop and restart chilled water and condenser

water pumps. SAFETY CIRCUIT and LOAD RECYCLE lights should go out as each pump stops. (Continuous operation of oil pump is unnecessary.)



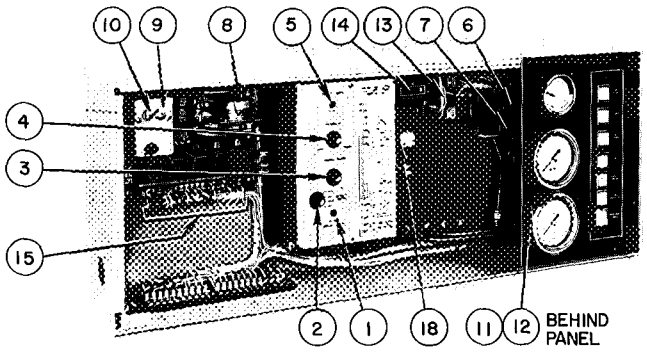
9. Shut off water pumps. Release OIL PUMP button. Press ON-STOP button (light goes out). Replace tagged wire on terminal (17).
10. Start cooler and condenser water pumps.
11. Press ON-STOP button (light goes on).
12. Press machine START button (motor leads disconnected).
13. Oil pump starts within 30 seconds.
14. Compressor motor start contacts close 30 seconds later. Starter transfers to run condition 30 seconds after starter is energized.
15. Open oil pump disconnect. Compressor motor starter must de-energize. OIL PUMP light remains on for about 30 seconds.
16. OIL PUMP light goes out.
17. Close oil pump disconnect. In approximately 15 minutes, the program timer completes the antirecycle portion of its cycle and machine is ready for restart.
18. Remove all power and then reconnect motor leads. Restore power.

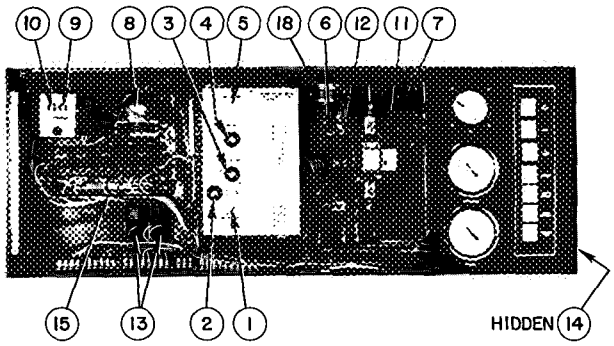
→ **Check Safety Control Settings** (Table 3)

With the exception of the chilled water low temperature cutout and recycle switch (Item 1, Table 3) these controls are most conveniently checked with machine off and unishell pressure at 0 psig. If switches are checked some time before machine initial start up; e.g., during leak test, be sure to tag each switch with temperature or pressure setting and date.

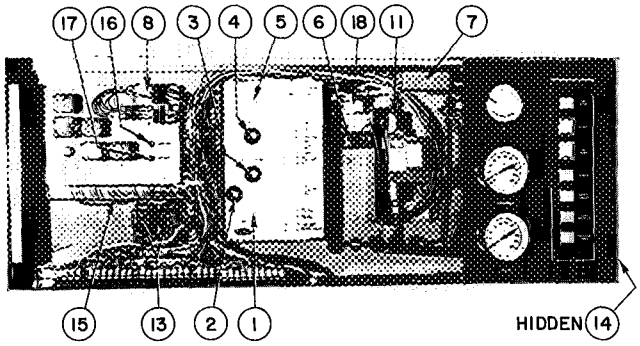
If machine is operated before safety check is complete, carefully monitor chilled water temperature to prevent tube freeze-up. Protection by safety controls cannot be assumed until all control settings have been confirmed.

Follow the procedures given in Table 3.





CONTROL DESIGN 1



CONTROL DESIGN 2

LEGEND

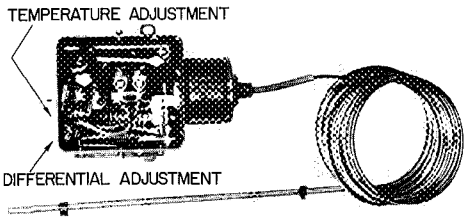
1 - Motor Current Calibration Adjustment
2 - Capacity Control Switch
3 - Electrical Demand Control
4 - Thermostat (chilled water)
5 - Throttle Range Adjustment
6 - Cond High-Press. Cutout (manual reset)
7 - Cooler Low-Press. Cutout (manual reset)
8 - Program Timer
9 - Mtr High-Temp Cir Breaker CB2 (manual reset)
10 - Brg High-Temp Cir Breaker CB1 (manual reset)
11 - Low Oil Pressure Cutout
12 - Econ-Cooler Diff Press Sw (on some machines)
13 - Temperature Sensor Modules
14 - Elapsed Time Indicator
15 - Relay Module
16 - Bearing Overtemperature Indicating Light
17 - Motor Overtemperature Indicating Light
18 - Cycling Timer

→ **Fig. 3 – Typical 19EA Control Centers**

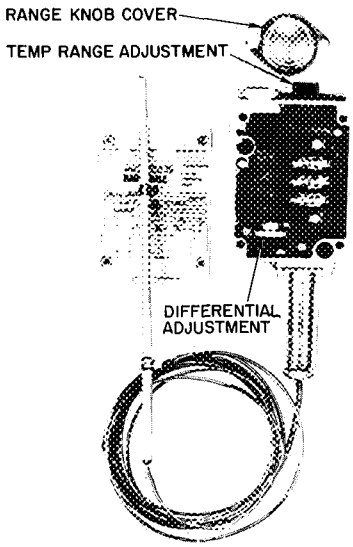
Table 3 — Checking Safety Controls

1. Chilled Water Low-Temperature Cutout and Recycle Switch (See Fig. 1)

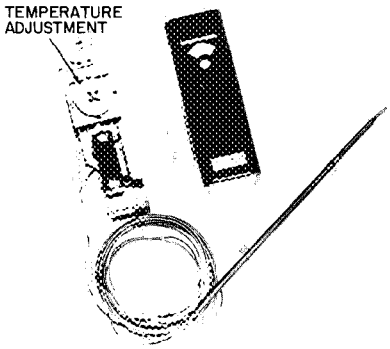
SWITCH MAY BE TYPE SHOWN IN 1a, 1b OR 1c.



TYPE 1a



TYPE 1b



TYPE 1c

Switch shown in 1c has nonadjustable differential of 10 F

1 With machine operating, adjust switch to open at approximately 5 F below design chilled water temperature, or 36 F, whichever is higher
2 If differential is adjustable (e g TYPE 1a and 1b), set at 10 F ± 1 F so that when machine shuts down automatically at set point chosen in step 1, it will restart automatically on water temperature rise of 10 F above the set point
3 This switch must open ahead of the cooler low-pressure cutout in order for the machine to recycle automatically

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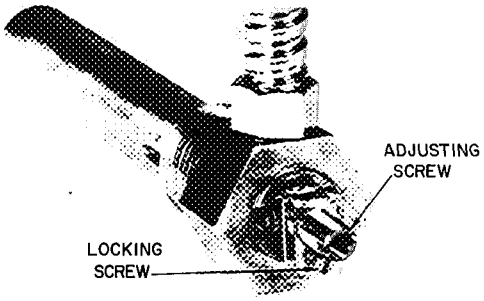
2. Oil Heater Thermostat (See Fig. 1)



Set the oil heater thermostat to maintain oil reservoir temperature of 140 - 145 F at machine shutdown

NOTE: When altering set point, turn adjusting screw in small increments; a half turn changes set point by 50 F

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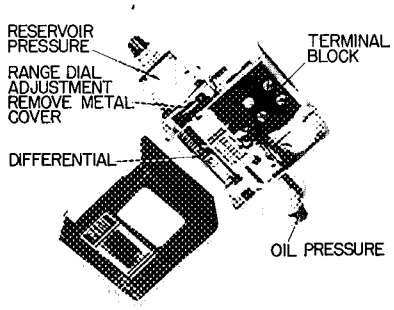
3. Oil Low Pressure Cutout (See Fig. 3)



On some machines, switch is behind gage panel Unscrew panel and move it forward to gain access to switch

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

Switch should close at 17 ± 1 psi differential between reservoir pressure connection and oil pressure connection Switch should open when pressure is reduced to 13 ± 1 psi differential

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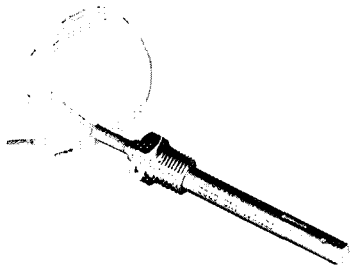
4. Oil Low Temperature Switch (See Fig. 1)

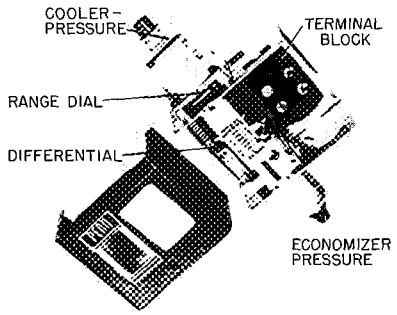


Supplied on some machines; see Fig 17, Control Design 1 Wiring Schematic

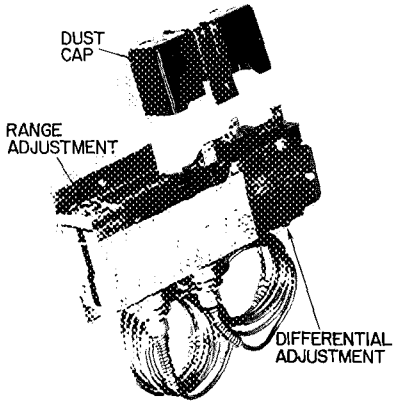
Switch is factory-set to prevent machine start if oil temperature is less than 120 ± 5 F Switch is not field adjustable.

Table 3 — Checking Safety Controls (Contd)

5. Economizer-Cooler Differential Pressure Switch (See Fig. 3)
SWITCH MAY BE TYPE SHOWN IN 5a OR 5b.



TYPE 5a



TYPE 5b

Not supplied on some machines If mounted behind gage panel, unscrew panel and move it forward to gain access to switch

Reduce unishell pressure to 0 psig Then disconnect switch pressure connections and check settings with a metered supply of air Always set range first, as indicated

STEP 1 — Set range adjustment so that switch will de-energize (cutout) on pressure rise at 22 ± 3 psi differential

STEP 2 — Set differential adjustment so that switch will energize (cut-in) on pressure drop at 12 ± 3 psi differential

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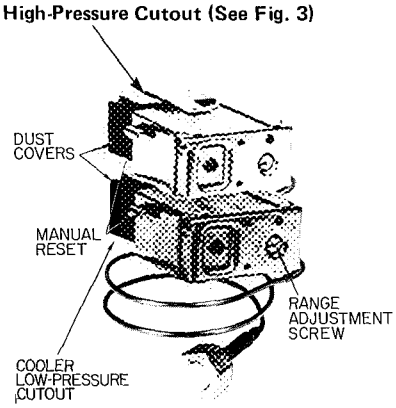
6. Condenser High-Pressure Cutout (See Fig. 3)



Mounted with cooler low-pressure cutout on some machines, as shown Reduce unishell pressure to 0 psig Disconnect switch pressure connections and check with metered supply of air

Switch should trip at 161 ± 5 psig Reduce pressure and check for manual reset at 130 ± 7 psig

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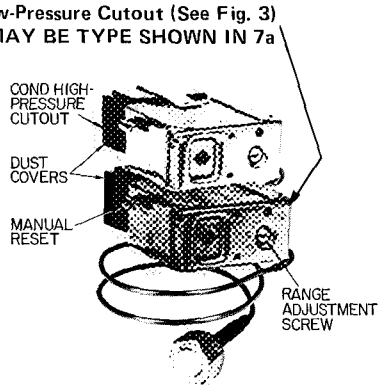
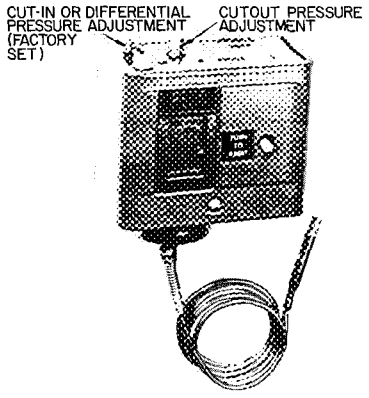
7. Cooler Low-Pressure Cutout (See Fig. 3)
SWITCH MAY BE TYPE SHOWN IN 7a OR 7b.



TYPE 7a



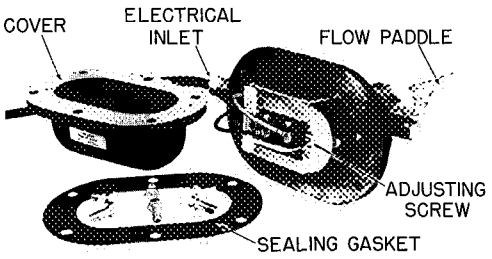
TYPE 7b

Mounted with condenser high-pressure cutout on some machines, as shown in 7a Reduce unishell pressure to 0 psig Disconnect switch pressure connections and check with a metered supply of air

Switch should cut out at the pressure corresponding to 1 F below suction temperature Refer to Table 4, Refrigerant 12 Properties (Saturated)

Table 3 — Checking Safety Controls (Contd)

8. Flow Switches (Field Supplied)



Operate water pumps with machine off Manually reduce water flow and observe switch for proper cutout point

Table 4 — Refrigerant R-12 Temperature vs Pressure (Saturated)

TEMP (F)	PRESS. (psig)	TEMP (F)	PRESS. (psig)	TEMP (F)	PRESS. (psig)
0	9.15	40	36.97	90	99.79
2	10.18	41	37.89	92	103.12
4	11.24	42	38.82	94	106.52
6	12.34	43	39.76	96	110.00
8	13.47	44	40.71	98	113.54
10	14.64	45	41.68	100	117.16
12	15.84	46	42.66	102	120.9
14	17.08	47	43.65	104	124.6
16	18.36	48	44.65	106	128.5
18	19.68	49	45.67	108	132.4
20	21.04	50	46.70	110	136.4
21	21.73	52	48.80	112	140.5
22	22.44	54	50.95	114	144.7
23	23.16	56	53.16	116	148.9
24	23.88	58	55.42	118	153.2
25	24.61	60	57.74	120	157.6
26	25.36	62	60.11	122	162.2
27	26.12	64	62.54	124	166.7
28	24.88	66	65.02	126	171.4
29	27.66	68	67.58	128	176.2
30	28.45	70	70.19	130	181.0
31	29.25	72	72.86	132	185.9
32	30.06	74	75.60	134	191.0
33	30.89	76	78.39	136	196.1
34	31.72	78	81.25	138	201.3
35	32.57	80	84.17	140	206.6
36	33.42	82	87.16	142	212.0
37	34.29	84	90.22	144	217.5
38	35.17	86	93.34	146	223.1
39	36.07	88	96.53	148	228.8

INITIAL START-UP

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

→ **Initial Start-Up** — Before operating machine for any length of time, check compressor rotation and operation as follows:

Start cooler and condenser water pumps. Set capacity control switch (item 2, Fig. 3) at HOLD. Press machine ON-STOP button and then START button. Compressor will start after start sequence has been completed (PROGRAM TIMER light goes out) and oil pump has operated for about 30 seconds (OIL PUMP light on).

As compressor motor begins to turn, check for clockwise motor rotation thru sight glass (item 20, Fig. 1) on motor end cover. Let compressor come up to speed. Note oil differential pressure on control center gage; differential should be 20 - 25 psi.

Press machine ON-STOP button *after compressor has reached operating speed.* Listen for any unusual sounds from compressor as it coasts to a stop. Confirm clockwise rotation as compressor coasts down.

If rotation is not clockwise, reverse any 2 of 3 power leads entering the motor starter and recheck rotation.

The program timer (item 8, Fig. 3) prevents rapid recycling of compressor and delays restart for 15 minutes after stop.

Check Operating Controls

Inspect guide vane linkage as described in the general maintenance section, Guide Vane Linkage, page 18.

CALIBRATE MOTOR CURRENT

1. Establish a steady motor current value for this calibration. Open guide vanes manually (capacity control at INC) until full load current is reached. Motor current calibration (item 1, Fig. 3) may have to be turned counterclockwise to permit vanes to open as needed. *Do not exceed 105% of nameplate full load amperes.*

   If full load current can be maintained for a period of time, calibrate at this condition. If not, pull down to and maintain (capacity control at HOLD) design leaving chilled water temperature, and calibrate at this condition.
2. Measure motor current at selected condition and determine its percentage of full load current.
3. Use this percentage to set the electrical demand control (item 3, Fig. 3) as follows:

PERCENT OF FULL LOAD MOTOR CURRENT	ELECTRICAL DEMAND ADJUSTMENT SETTING
105	100%
85 or above	80%
65 to 84	60%
45 to 64	40%
below 45	Control cannot be calibrated.

4. Turn motor current calibration adjustment fully clockwise. Guide vanes will close part way.
5. Turn thermostat (item 4, Fig. 3), to COOLER (fully counterclockwise).
6. Set capacity control at INC position.
7. Slowly turn motor current calibration counterclockwise. Allow the guide vanes to open until

motor current reaches 5% above electrical demand setting.

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

8. Check the foregoing motor current calibrations with machine under AUTO. control as follows:
   a. Close vanes manually (capacity control to DEC).
   b. Turn capacity control to AUTO. Vanes should stop opening at electrical demand setting.
9. If control was calibrated at less than 100% load, turn electrical demand control to 100%. Control is now automatically calibrated for 100% full load current.
10. If control cannot be calibrated with above procedure, check voltage signal from signal resistor in starter. At 100% full load current, voltage between terminals 23 and 24 inside control center must be 0.5 ± 0.1 volts. If not in this range, check sizing of resistor in starter.

Both excess motor current and chilled water temperatures below the thermostat set point will override the capacity control setting. If the capacity control knob is in the INC position, the guide vanes will stop opening. At any other knob position, the vanes will close as needed.

The motor current limiting circuit operates in 2 steps.

At 100% full load motor current, the vanes will stop opening further. If the motor current should increase to 105% because of some change in load conditions, the vanes will close until the current is reduced to about 102%.

When the motor current drops to 98% or below, control again responds to chilled water temperature.

CHILLED WATER CALIBRATION PROCEDURE

1. Turn throttle range calibration adjustment (item 5, Fig. 3) fully clockwise.
2. Turn chilled water thermostat (item 4, Fig. 3) until design chilled water temperature is maintained. Mark thermostat at this position. If capacity control vanes hunt, turn throttle range calibration adjustment counterclockwise in small increments until hunting ceases. Chilled water thermostat may require resetting.
3. Set chilled water low temperature cutout and recycle switch per Table 3.

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

Trim Refrigerant Charge – If it is necessary to adjust the refrigerant charge to obtain optimum machine performance, refer to Trimming Refrigerant Charge in the Operating Instructions section, page 17.

Calibrate Optional Controls (if supplied)

LEAD-LAG CONTROL – Establish a steady cooling load for this procedure.

1. Turn transfer switch on lead-lag control to MAN. position.
2. Push no. 1 machine ON-OFF button (light goes on).
3. Operate no. 1 machine manually and calibrate the chilled water controls as described under Chilled Water Calibration Procedure.
4. Turn off no. 1 machine by pushing ON-OFF button (light goes out).
5. Push no. 2 machine ON-OFF button (light goes on).
6. Operate no. 2 machine manually and calibrate the chilled water controls in a similar manner.
7. Start both machines and remove plug button from lead-lag control panel. Turn set point adjustment until leaving chilled water temperature on no. 2 machine is at the predetermined point for optimum series operation. A clockwise turn raises set point temperature; counterclockwise turn lowers set point.

REMOTE THERMOSTAT

1. Turn throttle range adjustment in machine control center fully clockwise. (See Fig. 3.)
2. Turn remote thermostat knob fully counterclockwise (maximum COOLER position).
3. Start machine.
4. Turn machine thermostat knob in control center to minimum chilled water set point per job requirements.
5. Adjust remote thermostat for desired chilled water temperature. If guide vanes hunt, turn throttle range adjustment counterclockwise in small increments until hunting ceases. Remote thermostat may require resetting.

INSTRUCT THE CUSTOMER OPERATOR

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

Compressor-Motor Assembly – Guide vanes, vane motor and linkage, motor cooling system, transmission, temperature sensing devices.

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 — ON-STOP, START, OIL PUMP switches, indicating lights, 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.

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, maintain proper levels of oil, water and refrigerant.
5. Protect system from damage during shutdown.

Prepare Machine for Start-Up — Before starting machine, check that:

1. Power is on to main starter, oil pump starter, water pumps and tower fan, oil heater and machine control circuit.
2. Cooling tower water is at proper level.
3. Machine is charged with refrigerant, with all refrigerant valves in normal operating position (see Pumpout Procedures).
4. Oil visible in reservoir sight glass.
5. Oil reservoir temperature is 140 - 150 F.
6. Oil cooler plug valve (item 36, Fig. 1) is partially open.
7. Valves in chilled water and condenser water circuits are open and water is circulating properly. *Do not permit water warmer than 100 F to flow thru cooler Refrigerant overpressure may actuate relief valves and result in loss of refrigerant charge.*

To Start Machine

1. Start water pumps, if not automatic.
2. Press ON-STOP button on machine control center. (ON-STOP, SAFETY CIRCUIT and LOAD RECYCLE lights go on.)
3. Press START button (light goes on). Oil pump starts (light goes on) within 1/2 minute. If PROGRAM TIMER light was on before pressing START button, oil pump will start within 15 minutes.
   Compressor starts approximately 30 seconds after oil pump; program timer stops and PROGRAM TIMER light goes out.

→ **Check Running System** — After compressor starts, operator should observe the following indications of normal operation.

Oil reservoir temperature should be 140 - 150 F. 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 differential at control center gage.

Bearing oil return temperature should be 150 - 175 F. If bearing thermometer (item 33, Fig. 1) reads more than 180 F 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. Check your selected design temperature.

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

Cooler refrigerant temperature varies with machine design conditions; range is usually 30 - 40 F. Check your selected design temperature.

Dehydrator pressure should be midway between cooler and condenser pressures.

NOTE: The compressor may operate at full capacity for a short time during pulldown, even though the building cooling load is small. The electrical demand control (item 3, Fig. 3) can be adjusted to avoid a high demand charge for the short period of full capacity operation.

To Stop Machine

1. Press ON-STOP button (ON-STOP, START, SAFETY CIRCUIT and LOAD RECYCLE lights go out; PROGRAM TIMER light goes on). Compressor motor is de-energized and begins coastdown.
2. Stop water pumps and tower fan, if not automatic.
3. Oil pump stops within 40 seconds; OIL PUMP light goes out.
4. Machine can be restarted 14 minutes after oil pump stops.

If machine fails to stop, close guide vanes 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 located and 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 in the Unishell. Maintain 140 - 145 F 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 (item 2, Fig. 3) permits the operator to change leaving chilled water temperature without altering the automatic temperature control settings.

Manual control is useful in checking control operation and safety cutout points, overcooling the building prior to a heavy load, 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 water temperature. HOLD maintains guide vane position. INC (increase) opens the guide vanes, increases machine capacity and *lowers* chilled water temperature.

NOTE: Motor current above the electrical demand control setting (item 3, Fig. 3) or above motor full load amperage, and chilled water temperature below the thermostat set point will prevent the machine from responding to an INC signal.

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 pressures, temperatures and liquid levels on a sheet similar to that shown (reduced in size) in Fig. 4. Full size (8½ x 11 in.) sheets can be obtained thru your Carrier representative. 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 thru 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 during shutdown. The heater pilot light indicates 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.

Check Dehydrator Operation — Noncondensable gas (air) in the dehydrator chamber is indicated by higher than normal dehydrator pressure. If dehydrator pressure is within 10 psig 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 can be seen 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 is allowed to remain in the machine refrigerant side, serious damage can 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 replacement of relays or modules. In the event of machine control malfunction, refer to the Troubleshooting Guide in this publication for control checks and adjustment procedures.

Be sure power is off when making checks and adjustments inside control center.

Check Safety Controls — To ensure machine protection, the 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 3 for control illustrations and 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, SSU	150 ± 10
Viscosity at 210 F, SSU	40 - 45
Dielectric, minimum	25 Kv
Floc point, maximum	−60 F
Pour point, maximum	−35 F
Neutralization no., maximum	.05
Flash point, minimum	330 F
Moisture content, maximum	30 ppm

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

Carrier Air Conditioning Company

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 _____					
Time	Shut-down Refrigerant Level	Refrigerant Pressure	Water Temperature IN	Water Temperature OUT	Refrigerant Pressure	Refrigerant Temperature	Water Temperature IN	Water Temperature 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. 4 — Refrigeration Log

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.
4. Stop compressor and isolate system by closing discharge service valve.
5. Slowly remove oil return line connection (item 40, 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 and should reset automatically on pressure drop to 130 (+7, −0) psig. Switch setting may be checked 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: Isolating knife switches must not be opened while machine is running. Serious injury may result.

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

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

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

1. Be sure that refrigerant has been transferred from unishell to utility vessel.
2. Open dehydrator air vent valve (item 8, Fig. 10) to be sure dehydrator pressure is 0 psig; then remove cover from dehydrator float chamber.

3. Clean float chamber.
4. Make sure that float valve (item 3, Fig. 10) operates freely thru 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.
7. Check the 1/16-in. orifice in the dehydrator sampling line (item 7, Fig. 10). 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 into the machine. Check for air per Dehydrator Operation section. If abnormal condition persists after this check, the tubes should be cleaned. A properly maintained Refrigeration Log will quickly show 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. 10), refrigerant orifice (item 31, Fig. 10) and screen (item 36, Fig. 10).

Be sure that the float valves move freely and that linkage is tight. If machine is equipped with a refrigerant feed control piston (item 28, Fig. 10), be sure that the float valve is fully open before the feed control piston reaches full stroke position. Adjust cable if necessary. When the float valve is closed, the piston should be against the snap ring and the cable should be without slack.

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, drain the oil from the reservoir thru the charging valve (item 6, Fig. 12), and from the filter-cooler by removing the drain plug (item 30, Fig. 12).
4. When unishell pressure reaches 0 psig, remove the oil cooler cover and replace the 2 oil filters (item 1, Fig. 12).
5. Replace the oil cooler cover, using a new O-ring. Add oil thru the charging valve. Approximately 15 gallons should bring the oil level to 1/3 sight glass (item 8, Fig. 12).
6. Turn on oil heater and warm oil to 140 - 145 F. 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, SSU	300 ± 25
Viscosity at 210 F, SSU	50 to 55
Viscosity index (min)	95
Pour point (max)	−5 F
Flash point (min)	400 F

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

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

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

With unishell pressure at 0 psig, examine bearings on a scheduled basis for signs of wear. The frequency of examination is determined by the hours of machine operation, type of load on machine and condition of the lubrication system.

The removal and examination of bearings should be done only by a trained service mechanic.

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

→ **Check Economizer Damper** – If machine is equipped with a damper (item 43, Fig. 1), check the assembly yearly or when machine is opened for repair.

With unishell/compressor pressure at 0 psig, remove the spring housing from the damper valve (Fig. 5). Exercise care in removing cover against force of valve spring (approximately 50 lb).

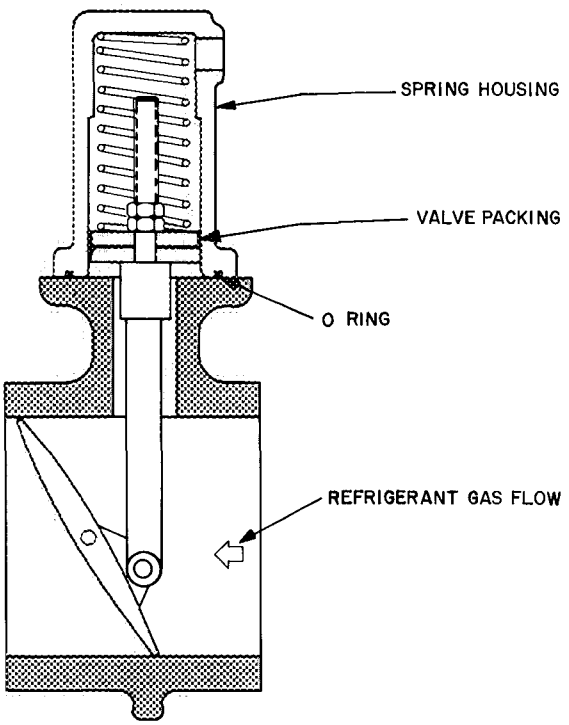
Check the valve, damper blade and linkage for free travel and clean the assembly thoroughly. Replace the valve packing and the housing O-ring gasket (Fig. 5) if necessary.

→ **Change Refrigerant Filter or Strainer** – With unishell pressure at 0 psig, change refrigerant filter or strainer (items 10 and 11, Fig. 10) yearly, or more often if filter or strainer 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.



→ **Fig. 5 — Economizer Gas Line Damper**

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 25 degrees below 0° F and 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 concentrations, *may displace enough oxygen to cause asphyxiation.* When handling this refrigerant, protect hands and eyes and avoid breathing fumes.

Charging Refrigerant — The 19EA 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.

Always charge refrigerant as a gas when unishell pressure is less than 35 psig. Below this pressure, liquid refrigerant will flash into gas at extremely low temperature. This can cause tube freeze-up and serious damage.

Connect the refrigerant container to valve (42) or to the charging connection near valve 6 (Fig. 8). Charge refrigerant *as a gas* until system pressure exceeds 35 psig. Then charge as a liquid until 2/3 of full charge (Table 2) 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 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. Mark the shutdown refrigerant level near the sight glasses on the utility vessel (items 23, 24 and 25, Fig. 1).

→ **Refrigerant Leak Testing** — Because Refrigerant 12 is 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 from the leaking vessel.

If all refrigerant has been lost:

CHECK UNISHELL (see Fig. 1 and 8 for item reference). Isolate unishell from utility vessel by closing valves (27), (28), (29) and (30). *Operate cooler and condenser water pumps*

Using dry gas or nitrogen with Refrigerant 12 tracer, raise vessel pressure to 5 psig 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 gas and tracer into unishell.

Leak test with halide or electronic leak detector. If leak is undetected at 5 psig, continue pressurizing to 30 psig 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 thru charging tee as required to reach 5 psig.

Leak test with halide or electronic leak detector. If leak is not apparent at 5 psig, pressurize to 30 psig and retest.

EVACUATE VESSELS – After repair, evacuate vessels and then charge with 400 lb of Refrigerant 12. If vessels remain leak tight, charge to normal operating levels. Table 2 lists nominal machine charges.

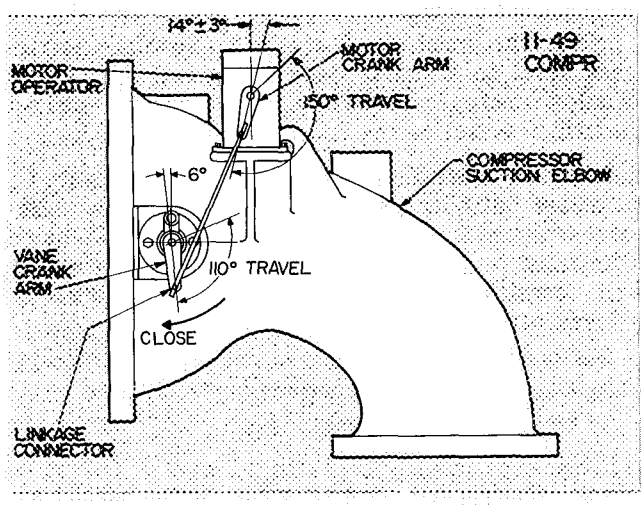
→ **Guide Vane Linkage** – The 19EA guide vane and linkage assembly is adjusted and set at the factory.

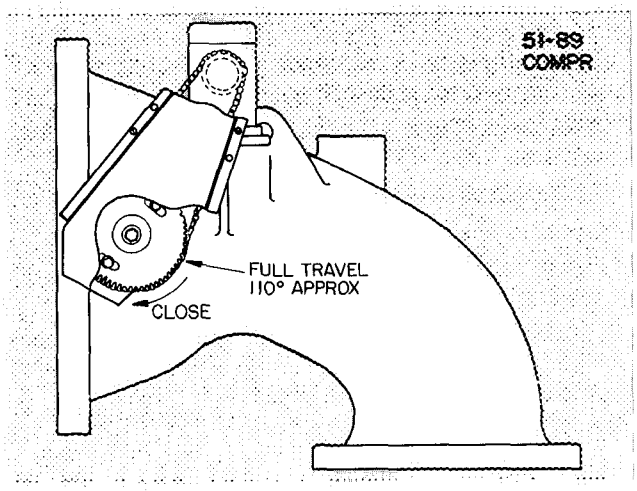
When the machine is off, the guide vanes are closed and the vane motor operator is stopped by a limit switch at the position shown in Fig. 6.

19EA4 (11-49) SIZE COMPRESSOR (Fig. 6)

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.





→ **Fig. 6 – Vane Motor Crank Angle**

19EA5 (51-89) SIZE COMPRESSOR (Fig. 6)

If slack develops in the drive train, eliminate backlash as follows:

1. With machine shut down (guide vanes closed), remove chain guard, loosen actuator hold-down bolts and remove chain.
2. Loosen guide vane sprocket set screw and rotate sprocket wheel until set screw clears existing spotting hole.
3. With set screw still loose, replace chain and move vane actuator to the left until all chain slack is taken up.
4. Tighten vane actuator hold-down bolts and retighten vane sprocket set screw in new position (31 lb/ft torque).
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.

→ **Sensor Test Procedure** – Bearing, discharge, motor slot and motor end-turn temperature sensors are connected to 2 modules in the machine control center (Fig. 3).

To check the sensors, turn off control power and disconnect the wires from module terminals SENSOR 1, SENSOR 2 and C. Refer to Fig. 7 and, with an ohmmeter, check resistance between wires from sensors as follows:

MODULE	SENSOR	CHECK WIRES BETWEEN
Discharge & Bearing Temperature Module	Discharge	Sensor 1 – C
	Bearing	Sensor 2 – C
Motor Temperature Module	End Turn	Sensor 1 – C
	Slot	Sensor 2 – C

The values plotted in Fig. 7 are resistance values at the sensor itself and do not include fuse and wiring resistance.

Use an ohmmeter only. Application of more than 6 volts to sensor will cause damage.

To determine whether the module has tripped on a temperature safety, apply the ohmmeter test above for the following resistance levels:

MODULE	TRIP TEMP	RESISTANCE
Motor Temperature	220 F	110 Ω
Discharge & Bearing	200 F(1)	105 Ω
	220 F(2)	110 Ω

(1) Control design 1. See Fig 17
(2) Control design 2 See Fig 18

→ **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 section entitled, Isolation Valve Operation, page 3. Improper closing of isolation valve can cause valve damage and refrigerant loss.

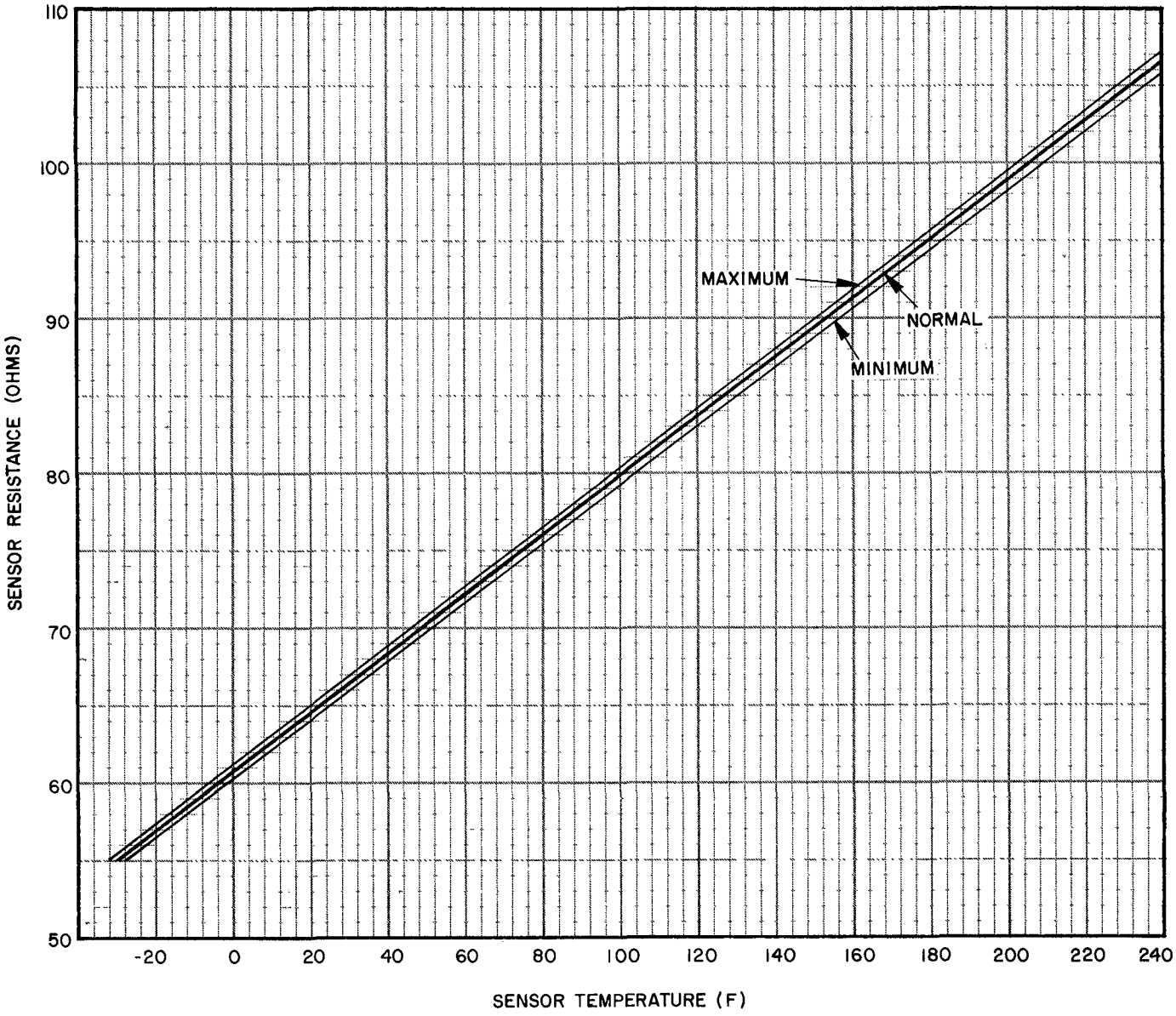


Fig. 7 — Sensor Resistance vs Temperature

Throughout the procedures, valves are identified by the item numbers used in Fig. 1 and 8. The letter C in the valve condition diagrams indicates a closed valve. For gage and pressure connections, see Table 1.

MACHINE VARIATIONS — If your machine model does not have one or more of the following valves; 7, 8, 9, 26 or 42, merely ignore the reference to the missing valve and follow the procedure in a normal fashion.

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.

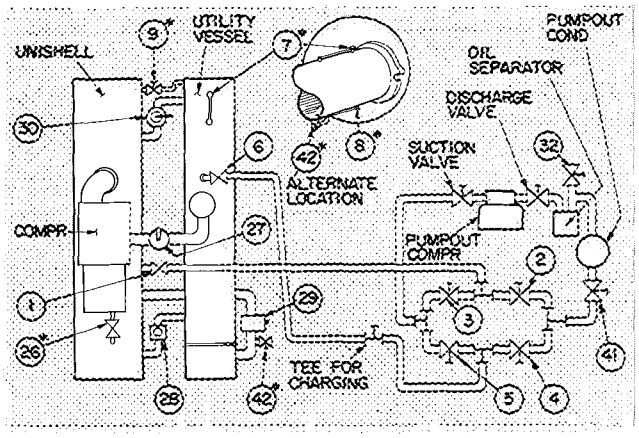
Loosen the compressor hold-down bolts sufficiently to allow free spring travel.

Open the pumpout condenser discharge valve (item 41, 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.

Pumpout unit control wiring is shown schematically in the Pumpout Unit Controls section.

PRESSURE AND VACUUM CONNECTIONS are listed in Table 1. 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.*



*Machine may not be equipped with some valves marked (*)

→ **Fig. 8 – Pumpout System Piping Schematic (See Fig. 1 Legend for Item Reference)**

■ TRANSFER REFRIGERANT FROM UTILITY VESSEL TO UNISHELL from normal operating condition. (See Fig. 1 and 8.)

VALVE NO.	1	2	3	4	5	6	7	8	9	26	27	28	29	30	32	42
CONDITION	C	C	C	C	C	C	C	C		C					C	C

1. Provide utility vessel pressure gage (see Table 1).
2. Close isolation valves (27), (28) and (30).
3. Open valves 1, 3, 4, 6, 7, 8 and (42) if connected to gage.
4. Close valve 9.

VALVE NO.	1	2	3	4	5	6	7	8	9	26	27	28	29	30	32	42
CONDITION		C			C				C	C	C	C		C	C	

5. Be sure that pumpout condenser water is off.
6. Operate pumpout compressor until liquid is out of utility vessel.
7. Close isolation valve (29). (See page 3.)
8. Turn off pumpout compressor.
9. Close valves 3 and 4.
10. Open valves 2 and 5.

VALVE NO.	1	2	3	4	5	6	7	8	9	26	27	28	29	30	32	42
CONDITION			C	C					C	C	C	C	C	C	C	

11. Turn on pumpout condenser water.
12. Run pumpout compressor until utility vessel pressure reaches 22 in. Hg vac ref 30-in. bar. (4 psia).
13. Turn off pumpout compressor.
14. Close valves 1, 2, 5, 6 and (42).
15. Turn off pumpout condenser water.

VALVE NO.	1	2	3	4	5	6	7	8	9	26	27	28	29	30	32	42
CONDITION	C	C	C	C	C	C			C	C	C	C	C	C	C	C

■ TRANSFER REFRIGERANT FROM UNISHELL TO UTILITY VESSEL from normal operating condition. (See Fig. 1 and 8.)

VALVE NO.	1	2	3	4	5	6	7	8	9	26	27	28	29	30	32	42
CONDITION	C	C	C	C	C	C	C	C		C					C	C

1. Turn off cooler and condenser water pumps.
2. Open drain valve (26).

VALVE NO.	1	2	3	4	5	6	7	8	9	26	27	28	29	30	32	42
CONDITION	C	C	C	C	C	C	C	C							C	C

3. Wait 10 minutes; close isolation valves (27) and (30).
4. Open valves 1, 2, 5, 6, 7 and 8.
5. Close valve 9.

VALVE NO.	1	2	3	4	5	6	7	8	9	26	27	28	29	30	32	42
CONDITION			C	C					C		C			C	C	C

6. Be sure that pumpout condenser water is off.
7. Run pumpout compressor for 10 minutes; then close isolation valve (28). (See page 3.)

VALVE NO.	1	2	3	4	5	6	7	8	9	26	27	28	29	30	32	42
CONDITION			C	C					C		C	C		C	C	C

8. Run pumpout compressor for 20 minutes or until bubbles are visible in sight glasses (23), (24) and (25); then close isolation valve (29). (See page 3.)

VALVE NO.	1	2	3	4	5	6	7	8	9	26	27	28	29	30	32	42
CONDITION			C	C					C		C	C	C	C	C	C

9. Turn off pumpout compressor.
10. Closes valves 2 and 5.
11. Open valves 3 and 4.

VALVE NO.	1	2	3	4	5	6	7	8	9	26	27	28	29	30	32	42
CONDITION		C			C				C		C	C	C	C	C	C

12. *Turn on cooler and condenser pumps and pumpout condenser water.*
13. Run pumpout compressor until unishell pressure reaches 35 psig 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.
14. Let pressure build up to about 40 psig and turn on pumpout compressor.
15. Repeat steps 13 and 14 until pressure stops rising.
16. Run pumpout compressor until unishell pressure reaches 22 in. Hg vac ref 30-in. bar. (4 psia).
17. Turn off pumpout compressor.
18. 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	7	8	9	26	27	28	29	30	32	42
CONDITION	C	C	C	C	C	C			C		C	C	C	C	C	C

■ UTILITY VESSEL EVACUATING PROCEDURE (See Fig. 1 and 8.)

VALVE NO.	1	2	3	4	5	6	7	8	9	26	27	28	29	30	32	42
CONDITION	C	C	C	C	C	C			C	C	C	C	C	C	C	C

1. Open valves 5, 6 and (42) if connected to gage.

VALVE NO.	1	2	3	4	5	6	7	8	9	26	27	28	29	30	32	42
CONDITION	C	C	C	C					C	C	C	C	C	C	C	

2. Turn on pumpout condenser water.
3. Remove flare cap 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	7	8	9	26	27	28	29	30	32	42
CONDITION	C	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. (4 psia).
6. Close valves 5, 6, 7, 8 and (42).
7. Shut off pumpout compressor.
8. Close vent valve (32) and replace flare cap.

VALVE NO.	1	2	3	4	5	6	7	8	9	26	27	28	29	30	32	42
CONDITION	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C

■ UNISHELL EVACUATING PROCEDURE (See Fig. 1 and 8.)

VALVE NO.	1	2	3	4	5	6	7	8	9	26	27	28	29	30	32	42
CONDITION	C	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	7	8	9	26	27	28	29	30	32	42
CONDITION		C		C	C	C			C		C	C	C	C	C	C

2. Turn on pumpout condenser water.
3. Remove flare cap 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	7	8	9	26	27	28	29	30	32	42
CONDITION		C		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. (4 psia).
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	7	8	9	26	27	28	29	30	32	42
CONDITION	C	C	C	C	C	C			C		C	C	C	C	C	C

■ RETURN REFRIGERANT TO NORMAL OPERATING CONDITIONS (See Fig. 1 and 8.)

1. Be sure that opened vessel has been evacuated.

   If unishell evacuated:

VALVE NO.	1	2	3	4	5	6	7	8	9	26	27	28	29	30	32	42
CONDITION	C	C	C	C	C	C			C	C	C	C	C	C	C	C

   If utility vessel evacuated:

VALVE NO.	1	2	3	4	5	6	7	8	9	26	27	28	29	30	32	42
CONDITION	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C

2. Open valves 1, 3, 6, 7 and 8.
3. Run water pumps.

VALVE NO.	1	2	3	4	5	6	7	8	9	26	27	28	29	30	32	42
CONDITION		C		C	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. 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.
5. Open valve 5 fully.

VALVE NO.	1	2	3	4	5	6	7	8	9	26	27	28	29	30	32	42
CONDITION		C		C					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, 7 and 8.
8. Open isolation valves (27), (28) and (30) and service valve 9.

VALVE NO.	1	2	3	4	5	6	7	8	9	26	27	28	29	30	32	42
CONDITION	C	C	C	C	C	C	C	C		C					C	C

→ **Machines Without Pumpout Systems** – Use the following procedures for transferring refrigerant by means of nitrogen and for evacuating vessels by vacuum pump. *Some loss of refrigerant is unavoidable when nitrogen or other gas is used for transfer of refrigerant*

■ TRANSFER REFRIGERANT FROM UTILITY VESSEL TO UNISHELL from normal operating condition. (See Fig. 1 for all numbered references.)

VALVE NO.	1	6	7	8	9	26	27	28	29	30	42
CONDITION	C	C	C	C		C					C

1. Close isolation valves (27), (28), (30) and service valve 9.
2. Open equalizing valves 7 and 8.
3. Connect a *regulated* bottle of nitrogen to 1/2-in. male flare charging valve 6.
4. Open valve 6 fully.
5. Open cylinder regulating valve slowly and increase utility vessel pressure 5 psi until all liquid refrigerant is in unishell.
6. Close isolation valve (29). (See shaded note, page 3.)
7. Close cylinder regulating valve.
8. Close valve 6 and disconnect nitrogen bottle.
9. Open valve 6 and vent nitrogen and refrigerant gas until vessel pressure is 0 psig. Close valve 6.

■ TRANSFER REFRIGERANT FROM UNISHELL TO UTILITY VESSEL from normal operating condition. (See Fig. 1.)

1. Turn off cooler and condenser water pumps.
2. Wait 10 minutes; close isolation valves (27), (28) and (30). Observe shaded note, page 3.
3. Connect a regulated bottle of nitrogen to valve 1 (1/2-in. ODS connection).
4. Open valve 1 fully.
5. Open cylinder regulating valve and increase unishell pressure by 5 psi. Maintain pressure until all liquid refrigerant is transferred to utility vessel (nitrogen bubbles will be visible in the utility vessel sight glasses).
6. Close isolation valve (29) quickly (observe shaded note, page 3).
7. Close cylinder regulating valve.
8. Close valve 1 and disconnect nitrogen bottle.
9. *Turn on cooler and condenser water pumps.*
10. Open valve 1 and slowly vent nitrogen and refrigerant gas until unishell pressure drops to 35 psig. Close valve 1 and let stand. Any liquid refrigerant trapped in the unishell will boil off from the heat of the cooler and condenser water and unishell pressure will rise.
11. If pressure rises, open valve 1 and vent back to 35 psig. Repeat until pressure holds at 35 psig.
12. Vent unishell to 0 psig. Close all valves.

■ UTILITY VESSEL EVACUATION PROCEDURE (see Fig. 1)

VALVE NO.	1	6	7	8	9	26	27	28	29	30	42
CONDITION	C	C			C	C	C	C	C	C	C

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

■ UNISHELL EVACUATION PROCEDURE (see Fig. 1)

VALVE NO.	1	6	7	8	9	26	27	28	29	30	42
CONDITION	C	C	C	C	C	C	C	C	C	C	C

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

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

1. Install 1/2-in. copper line between valves 1 and 6.
2. Be sure that opened vessel has been evacuated.

   If unishell evacuated:

VALVE NO.	1	6	7	8	9	26	27	28	29	30	42
CONDITION	C	C			C	C	C	C	C	C	C

   If utility vessel evacuated:

VALVE NO.	1	6	7	8	9	26	27	28	29	30	42
CONDITION	C	C	C	C	C	C	C	C	C	C	C

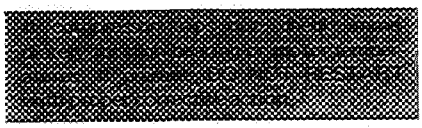
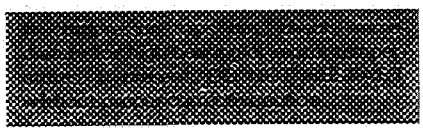
3. Run cooler and condenser water pumps.
4. Open valves 7 and 8.
5. a. *If unishell has been evacuated* – Open valve 6 and crack open valve 1, gradually increasing unishell pressure to 35 psig. Feed refrigerant gas slowly to prevent tube freeze-up.

   b. *If utility vessel has been evacuated* – Open valve 1 and crack open valve 6 to gradually equalize pressure between unishell and utility vessel. To avoid tube freeze-up, be sure that unishell pressure does not drop below 35 psig.
6. Open valves 1 and 6 fully.
7. Open valve (29) to equalize liquid refrigerant level between vessels.
8. Open valves (27), (28), (30) and 9.
9. Close valves 1, 6, 7 and 8 and remove interconnecting tubing.

TROUBLESHOOTING GUIDE

For pictorial identification of Control Design 1 and Control Design 2 models, refer to Fig. 3.

TROUBLE/SYMPTOM – COMPRESSOR WILL NOT START

SYMPTOM	PROBABLE CAUSE	REMEDY
All panel lights out.	No control power	Check for building power failure Check main circuit breaker
	Blown fuse	Check 15-amp fuse in control circuit; examine circuit for ground or short
Panel lights as shown; SAFETY CIRCUIT light does not come on. ■ ON-STOP □ START □ OIL PUMP ■ POWER □ SAFETY CIRCUIT □ LOAD RECYCLE □ PROGRAM TIMER	Bearing or motor winding circuit breaker (CB1 or CB2) tripped DESIGN 1	Check CB1 If open, reset Check relay KB by replacing it with relay KM Check CB2 If open, reset Check relay KM by replacing it with relay KB.  Check sensors Refer to Sensor Test Procedure, page 18
	Bearing or motor winding temperature switch open DESIGN 2	If BRG or MTR indicating light on relay module (Fig 3) is lit, check immediately for high bearing or motor temperature. If temperatures are normal, check relay KB and KM.  Check sensors Refer to Sensor Test Procedure, page 18 Reset is made by pressing ON-STOP button
	Cooler low-pressure or condenser high-pressure switch tripped.	Reset switch manually
	Blown fuse.	Check 3-amp fuse in control circuit; examine circuit for ground or short
	Compressor motor overloads tripped	Reset overloads in starter.
	Time-delay relay K4 open DESIGN 1	Remove control power and check continuity between [17] and (14); if open, check K4 relay
	Program timer switch PT-4 in N.C position DESIGN 2	Remove control power and check continuity between [17] and (14); if open, check PT-4
	Oil temperature too low (on some machines) Oil low-temperature switch (Fig 12) open	Check oil heater setting and operation (Table 3)
Panel lights as shown; LOAD RECYCLE light does not come on. ■ ON-STOP ■ START □ OIL PUMP ■ POWER ■ SAFETY CIRCUIT □ LOAD RECYCLE □ PROGRAM TIMER	Chilled water temperature too low.	Check water temperature.
	Chilled water low-temperature switch incorrectly set	Check setting of switch
✱ **PROGRAM TIMER light goes on momentarily, then out.** ■ ON-STOP ■ START □ OIL PUMP ■ POWER ■ SAFETY CIRCUIT ■ LOAD RECYCLE ✱ PROGRAM TIMER	1CR normally closed contact open.	Check for 115 volts between (15) and [L2]

TROUBLE/SYMPTOM – COMPRESSOR WILL NOT START

SYMPTOM	PROBABLE CAUSE	REMEDY
OIL PUMP light goes on 10 to 30 seconds after pushing START button; goes out after about one minute. **START light stays on.** ■ ON-STOP ■ START ◉ OIL PUMP ■ POWER ■ SAFETY CIRCUIT ■ LOAD RECYCLE ■ PROGRAM TIMER	Oil pump not operating (check by pressing OIL PUMP button) DESIGN 1	Push ON-STOP button (light out) and then: Check for open oil pump disconnect. Check for faulty pump wiring Check for faulty oil pump.
	Oil pump operates but oil pressure low. DESIGN 1	Check oil level Check for dirty oil filters; replace Check oil pressure regulating valve
	Oil low-pressure switch open (oil pressure normal). DESIGN 1	Check setting of oil low-pressure switch Check that both sets of contacts close when oil pressure is normal
	Vane-Closed switch open. DESIGN 1	Check continuity between (V1) and (V2); if none, check guide vane adjustment linkage per Fig 6 If actuator is not in fully closed position, check relay K2 by replacing it with K3
	Vane-Closed switch open DESIGN 2	Check continuity between (V1) and [61]; if none, check guide vane adjustment linkage per Fig 6 If actuator is not in fully closed position, check relay K2
	Start relay 1CR inoperative.	Check for 115 volts between (V2) and (L2) Voltage should be present for 10 seconds approximately 1/2 minute after oil pump starts. If not, check PT-3; if so, then remove all power to main starter and examine 1CR relay
OIL PUMP light goes on 10 to 30 seconds after pushing START button; goes out after about one minute. **START light goes out.** ■ ON-STOP □ START ◉ OIL PUMP ■ POWER ■ SAFETY CIRCUIT ■ LOAD RECYCLE ■ PROGRAM TIMER	Water pumps not running	Start pumps Check pump starter(s) and relay(s)
	Water flow switches open (pumps running)	Check contacts of flow switches Check for air in water line; vent air
	Oil pump starter auxiliary contacts M3 open (oil pressure normal)	Check contacts.
	Oil pump not operating (check by pressing OIL PUMP button) DESIGN 2	Push ON-STOP button (light out) and then: Check for open oil pump disconnect Check for faulty pump wiring. Check for faulty oil pump
	Oil pump operates but oil pressure low. DESIGN 2	Check oil level Check for dirty oil filters; replace. Check oil pressure regulating valve.
	Oil low-pressure switch open (oil pressure normal) DESIGN 2	Check setting of oil low-pressure switch Check that both sets of contacts close when oil pressure is normal.

TROUBLE/SYMPTOM – COMPRESSOR TRIPS OFF (Note: See Machine Recycle, page 40)

All panel lights out.	Power failure	Check for building power failure Check main circuit breaker and/or fuses.
	Blown fuse	Check 15-amp fuse in control circuit; examine circuit for ground or short
OIL PUMP light goes out approximately 40 seconds after compressor stops. START light goes out, but SAFETY CIRCUIT light stays on. ■ ON-STOP □ START ◉ OIL PUMP ■ POWER ■ SAFETY CIRCUIT ■ LOAD RECYCLE ■ PROGRAM TIMER	Low oil pressure	Check oil level in reservoir Check for dirty oil filters
	Oil pump not operating (button depressed).	Check for open oil pump disconnect Check for faulty pump wiring Check for faulty oil pump
	Water-flow switch(es) open.	Pump(s) off; check starting equipment Insufficient water flow; check water valves Check for air in water lines; vent air Defective flow switch; check contacts of switch.
	Momentary power interruption DESIGN 1	Push START button Compressor will restart within 15 minutes

TROUBLE/SYMPTOM – COMPRESSOR TRIPS OFF (Note: See Machine Recycle, page 40)

SYMPTOM	PROBABLE CAUSE	REMEDY
Panel lights as shown; START light and SAFETY CIRCUIT light go out. ■ ON-STOP □ START □ OIL PUMP ■ POWER □ SAFETY CIRCUIT □ LOAD RECYCLE ■ PROGRAM TIMER		Check bearing thermometer. If over 200 F, or if no one was present when machine stopped, DO NOT ATTEMPT TO RESTART MACHINE until cause is determined.
DESIGN 1 – Circuit breaker CB1 tripped. **DESIGN 2 – Bearing temperature light at relay module is on.**	High bearing or discharge temperature, or impeller displacement switch tripped	Check for high discharge temperature; if present, make sure guide vanes are closed Check condensing water flow and temperature. If water temperature is high, examine cooling tower operation Check condenser for air or water leaks Check oil reservoir temperature; if high, refer to Troubleshooting section in that category With control power off, check 1/8 amp fuses in sensor junction box on compressor Check for open circuit in sensors per Sensor Test Procedure, page 18 With control power on, check bearing and discharge protection-circuit transformer: 24 volts a-c across yellow leads /S/ and /S/, 12 volts a-c across blue and yellow leads /CT/ and /S/. If no voltage across /CT/ and /S/, check continuity across leads of impeller displacement switch (line 11, Fig 17 and line 15, Fig 18) If switch is open, it must be inspected. DO NOT OPERATE MACHINE Check relay KB On DESIGN 1 machines only, relay function can be checked by exchanging it with relay KM If all else fails, replace sensor module for discharge and bearing protection
DESIGN 1 – Circuit breaker CB2 tripped. **DESIGN 2 – Motor temperature light at relay module is on.**	High motor winding temperature	Check motor cooling system; clean orifices, clean refrigerant strainer With control power off, check 1/8 amp fuses in sensor junction box on motor end bell Check for open circuit in sensors per Sensor Test Procedure, page 18 With control power on, check motor protection circuit transformer: 24 volts a-c across yellow leads /S/ and /S/, 12 volts a-c across red and yellow leads /CT/ and /S/ Check relay KM. On DESIGN 1 machines only, relay function can be checked by exchanging it with relay KB If all else fails, replace sensor module for motor protection.
	Momentary power interruption Motor temp light goes on DESIGN 2	If power interruption is suspected, press ON-STOP button. If motor temp light then goes out, start machine and carefully monitor motor temperature
	Cooler low-pressure switch tripped.	Manually reset switch and: Check that capacity control switch is at AUTO position Check for refrigerant loss Determine and correct cause and add refrigerant Low chilled water recycle switch should trip out machine before cooler low temperature switch. If chilled water temperature is low, check settings of both switches.
	Condenser high-pressure switch tripped	Manually reset switch and: Check condensing water flow Check condenser water temperature; if high, examine cooling tower operation. Check for air and water leaks, fouled tubes (see Maintenance section)

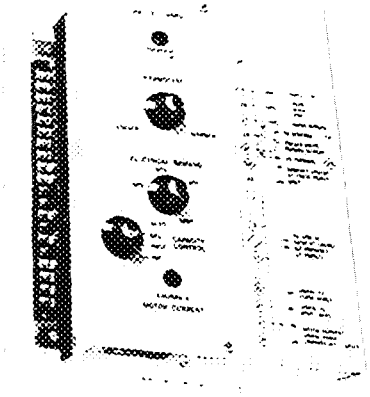
TROUBLE/SYMPTOM – COMPRESSOR TRIPS OFF (Note: See Machine Recycle, page 40)

SYMPTOM	PROBABLE CAUSE	REMEDY
Panel lights as shown; START light and SAFETY CIRCUIT light go out. ■ ON-STOP □ START □ OIL PUMP ■ POWER □ SAFETY CIRCUIT □ LOAD RECYCLE ■ PROGRAM TIMER	Motor overload relays tripped	Manually reset relays in starter and: Check that guide vanes stop opening when motor current exceeds 100% of full load amps Adjust electrical demand control, if required, per 19EA Initial Start-Up section Check overload relay setting per starter manufacturer's instructions DO NOT ATTEMPT FIELD ADJUSTMENT
	Blown fuse	Check 3-amp fuse in control circuit; examine circuit for ground or short

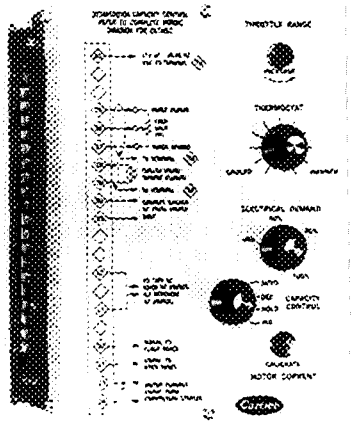
TROUBLE/SYMPTOM – COMPRESSOR RUNS BUT MACHINE MALFUNCTIONS AS NOTED

MALFUNCTION	PROBABLE CAUSE	REMEDY
→ **COMPRESSOR RUNS BUT GUIDE VANES WILL NOT OPEN.**	Capacity control switch improperly set	Check per: Check Operating Controls
	Compressor not in "Run" condition	At least one minute after compressor starts, check for 120 volts across (18) and (L1)
	K2 or K3 relay open	Check for continuity between (73) and (74)
	Cycling timer defective	Check for continuity between (21) and (74)
	Motor current calibration incorrect	See Calibrate Motor Current, page 11
	Chilled water probe defective	Check probe resistance per Fig 9 Replace
	Incorrect voltage in capacity control module	Check voltage between terminals as indicated Replace module if voltage varies by more than amount specified in Table

MODULE TYPE	TEST VOLTAGES (83) to (28)	(30) to (28)	(81) to (28)
A	28± 3 v ac	+24± 1 v dc	-24±1 v dc
B	12±1.5 v ac	+ 9±.5 v dc	–



TYPE A



TYPE B

CHILLED WATER TEMPERATURE TOO HIGH (machine running).	Thermostat set too high	Return thermostat to proper setting as marked on dial at initial start-up
	Excessive cooling load (machine at capacity)	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, fouled tubes
	Refrigerant level low	Check for leak; repair Add refrigerant
	Liquid bypass in water box	Examine division plates and gaskets for leaks
	Excess throttling range (should be near minimum for proper control)	Reduce throttling range by turning adjustment screw clockwise in small increments
	Guide vanes fail to open fully	Ensure 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 relays K2 and K3 Check guide vane linkage (See Fig 6) Check cycling timer Check limit switch on actuator

TROUBLE/SYMPTOM – COMPRESSOR RUNS BUT MACHINE MALFUNCTIONS AS NOTED

MALFUNCTION	PROBABLE CAUSE	REMEDY
CHILLED WATER TEMPERATURE TOO LOW (machine running).	Thermostat set too low	Return thermostat to setting marked on dial at initial start-up
	Low chilled water switch improperly set	Water chilling duty – Switch should open at 5 F below design chilled water temperature, or at 37 F, whichever is higher Brine chilling duty – Switch should open at 5 F below design leaving brine temperature
	Excess throttling range (should be near minimum for proper control)	Reduce throttling range by turning adjustment screw clockwise in small increments
	Guide vanes fail to close	Ensure that capacity control switch is in AUTO position Check chilled water probe resistance per Fig 9 Check guide vane linkage (See Fig 6) If all else fails, and vanes close in DEC but not in AUTO, replace capacity control module
CHILLED WATER TEMPERATURE FLUCTUATES: VANES HUNT	Throttling range too narrow	Add throttling range by turning adjusting screw counterclockwise in small increments.
	Defective capacity control module	Replace module
	Loose vane linkage	Adjust guide vane linkage (See Fig 6)
	Defective vane actuator	Replace actuator.
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 it, 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 (item 36, Fig 1)
	Oil cooler solenoid valve operating improperly	Check electrical operation of solenoid Inspect valve; if screen is fouled, install a 20-mesh screen ahead of valve
	Oil cooler coil fouled	Clean coil, replace cooler if required

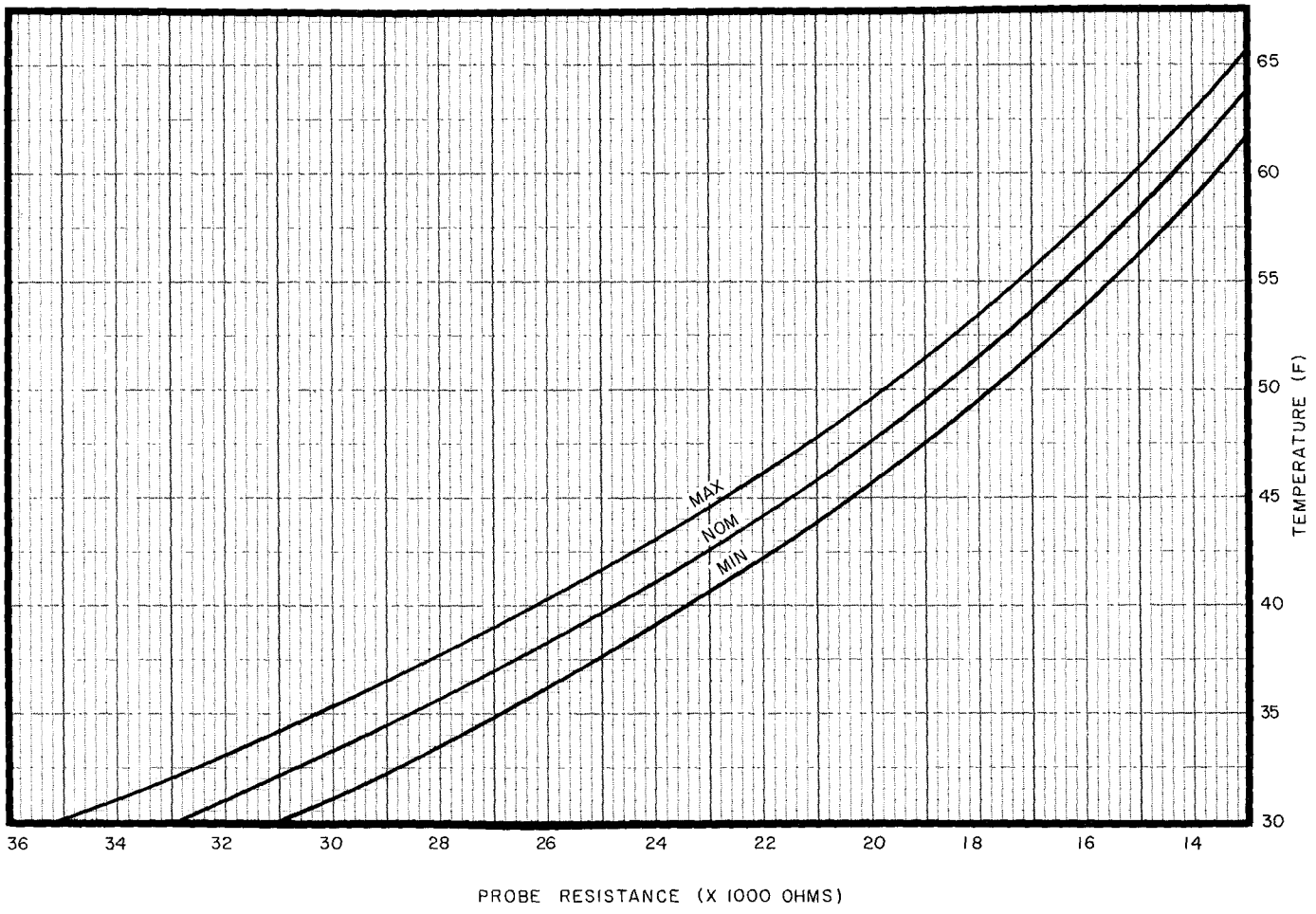


Fig. 9 – Chilled Water Probe Resistance vs Temperature

GENERAL DATA

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

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

System Components include unishell cooler-condenser, motor-compressor, utility vessel, oil pump, dehydrator and control center. A pumpout unit is used for transferring refrigerant during services and shutdown.

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

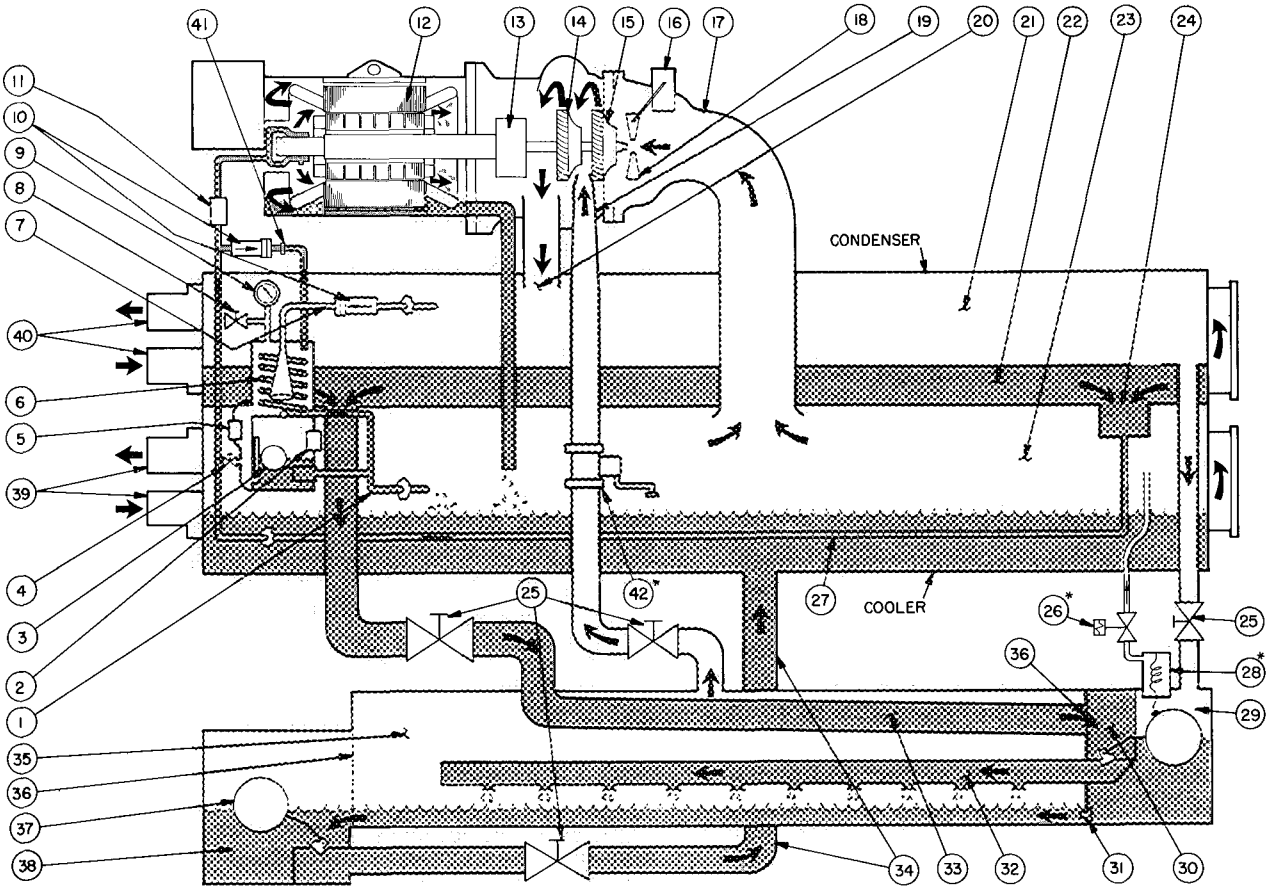
MOTOR-COMPRESSOR maintains system pressure differences and moves the heat-carrying refrigerant from cooler to condenser.

CONDENSER, in the unishell upper portion, removes heat from the compressed refrigerant and passes the 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 and records machine operating hours.



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 Orifice
8 – Dehydrator Air Relief Valve
9 – Dehydrator Pressure Gage
10 – Refrigerant Strainers
11 – Refrigerant Strainer or 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 – Refrigerant Feed Control Solenoid Valve*
27 – Motor Cooling and Dehydrator Supply Line
28 – Refrigerant Feed Control*
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 (2)
37 – Low-Side Float Valve
38 – Low-Side Float Chamber
39 – Chilled Water (Brine) Connections
40 – Condenser Water Connections
41 – Orifice, 1/8-in
42 – Economizer Gas Damper Valve*

*On some machines

Fig. 10 – Refrigeration Cycle

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).

The liquid refrigerant obtains the energy needed for the change to vapor by removing heat from the water in the cooler tubes. The cold water can then be used in the air conditioning process.

After removing heat from the water, 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 thru the condenser tubes. When the warm (typically 100 to 105 F) refrigerant vapor comes into contact with the condenser tubes, the relatively cool condensing water (typically 85 to 95 F) 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 gas already compressed by the first stage impeller. Since the flash gas has to pass thru only half the compression cycle to reach condenser pressure, there is a savings in power.

The cooled liquid refrigerant in the economizer is metered thru 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

Refrigerant liquid from a sump in the condenser (item 24, Fig. 10) is subcooled by passage thru a line in the cooler (item 27, Fig. 10). The refrigerant then flows externally thru a strainer and variable orifice (item 11, Fig. 10) 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 19EA dehydrator removes water and non-condensable 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. Vapor is condensed into a liquid by the dehydrator condensing coil. Water,

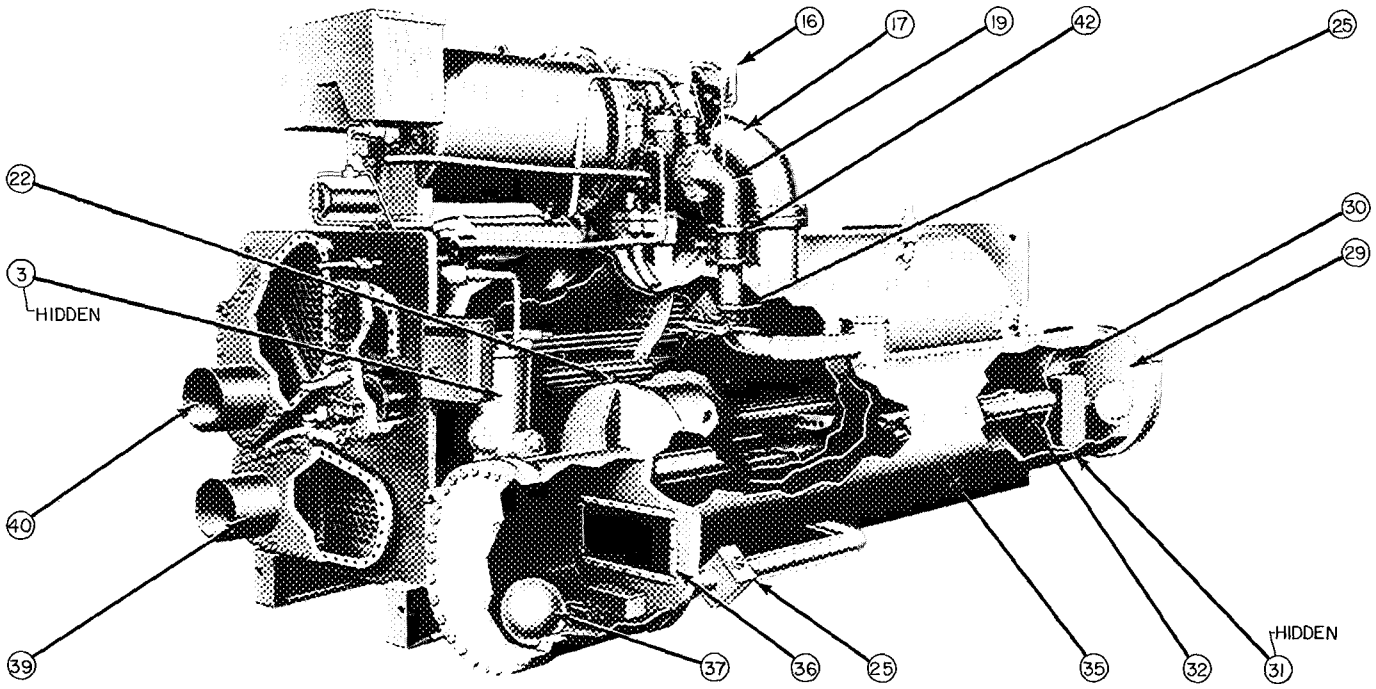


Fig. 11 – Machine Sectional View
(See Fig. 10 Legend for Item Description)

if present, separates from and floats on the refrigerant liquid. The water level can be observed thru 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 thru a rise in pressure. These gases may be manually vented thru 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 oil pump and oil reservoir are contained within the unishell. Oil is pumped thru 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.

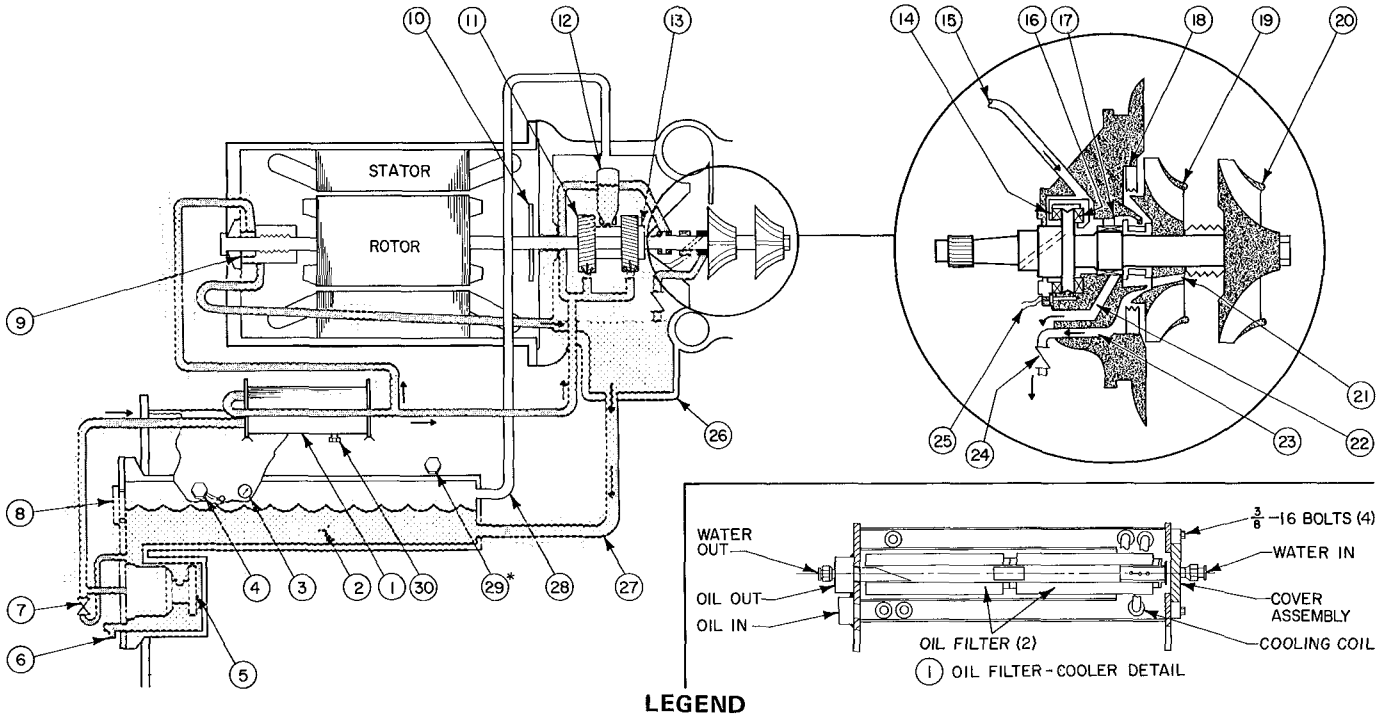
Details (see Fig. 12 for numbered references) – Oil is charged into the oil reservoir (2) thru a hand valve (6). A sight glass (8) permits observation of the oil level. The motor-driven pump (5) discharges oil thru a pressure regulating valve (7) at a differential pressure of 20-25 psi. The pressure may be read directly on the oil gage at the machine control center.

The oil is pumped thru a filter-cooler (1). The oil cooler water flow may be manually adjusted by a plug cock to ensure the proper oil temperature (140-150 F) 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 will supply 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) thru the seal oil check valve (24).

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

The temperature of the oil as it leaves the thrust bearings of the compressor is indicated on a gage on the compressor casing. The return oil (22 and 27) reenters the main oil reservoir and the cycle is repeated.



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-Temp Sensor
26 – Compressor Oil Return Sump
27 – Oil Return Line
28 – Reservoir Vent Line
29 – Oil Low-Temperature Switch*
30 – Filter-Cooler Drain Plug

*On some machines

Fig. 12 – 19EA Lubrication Cycle

An oil heater and thermostat (4) in the reservoir is set to maintain a minimum oil temperature of 140 - 145 F at shutdown. At this temperature, most refrigerant absorbed by the oil is returned to vapor. The vapor thus removed is returned to the system thru a vent line (28).

An oil low-temperature switch (29) in the oil reservoir of some machines will prevent the machine from starting if the oil temperature is less than 120 ± 5 F.

CONTROLS

Operating Controls – The cooling capacity of all 19EA machines is automatically adjusted to match the cooling load by changes in the position of the compressor inlet guide vanes (Fig. 6).

A temperature sensing device in the leaving chilled water circuit of the machine cooler continuously transmits signals to a solid state module in the machine control center. The module, in turn, transmits the amplified and modulated temperature signals to an automatic guide vane actuator.

A drop in leaving chilled water temperature causes the guide vanes to move towards the closed position. This reduces the rate of refrigerant evaporation and vapor flow into the compressor; machine capacity decreases. A rise in chilled water temperature opens the vanes. More refrigerant vapor moves thru the compressor and capacity increases.

The modulation of the temperature signals in the control center allows precise control of guide vane response regardless of the system load.

SOLID STATE CAPACITY CONTROL – In addition to amplifying and modulating the signals from chilled water sensor to vane actuator, the solid state module in the control center provides a means for preventing the compressor from exceeding full load amps, and for limiting motor current down to 40% of full load amps as a means of reducing electrical demand rates.

A throttle range adjustment screw eliminates guide vane hunting, and a manual capacity control knob allows the operator to open, close or hold guide vane position when desired.

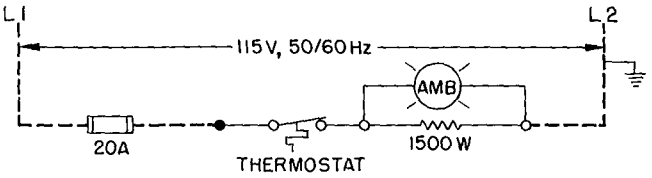
Safety Controls shut down the machine to protect it against possible damage from compressor bearing or discharge-gas high temperature, motor winding high temperature, cooler refrigerant low pressure, condenser high pressure, oil low pressure and inadequate water flow. In addition, compressor motor overload or impeller displacement can shut down the machine.

A vane-closed switch ensures that the compressor starts only in an unloaded condition (guide vanes closed).

A cycling timer, by intermittent interruption of the vane actuator "open" circuit, slows the rate of guide vane opening and prevents rapid increases in compressor loading.

Some machines have an oil low temperature switch (item 38, Fig. 1) that prevents machine start unless the oil temperature is at least 120 F.

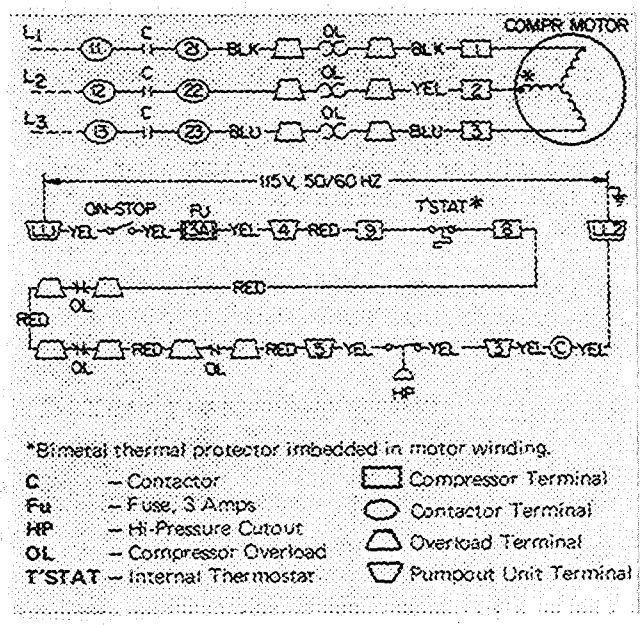
Oil Heater and Thermostat – These controls are typically wired by the field in a manner similar to Fig. 13. Heater should be kept energized during machine shutdown to minimize refrigerant absorption by the oil.



NOTE: Power must be from separate source
– – – Field Wiring

Fig. 13 – Oil Heater Wiring

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. Pumpout unit fused-disconnect is field supplied.

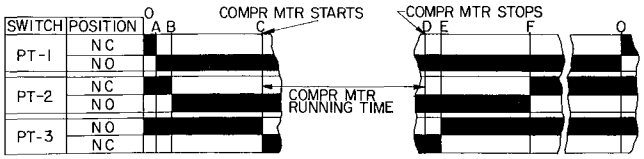


→ **Fig. 14 – 19EA Pumpout Unit Wiring Schematic**

→ **Program Timer** (item 8, Fig. 3) – The 19EA program timer controls machine start and stop sequences and provides proper pre-lube and post-lube times for the compressor-motor assembly. The program timer also provides a minimum 15-minute interval to allow machine conditions to stabilize between shutdown and subsequent restart.

This 15-minute interval is not intended to permit or endorse modes of operation calling for continuous on-off recycling. The long term reliability of any induction motor driven machinery depends on good system design and operating practices that minimize the number of starts and stops required of the equipment during normal operation.

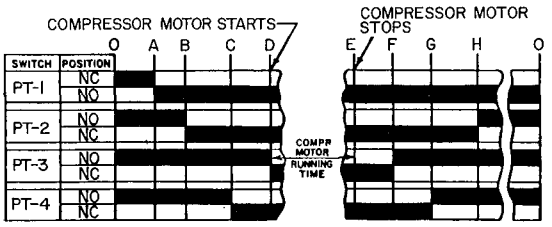
The program timer sequences of Control Design 1 and Control Design 2 are illustrated in Fig. 15 and 16. The timer cam numbers and positions are those shown on the machine wiring schematics, Fig. 17 and 18.



O = Starting sequence begins (condition shown on schematic)
A = 13 ± 5 sec after O
B = 10 ± 8 sec after A (oil pump starts)
C = 28 ± 8 sec after B (compr motor starts and program timer stops)
D = Time at which compressor motor stops and program timer starts
E = 13 ± 5 sec after D
F = 28 ± 8 sec after E (oil pump stops)
O = 15 min ± 15 sec total cycle time (D to C)

NC – Normally Closed
NO – Normally Open

Fig. 15 – Program Timer Sequence (Control Design 1)



O = Starting sequence begins (condition shown on schematic)
A = 13 ± 5 sec after O
B = 10 ± 5 sec after A (oil pump starts)
C = 15 ± 5 sec after B
D = 13 ± 5 sec after C (compr motor starts and program timer stops)
E = Time at which compr motor stops and program timer restarts.
F = 13 ± 5 sec after E
G = 13 ± 5 sec after F
H = 15 ± 5 sec after G (oil pump stops)
O = 15 min ± 15 sec total cycle time (E-D)

NC – Normally Closed
NO – Normally Open

→ **Fig. 16 – Program Timer Sequence (Control Design 2)**

→ **Machine Control Wiring** – Two typical control schemes are described in this publication. The two schemes, Control Design 1 and Control Design 2, can be readily identified by the appearance of the control relay module (item 15, Fig. 3).

CONTROL DESIGN 1 is shown schematically in Fig. 17. This scheme is representative of machines with:

1. Circuit breakers for motor, bearing and discharge overtemperature cutout.
2. Three-cam program timer, plus K4 time-delay relay.
3. Single-pole, single-throw ON-STOP switch.
4. Economizer-cooler differential pressure switch and refrigerant feed control.
5. Field-supplied oil pump starter.

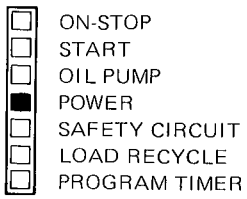
CONTROL DESIGN 2 is shown schematically in Fig. 18. This scheme is representative of machines with:

1. Motor and bearing (includes discharge) overtemperature indicating lights, without circuit breakers.
2. Four-cam program timer.
3. Double-pole, single-throw ON-STOP switch.
4. Economizer damper replacing economizer-cooler differential pressure switch and refrigerant feed control.
5. Factory-installed oil pump starter.

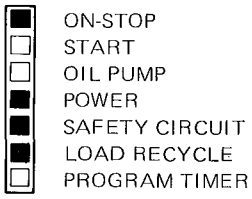
Your machine may vary slightly from these typical designs; check your machine control wiring label.

Typical Control Sequence – Machine Start
(Control Design 1; see Fig. 17)

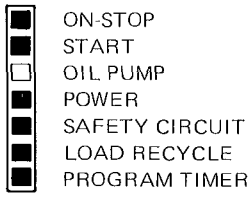
1. Supply power to machine.
   a. POWER light goes on.



2. Press water pump start button (line 2).
   a. Pilot relay (PR) energizes water pumps and cooling tower fan. PR contact holds relay in.
   b. Water flow switches (line 26) close.
3. Press ON-STOP button.
   a. Discharge and bearing temperature and motor temperature control circuits close and relays KB and KM are energized.
   b. KB and KM contacts (lines 21 and 22) open, breaking circuit to CB1 and CB2 magnetic elements (lines 21 and 22).
   c. KB and KM contacts (line 23) close, completing circuit to cooler low-pressure and condenser high-pressure switches, compressor motor overloads, oil low-temperature switch, K4 contact and low chilled water temperature switch. Oil low-pressure switch (line 26) and water flow switches are temporarily bypassed.
   d. ON-STOP, SAFETY CIRCUIT and LOAD RECYCLE lights go on.

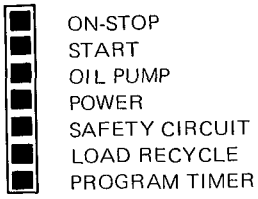


4. Press machine START button.
   a. K1 is energized and is held in by its holding contact. Second K1 relay contact (line 31) closes circuit to program timer motor.
   b. START and PROGRAM TIMER lights go on.

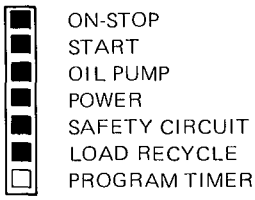


5. PT-1 (Fig. 15) moves to N.O. position; timer motor is kept energized thru 1CR normally closed contact.

6. PT-2 moves to N.O. position.
   a. Power reaches oil pump starter M3, and reaches refrigerant feed control thru the econ-cooler diff switch (line 5).
   b. OIL PUMP light goes on.



   c. Oil pressure builds up. Contacts (lines 26 and 31) close.
   d. K4 time-delay relay is energized. In 10 seconds, contact (line 25) opens; safety circuit is completed thru M3 contact, low oil-pressure switch and water flow switches. K4 contact (line 31) closes circuit to PT-3.
7. PT-3 moves to N.C. position. Compressor motor start relay 1CR and relay K2 are energized thru the vane-closed switch. Compressor starts.
   a. 1CR contact (line 31) closes to hold in 1CR relay.
   b. 1CR contact (line 35) opens; program timer stops and PROGRAM TIMER light goes out.

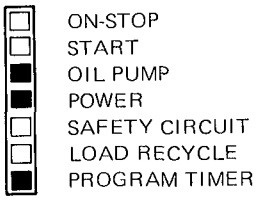


   c. K2 contact (line 40) opens and removes "close" signal from guide vane actuator.
   d. Cycling timer alternately makes and breaks circuit to K3 contact (line 42).
8. Compressor reaches "Run" condition.
   a. Relay K3, oil cooler solenoid valve and capacity control module are energized.
   b. K3 contacts (lines 3 and 4) close to interlock oil pump, water pumps and cooling tower fan.
   c. K2 and K3 contacts (line 42) are now closed to allow an "open" signal to be applied to the guide vane actuator.

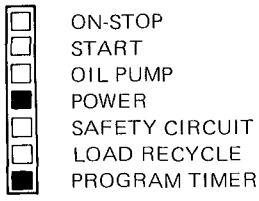
Typical Control Sequence – Machine Stop

(Control Design 1; see Fig. 17)

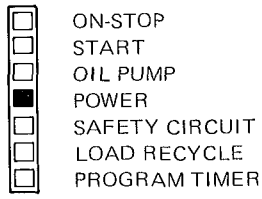
1. Push ON-STOP switch.
   a. All machine control relays are de-energized.
   b. As 1CR relay drops out, compressor stops. 1CR contact (line 35) closes and program timer starts.
   c. As K3 relay drops out, its contacts (lines 3 and 4) open and remove interlocking circuits to water pumps, cooling towers and oil pump starter.
   d. Third K3 contact (line 42), and both K2 contacts return to de-energized condition and guide vanes close.
   e. ON-STOP, START, SAFETY CIRCUIT and LOAD RECYCLE lights go off; PROGRAM TIMER light goes on.



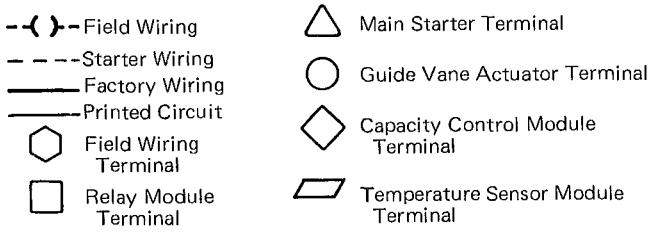
2. In a few seconds, PT-3 moves to its N.O. position, preventing compressor start relay from being energized for 15 minutes.
3. PT-2 moves to N.C. position about 40 seconds after ON-STOP switch was pushed. Oil pump stops. OIL PUMP light goes off.



4. In approximately 14 minutes, PT-1 moves to its N.C. position. Program timer stops and light goes off. Machine may be restarted.



COMBINED LEGEND (Fig. 17 and 18)



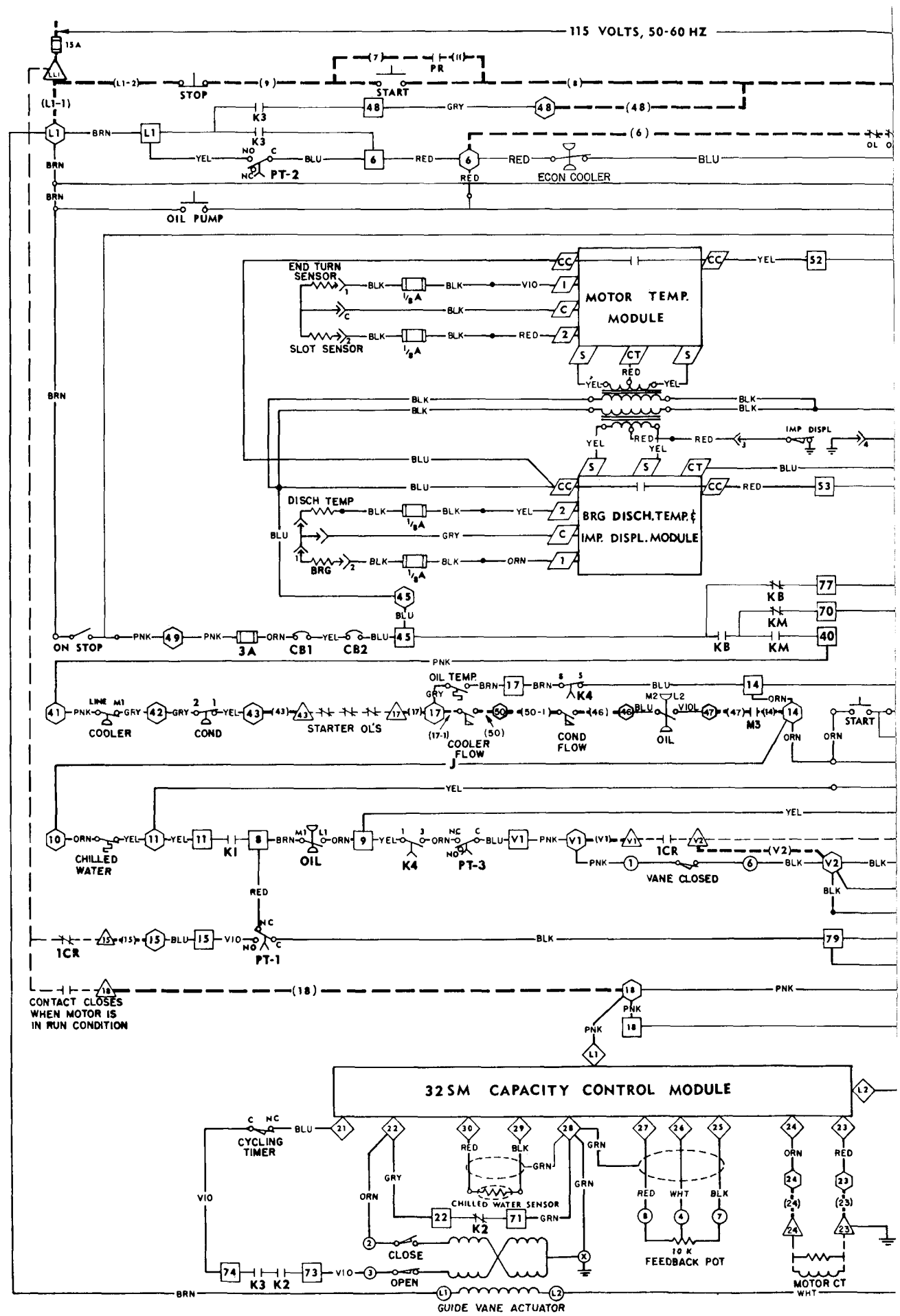
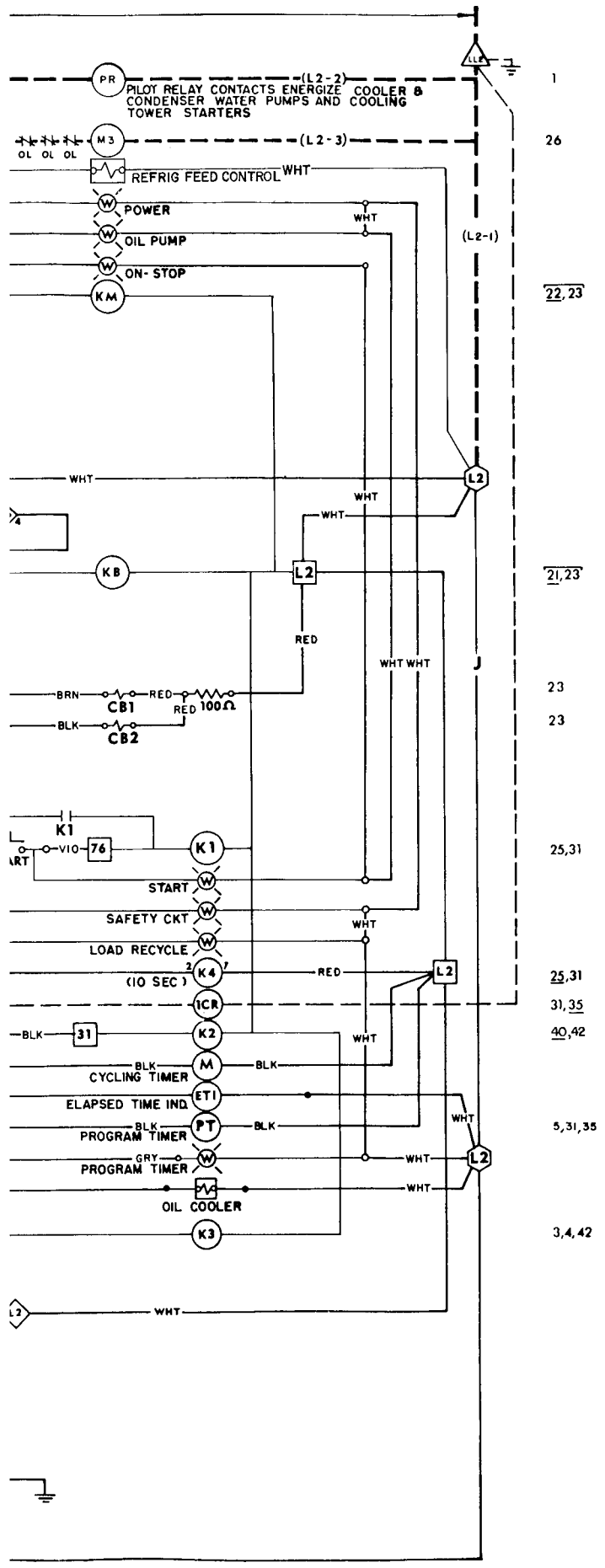
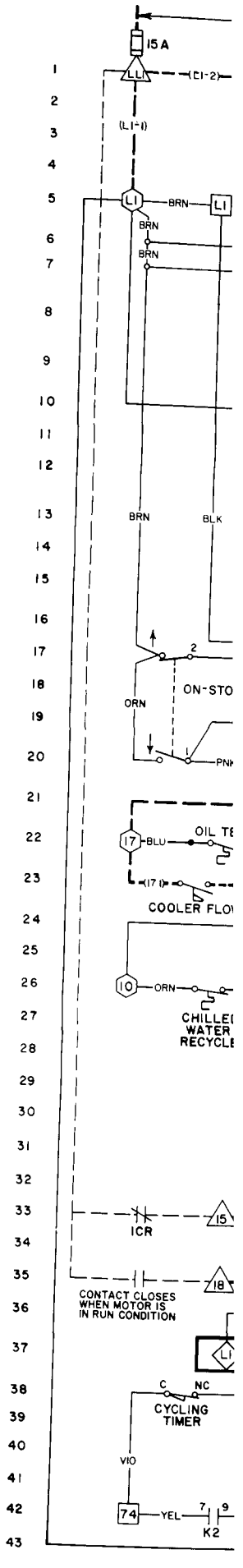


Fig. 17 — 19EA Machine Control Wiring Schematic (Control De


PR
PILOT RELAY CONTACTS ENERGIZE COOLER & CONDENSER WATER PUMPS AND COOLING TOWER STARTERS
(L2-2)
1
M3
OL OL OL
(L2-3)
26
REFRIG FEED CONTROL
WHT
POWER
OIL PUMP
ON-STOP
KM
(L2-1)
22,23
WHT
L2
KB
21,23
RED
WHT WHT
BRN
RED
CB1
100Ω
23
BLK
CB2
23
K1
VIO
76
25,31
START
SAFETY CKT
LOAD RECYCLE
(10 SEC)
K4
RED
25,31
1CR
31,35
BLK
31
K2
40,42
CYCLING TIMER
ELAPSED TIME IND
ET1
PROGRAM TIMER
PT
5,31,35
GRY
OIL COOLER
K3
3,4,42

ol Design 1)


15A
L1
(L1-2)
(L1-1)
L1
BRN
L1
BRN
BRN
BRN
BLK
2
ON-STO
ORN
1
PNK
17
BLU
OIL TE
(17)
COOLER FLO
10
ORN
CHILLE
WATER
RECYCLE
ICR
15
CONTACT CLOSES
WHEN MOTOR IS
IN RUN CONDITION
18
L1
C
NC
CYCLING
TIMER
VIO
74
YEL
7
9
K2

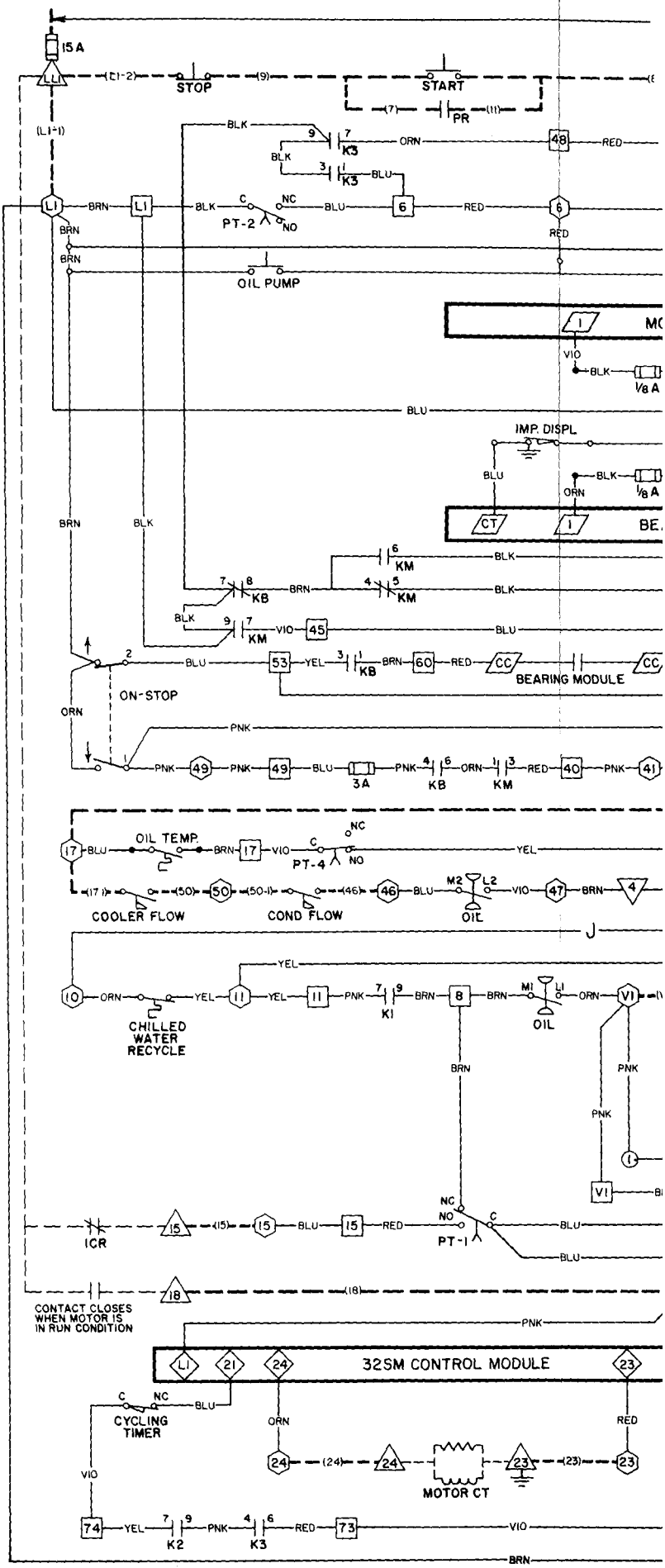
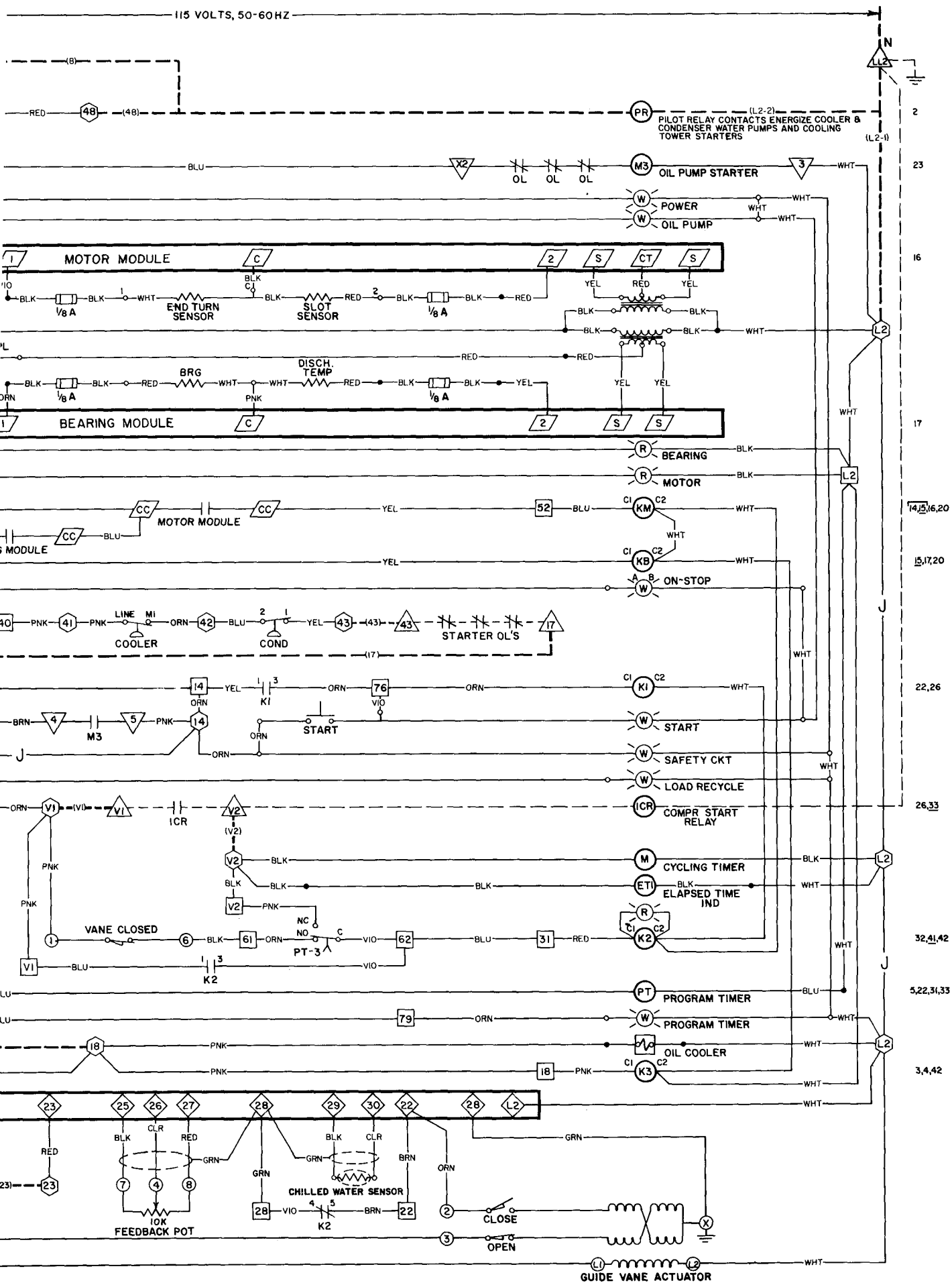

15A
STOP
START
PR
OIL PUMP
PT-2
IMP. DISPL.
KM
KB
ON-STOP
OIL TEMP.
PT-4
COOLER FLOW
COND FLOW
OIL
CHILLED WATER RECYCLE
K1
ICR
PT-1
CONTACT CLOSES WHEN MOTOR IS IN RUN CONDITION
32SM CONTROL MODULE
CYCLING TIMER
MOTOR CT
K2
K3
BEARING MODULE

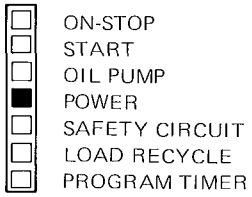
Fig. 18 – 19EA



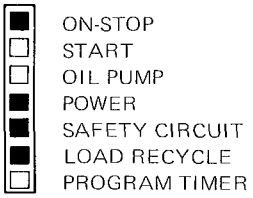
— 19EA Machine Control Wiring Schematic (Control Design 2)

→ **Typical Control Sequence — Machine Start**
(Control Design 2; see Fig. 18)

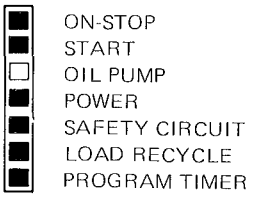
1. Supply power to machine.
   a. POWER light goes on.



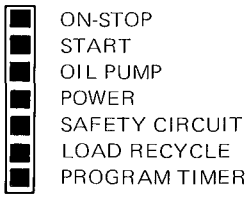
   b. Motor module (line 8) is energized and, if impeller displacement switch (line 11) is closed, bearing module is also energized; module contacts (lines 16 and 17) close; relays KM and KB (lines 16 and 18) are energized thru normally closed contact of machine ON-STOP switch (line 17).
2. Press water pump start button (line 1).
   a. Pilot relay PR (line 3) energizes starters for water pumps and cooling tower fans. PR contact (line 2) holds relay in.
   b. Water flow switches (line 23) close.
3. Press machine ON-STOP button.
   a. Relays KM and KB remain energized thru KM contact (line 16) and KB contact (line 17). Circuit is completed thru cooler refrigerant low pressure cutout, condenser high pressure cutout and compressor motor overloads (line 20), and thru the chilled water recycle switch (line 26).
   b. Oil low pressure switch and water flow switches (line 23) are temporarily bypassed thru program timer switch PT-4 (line 22).
   c. ON-STOP, SAFETY CIRCUIT and LOAD RECYCLE lights go on.



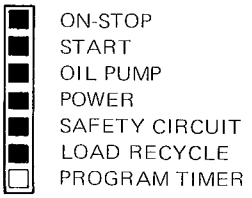
4. Press machine START button.
   a. Relay K1 (line 22) is energized and is held in by its holding contact. Second K1 contact (line 26) closes circuit to program timer motor PT (line 33).
   b. START and PROGRAM TIMER lights go on.



5. Program timer switch PT-1 moves to N.O. position (line 33). Timer motor is kept energized thru 1CR N.C. contact.
6. PT-2 moves to N.C. position (line 5).
   a. Power reaches oil pump starter M3.
   b. OIL PUMP light goes on.



   c. Oil pressure builds up. Pressure switch contacts (lines 20 and 23) close.
   d. Relay K2 (line 31) is energized thru the vane closed switch. K2 contact (line 32) holds in the K2 relay. Second K2 contact (line 41) opens to remove "close" signal from guide vane actuator. Third K2 contact, in the actuator "open" circuit (line 42), closes. K2 indicating light goes on.
7. In 15 seconds, contact PT-4 (line 22) moves to the N.C. position and the safety circuit is now completed thru the flow switches, oil low pressure switch and M3 contact (line 23).
8. PT-3 moves to the N.C. position 13 seconds later. Compressor motor start relay 1CR is now energized thru the K2 holding contact (line 32). Compressor starts. Cycling timer motor is energized; timer contact (line 38) alternately makes and breaks "open" circuit to guide vane actuator thru K2 and K3 contacts.
   a. Normally open 1CR contact (line 26) closes to hold in 1CR relay.
   b. Normally closed 1CR contact (line 33) opens; program timer stops and PROGRAM TIMER light goes out.



9. Compressor reaches run condition.
   a. Run contact (line 35) closes.
   b. Relay K3, oil cooler solenoid valve and capacity control module are energized.
   c. Normally open K3 contacts (lines 3 and 4) close to interlock oil pump, water pumps and cooling tower fans with compressor motor.
   d. The K2 and K3 contacts (line 42) close to allow the "open" signal to reach the guide vane actuator.

→ **Typical Control Sequence — Machine Stop**
(Control Design 2; see Fig. 18)

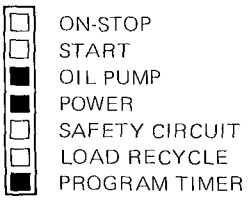
1. Push machine ON-STOP switch.
   a. Machine control relays K1 and K2, and motor start relay 1CR are de-energized.
   b. As 1CR relay drops out, compressor stops, 1CR contact (line 33) closes and program

timer starts. Run contact (line 35) opens and de-energizes relay K3.

c. As K3 relay drops out, its contacts (lines 3 and 4) open and remove the interlocking circuit to water pumps, cooling tower fans and oil pump starter. Pumps and fans remain energized thru PR contact (line 2); oil pump remains energized thru PT-2 (line 5).

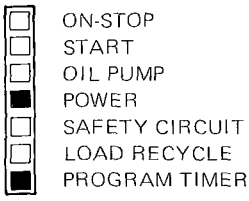
d. A third K3 contact (line 42) and both K2 contacts in the vane actuator circuit return to the de-energized condition and the guide vanes close.

e. ON-STOP, START, SAFETY CIRCUIT and LOAD RECYCLE lights go off. PROGRAM TIMER light goes on.

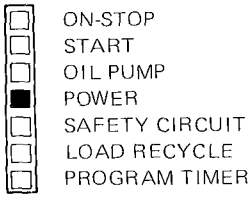


2. In a few seconds, PT-3 moves to its N.O. position, preventing compressor start relay 1CR from being energized for 15 minutes.

3. Oil pump stops approximately 40 seconds after ON-STOP button is pushed when PT-2 moves to its N.O. position. OIL PUMP light goes off.



4. In approximately 15 minutes after compressor stop, PT-1 moves to its N.C. position. Program timer stops, PROGRAM TIMER light goes out and machine can be restarted.

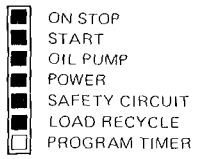


5. Water pumps and cooling tower fans are stopped by pressing water pump stop button (line 1).

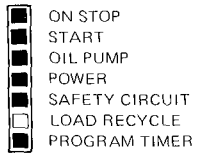
Typical Control Sequence — Machine Recycle
(Control Designs 1 and 2)

During normal cooling, the building load may drop low enough to make continuous operation of the refrigeration machine unnecessary. When the chilled water temperature reaches its low cutout point, the machine will shut off automatically. It will remain off for a minimum of 15 minutes and until the rise in chilled water temperature closes the switch contacts. The machine will then restart automatically.

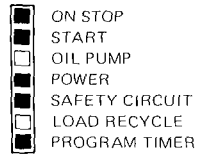
1 Machine operating normally



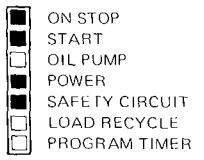
2 Chilled water temperature drops 5 F below selected set point; low chilled water temperature cutout opens
Relay 1 CR is de-energized
Compressor stops
Program timer starts



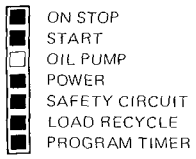
3 Oil pump stops approximately 40 seconds after compressor



→ 4 Program timer completes its cycle (approximately 15 minutes after machine shutdown)
Machine restart is now possible

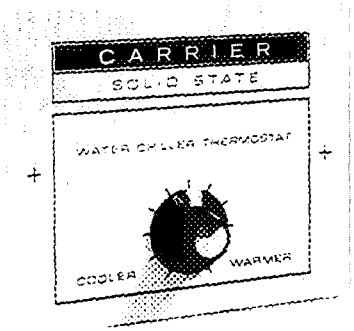


5 Chilled water temperature rises 10 F and low chilled water temperature cutout closes Machine restarts automatically

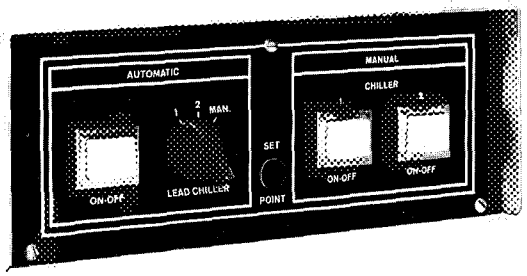


CONTROL OPTIONS

General — This section presents a brief description of the more common optional controls and their operation. Installation and calibration of optional controls are covered in the instructions accompanying each accessory package. Your nearest Carrier office can provide you with this information if required.



Remote Thermostat — This setpoint control permits selection and alteration of the leaving chilled water temperature from a central station or other location of the customer's choice

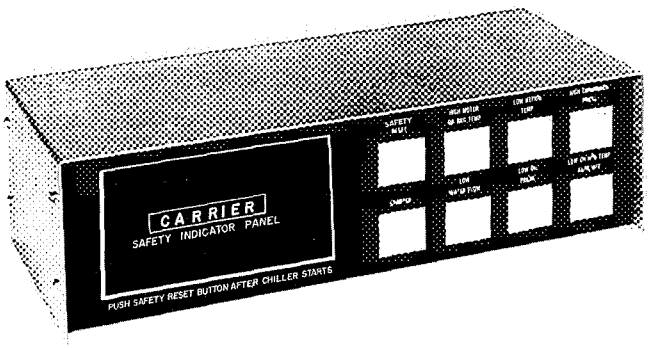


Lead-Lag Control provides centralized control of 2 refrigeration machines. Control may be applied to parallel machines, series machines with a common control point or series machines with a split control point.

PREPARATION – On initial start only, push the ON-STOP and START buttons (lights go on) at each control center. Machine start and stop can now be made at the lead-lag control.

AUTOMATIC OPERATION – When the lead-lag ON-OFF button at the left side of the control is pushed and lighted, the chillers, water pumps and tower fans will start and stop automatically in response to a field-supplied outside-air thermostat or other device. The transfer switch permits selection of either machine for part load recycle.

MANUAL OPERATION – With the transfer switch at MAN. position, either or both chillers may be stopped or started manually by pushing the ON-OFF buttons at the right side of the control.



Safety Indicator Panel provides first-out indication for each of the 7 machine safety controls listed below, plus the sounding or lighting of an optional remote alarm.

First-out indication is given for:

1. High motor or bearing temperature
2. Low refrigerant temperature
3. High condenser pressure
4. Motor overload
5. Insufficient water flow (cooler and condenser)
6. Low oil pressure
7. Low chilled water temperature

SETTING INDICATOR PANEL – After refrigeration machine has been started, press the panel SAFETY RESET button. Panel is now in ready condition.

On some panels, SAFETY RESET button is equipped with a light. Light goes out when button is pressed and panel is reset.

All lights remain off until machine shuts down on a safety cutout. The indicator lamp for that particular safety then lights and (except for LOAD RECYCLE/AUTO. OFF lamp) remains lit until the panel is reset. The LOAD RECYCLE/AUTO. OFF lamp goes out when chilled water temperature rises and the switch remakes.

RESETTING INDICATOR PANEL

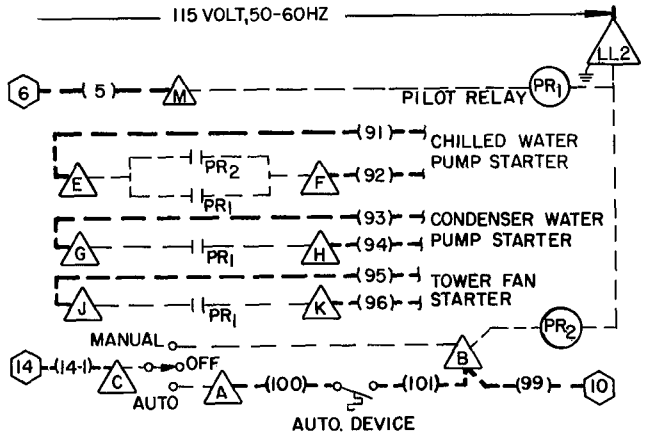
1. Correct the condition which caused the safety tripout (except low chilled water temperature).
2. Reset the safety control if manual reset.
3. Restart the refrigeration machine.
4. Press indicator panel SAFETY RESET button.

PRESS-TO-TEST FEATURE – To check the condition of any of the indicator lamps, merely press the lamp button. A burned out lamp does not affect the operation of the alarm circuit. This lamp test does not in any way indicate whether the safety control itself is tripped or not.

If an alarm has been added to the panel, it will sound and/or light while the LOW OIL PRESSURE button is pressed.

OTHER SAFETY INDICATIONS – The HIGH MOTOR OR BEARING TEMP lamp lights in the unlikely event that the compressor thrust bearing is displaced. If discharge or bearing temperatures appear normal (under 180 F) but machine will not restart, check the bearing and discharge sensor module, relay KB and the impeller displacement switch contacts as described in the Trouble-shooting section.

→ **Autostart Control** – Automatic machine and auxiliary start and stop in response to an outside-air thermostat, time clock or other customer-supplied device is available as a modification to the refrigeration machine starter. Figure 19 shows a typical autostart circuit. For application of this circuit to machine control system, refer to your Job Wiring Data.



NOTE: Remove jumper on terminal block between 14 and 10

–( )– Field Wiring
– – – – Starter Wiring
△ Starter Terminal
⬡ Field Wiring Terminal in Machine Control Center

→ **Fig. 19 – Autostart Connection Diagram (Typical)**

Table 5 – Compressor Assembly Torques (lb ft)

ITEM*	DESCRIPTION	TORQUE	
		Compressor Size	
		11–49	51–89
A	Main Motor Terminal	10	10
B	Impeller Locknut	200	250
C	Gear and Motor Shaft Nut	300	300
D	Transmission Bearing Hold-Down Bolt	60	60
E	Impeller Displacement Detector Locknut	10	10

*See Figure 20 for item callout

COMPRESSOR FITS AND CLEARANCES

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 19EA4	DIMENSION 19EA5
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	.016 / .020
4	Interstage labyrinth	Diametral	.012 / .016	.012 / 016
5	2nd stage labyrinth	Diametral	.008 / .012	.008 / 012
6	Balancing piston labyrinth	Diametral	.008 / .012	.008 / .012
7	Impeller shaft journal bearing	Diametral	.0020 / .0035	.0030 / .0045
8	Thrust-end float	Axial	.008 / 014	.010 / .015
9	Counterthrust bearing seal ring	Diametral	.002 / .004	.002 / 004
10	Gear bearing to gear	Diametral	.0040 / .0055	.0040 / 0055
11	Gear bearing to bearing housing	Diametral	.0005 / .0025	.0005 / .0025
12	Pinion bearing to pinion	Diametral	.0030 / .0045	.0030 / 0045
13	Pinion bearing to bearing housing	Diametral	.001 / .003	.001 / .003
14	Transmission labyrinth	Diametral	.006 / 010	.006 / .010
15	Motor-end labyrinth	Diametral	.005 / 008	.005 / 008
16	Motor-end bearing to shaft	Diametral	.004 / 005	.004 / 005
17	Motor-end bearing to bearing housing	Diametral	.0005 / .0020	.0005 / .0020
18	Impeller displacement switch to impeller shroud (impeller in thrust position)	Axial	.057 / .072	.057 / .072

Tabulation — Impeller Clearances

COMPR SIZE New	COMPR SIZE Old	IMPELLER DIAMETER	DIMENSION* (Item 1)	DIMENSION* (Item 2)
11	431	9 10	701	.548
13	433	9.40	671	.508
15	435	9 70	641	488
17	437	10 00	611	468
19	439	10.40	.596	458
21	441	9.10	.811	628
23	443	9 40	781	578
25	445	9 70	741	.558
27	447	10 00	711	528
29	449	10.40	.686	518
31	451	9 10	921	708
33	453	9 40	881	668
35	455	9 70	841	638
37	457	10.00	801	598
39	459	10.40	.776	.578
41	461	9 10	1 041	798
43	463	9 40	991	758
45	465	9.70	951	.718
47	467	10 00	901	668
49	469	10.40	.866	.648
51	531	12.00	.837	638
53	533	12 38	797	609
55	535	12.75	757	.579
57	537	13 25	717	.541
59	539	13.75	.690	.541
61	541	12.00	.977	.760
63	543	12.38	.937	726
65	545	12 75	.897	.688
67	547	13 25	837	639
69	549	13 75	810	.632
71	551	12.00	1 177	895
73	553	12 38	1.137	852
75	555	12.75	1 077	809
77	557	13 25	1.017	.750
79	559	13 75	.970	.731
81	561	12.00	1 297	.972
83	563	12.38	1 237	.928
85	565	12 75	1 177	.880
87	567	13 25	1.097	817
89	569	13 75	1 050	.796

*Measured with shaft in thrust position; tol = ± 005

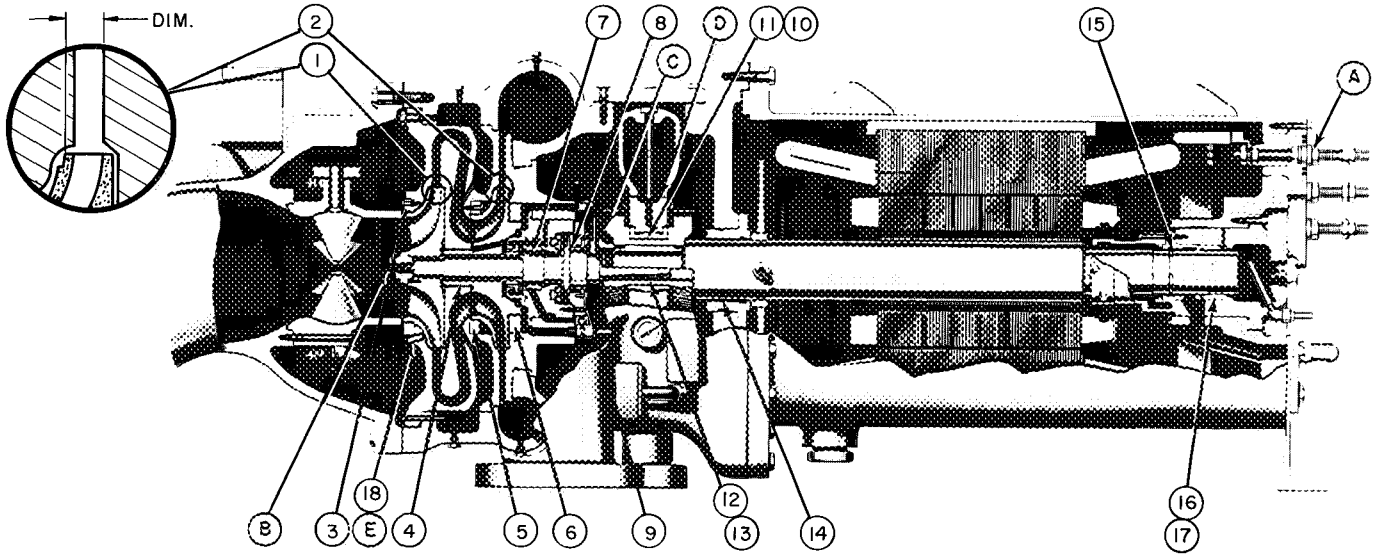


Fig. 20 — Compressor Fits and Clearances