Carrier

TRANSICOLD

Container Refrigeration Unit

Model 69NT40-469

OPERATION AND SERVICE

T-258 $6.00

Carrier

TRANSICOLD

OPERATION AND SERVICE MANUAL

CONTAINER REFRIGERATION UNIT

MODEL 69NT40-469

UNITED TECHNOLOGIES CARRIER TRANSICOLD

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1.1 INTRODUCTION

WARNING

It has been determined that pressurized, air-rich mixtures of refrigerants and air can undergo combustion when exposed to an ignition source.

This manual contains Operating Data, Electrical Data and Service Instructions for the refrigeration units listed in Table 1-1. Also, Table 1-1 charts most of the significant differences between these models.

The unit, of lightweight aluminum frame construction, is an all electric, one piece self-contained cooling and heating refrigeration unit. The unit is designed to fit in the front of a container and to serve as the container front wall. Fork lift pockets are provided for installation and removal of the unit.

The unit is complete with a charge of Refrigerant-134a, compressor lubricating oil, mode indicating lights, temperature controller and is ready for operation upon installation.

These units are dual voltage units designed to operate on 190/230 or 380/460 vac, 3 phase, 50-60 hertz power. (Refer to Table 1-1 and section 1.13)

WARNING

Beware of unannounced starting of the evaporator and condenser fans. Do not open condenser fan grille before turning power OFF and disconnecting power plug.

Operating control power is provided by a single phase transformer which steps down the AC power supply voltage to 24 vac, 1 phase control power.

The temperature controller is a solid state controller. (Refer to section 1.11) Once the temperature controller is set at desired container temperature, the unit will operate automatically to maintain the desired temperature within very close limits. The control system automatically selects cooling, holding or heating as necessary to maintain the desired temperature within the container.

The units are equipped with a Partlow temperature recorder.

Also, these units are equipped with a digital display (switchable for _C or _F). Refer to section 1.7.

Table 1-1. Model Chart

MODELS	UNIT WEIGHT		REFRIGER-ANT 134a		Two Speed Evaporator Fan Motors	Water-Cooled Condenser	Receiver	Power Transformer	Suction & Discharge Gauges	Dual Voltage Compressor
	LB	KG	LB	KG						
69NT40-469-7	1265	574	11.5	5.2	–	–	X	–	–	X

A – Provision for water-cooled condenser. If water-cooled condenser is added, refrigerant charge will change.
B – Provision for step-up power transformer.
X – Designates item provided.

1.2 GENERAL DESCRIPTION

a. Compressor Section

NOTE

Check the compressor Serial/Model Number plate for CFM displacement, refer to Table 1-2.

The compressor section includes the compressor (with high pressure switch), power cable storage compartment, and an optional power transformer, located to the left of the compressor.

This section also contains the suction modulation valve, suction solenoid valve, quench expansion valve, moisture-liquid indicator, manual liquid line valve, filter-drier, pressure relief valves (high and low), discharge pressure regulator valve, and the receiver or the water-cooled condenser/receiver.

The supply air temperature sensor (STS) is located at the right of the compressor.

Table 1-2. Compressor Model Number Significance Chart

06DR2419CC1970

1st, 2nd & 3rd DIGIT
06D Hermetic Reciprocal

4th DIGIT	
R	Refrigeration Duty

6th & 7th DIGIT	VOLUME
41	41CFM

b. Condenser Section

The condensing section consists of a condenser fan motor, condenser fan, and an air-cooled condenser coil. When the unit is operating with air-cooled condenser operation, air is pulled in the bottom of the coil and discharges horizontally out the front center of the unit.

Some units are equipped with a water-cooled condenser (condenser/receiver) and a water pressure switch. This switch is located on the water inlet line.

c. Evaporator Section

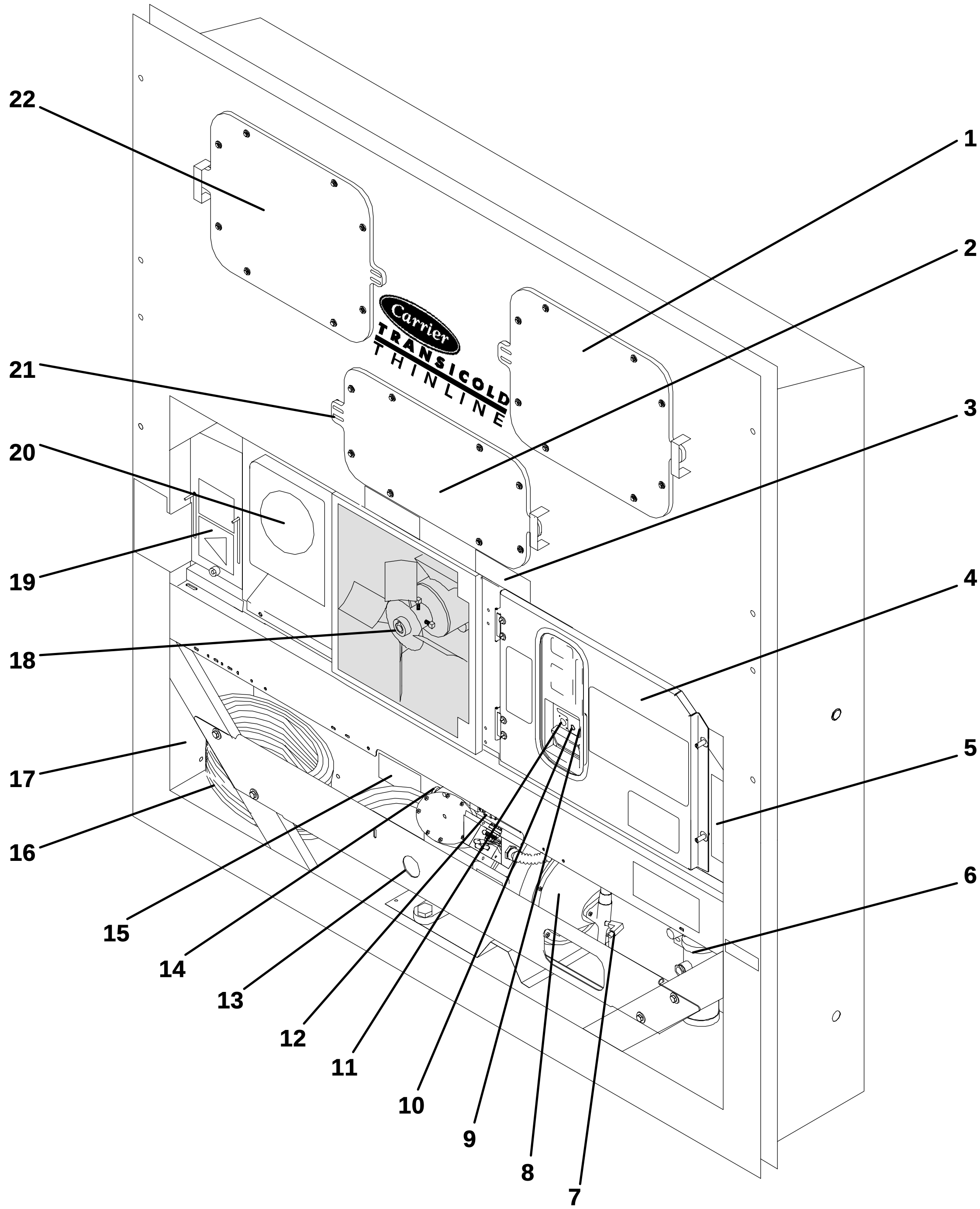
The evaporator section contains the recorder bulb, controller return temperature sensor (RTS), thermostatic expansion valve, evaporator fan motors and fans (2), evaporator coil and heaters, drain pan and heaters, defrost and heat termination switches, humidistat (optional), heat exchanger, and the suction solenoid thermostat (located above the fan deck).

The evaporator fans circulate air throughout the container by pulling air in the top of the refrigeration unit and directing the air through the evaporator coil where it is either heated or cooled, and then discharged out the bottom of the refrigeration unit into the container.

The evaporator coil heaters and the thermostatic expansion valve are accessible by removing the front, lower access panel. The defrost termination switch is located on the center bracket of the evaporator coil and may be serviced by removing the rear, middle, panel or by removing the front, upper access panel and reaching through the left hand evaporator fan venturi AFTER POWER IS TURNED OFF AND POWER PLUG DISCONNECTED.

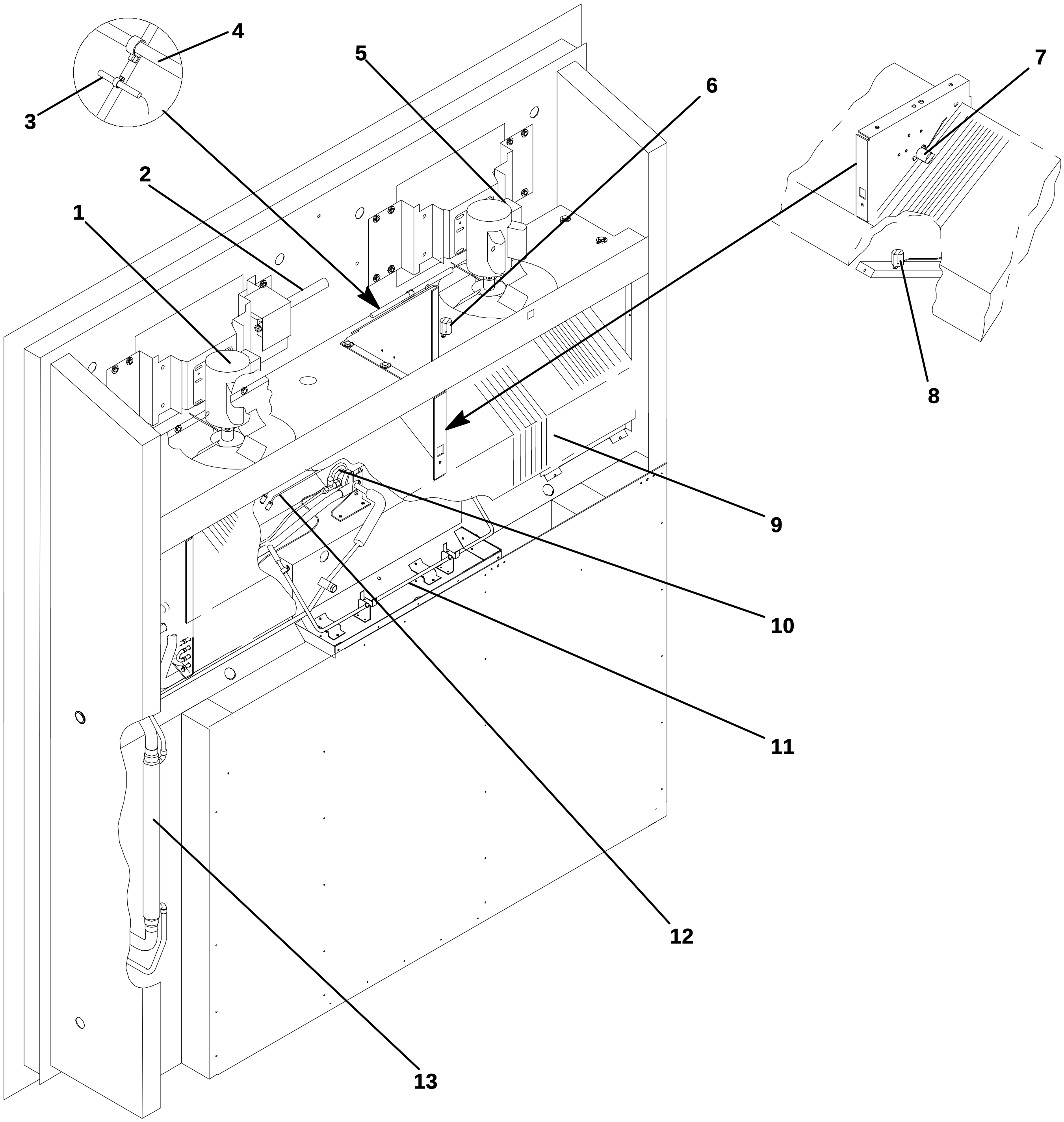
d. Control Box

The control box and door include the indicator lights, manual switches, temperature set station, circuit breaker(s), contactors, relays, transformers (current limiting and control), the optional digital display and fuses (6 amp for control and 3 amp for controller). (See Figure 1-4) Also, located above the temperature set station is the defrost interval.



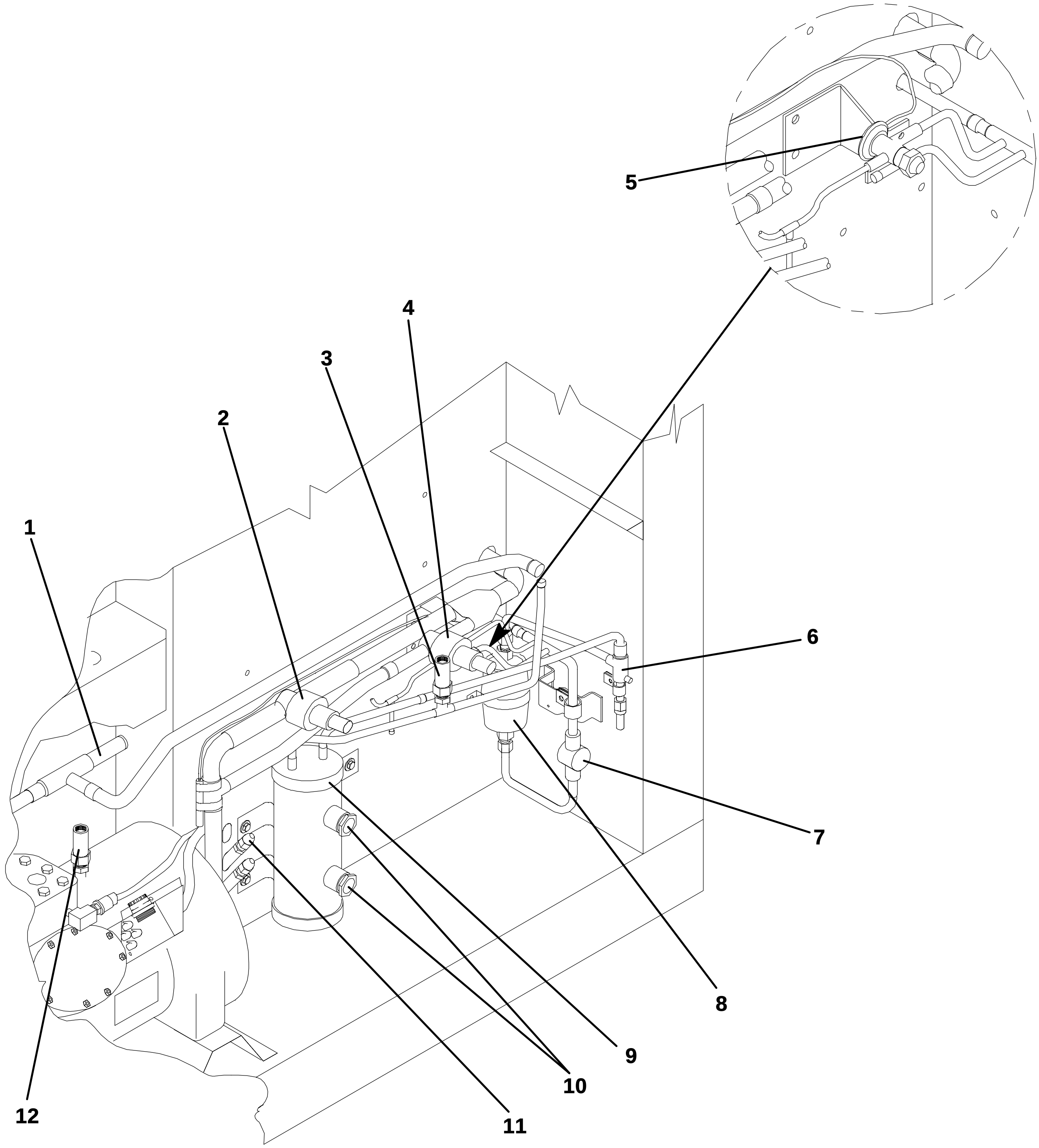
1.	Access Panel (Evaporator Fan Motor #1)	12.	High Pressure Switch (HPS)
2.	Access Panel (Heater and Thermostatic Expansion Valve Location)	13.	Compressor Sight Glass
3.	Fork Lift Pockets	14.	Discharge Service Valve
4.	Control Box	15.	Unit Serial/Model No. Plate – Location
5.	Voltage Selector Switch Cover	16.	Power Cables and Plug
6.	Receiver and Tubing Section	17.	Power Transformer (Optional) – Location
7.	Suction Service Valve	18.	Condenser Fan Motor (CM)
8.	Compressor Motor (CP)	19.	Make-Up Air Cover
9.	Start-Stop Switch (ST)	20.	Recording Thermometer
10.	Manual Defrost Switch (MDS)	21.	TIR Locking Devices
11.	Remote Monitoring Receptacle (RM)	22.	Access Panel (Evaporator Fan Motor #2)

Figure 1-1. Refrigeration Unit – Front



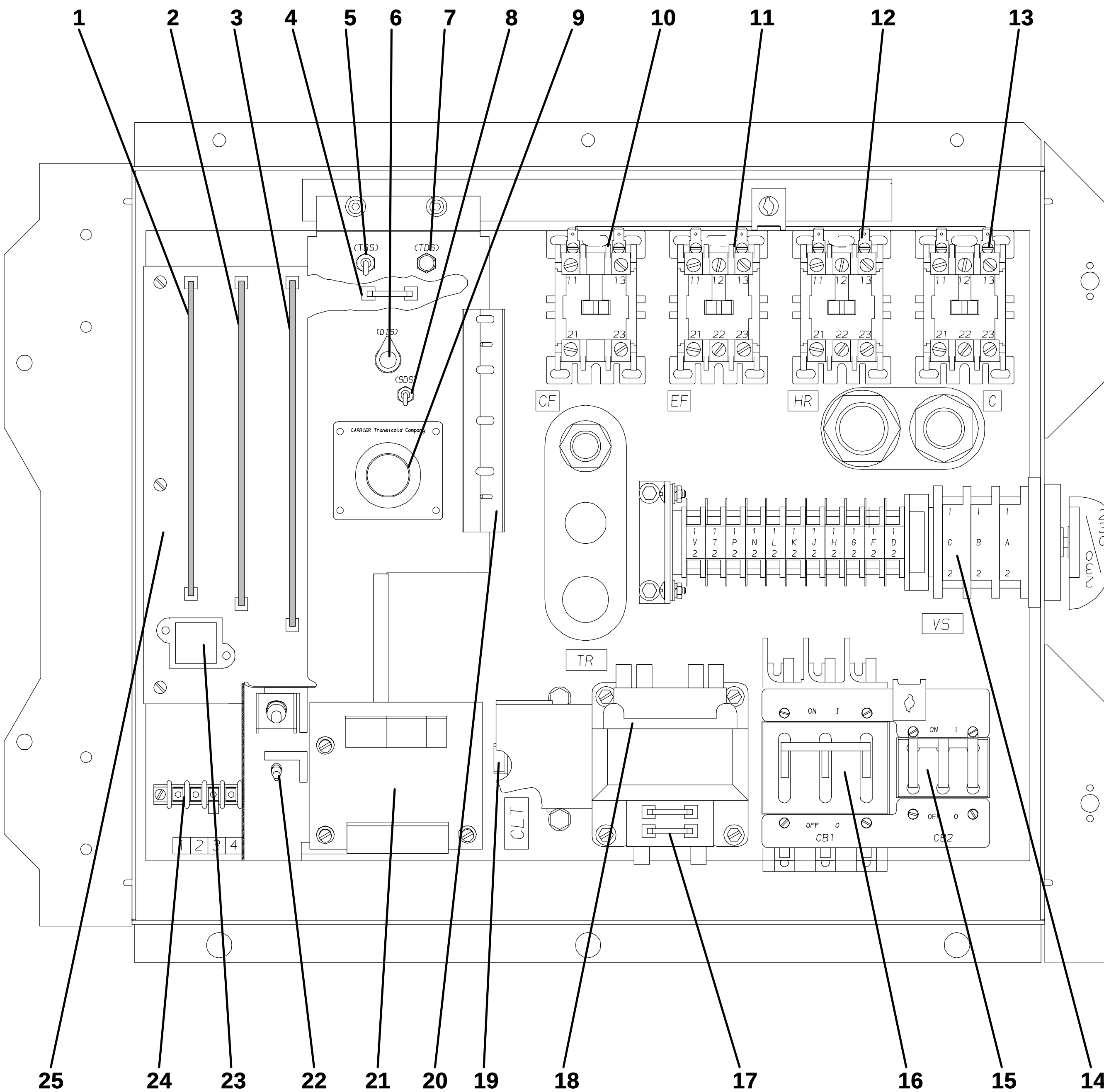
1. Evaporator Fan Motor #1 (EM1)
2. Humidistat (Optional) – Location
3. Return Temperature Sensor (RTS)
4. Partlow Thermister Sensor
5. Evaporator Fan Motor #2 (EM2)
6. Suction Solenoid Thermostat (SST)
7. Defrost Termination Thermostat (DTT)
8. Heater Termination Thermostat (HTT)
9. Evaporator Coil
10. Thermostatic Expansion Valve
11. Drain Pan Heater (DPH)
12. Evaporator Coil Heaters
13. Heat Exchanger

Figure 1-2. Refrigeration Unit – Rear (Panels Removed)



1 Discharge Pressure Regulating Valve
2. Suction Modulation Valve (SMV)
3. Pressure Relief Valve – High Side
4. Suction Solenoid Valve (SSV)
5. Quench Expansion Valve
6. Manual Liquid Line Valve
7. Moisture-Liquid Indicator
8. Filter-Drier
9. Receiver
10. Receiver Sight Glasses
11. Supply Temperature Sensor (STS)
12. Pressure Relief Valve – Low Side

Figure 1-3. Receiver and Tubing Section



1. Power Supply and In-Range Board
2. Timing and Current Control Board
3. Temperature Control Board
4. Fuse Location (F1 – 3 amp)
5. Temperature Simulator Switch (TSS)
6. Defrost Interval Selector (DIS)
7. Time Delay Override Switch (TDS)
8. Set Temperature Display Switch (SDS)
9. Temperature Set Station (CSS)
10. Condenser Fan Contactor (CF)
11. Evaporator Fan Contactor (EF)
12. Heat Contactor (HF)
13. Compressor Contactor (C)
14. Voltage Switch (VS)
15. Circuit Breaker (CB2 – 230v)
16. Circuit Breaker (CB1 – 460v)
17. Control Fuse (F – 6 amp)
18. Control Transformer (TR)
19. Current Limiting Transformer (CLT)
20. Status Indicator
21. Digital Display (DD)
22. Scale Selector Switch (SSS)
23. Relay (24 vac w/12 vdc coil) (DR, IRS, TC, TU & TQ)
24. Terminal Block Connection (TB)
25. Controller (Mother) Board

Figure 1-4. Control Box and Controller

1.3 REFRIGERATION SYSTEM DATA

a. Compressor – Motor Assembly

No. of Cylinders: 6
Model: 06DR
Weight (Dry): 118 kg (260 lb)

b. Approved Compressor Oil

Castrol Icematic – SW20

c. Compressor Oil Charge

3.6 liters (7.6 U.S. pints)

d. Compressor Oil Sight Glass

Oil level should be between 1/8 to 1/4
of the sight glass with the compressor in operation.

e. Defrost Timer

Initiates Defrost: Refer to paragraph 1.11.f.

f. Defrost Termination Thermostat

Opens: 23.9 (¦ 3)_C = 75 (¦ 5)_F
Closes: 15.6 (¦ 3)_C = 60 (¦ 5)_F

g. Expansion Valve Superheat

Setting at 0_C (32_F) container box temperature:
3.36 to 4.48_C (6 to 8_F)

h. Heater Termination Thermostat

Opens: 54 (¦ 3)_C = 130 (¦ 5)_F
Closes: 38 (¦ 3)_C = 100 (¦ 5)_F

i. High Pressure Switch

Cutout: 25 (¦ 0.7) kg/cm@ = 350 (¦ 10) psig
Cut-In: 18 (¦ 0.7) kg/cm@ = 250 (¦ 10) psig

j. Refrigeration Charge

Refer to Table 1-1

k. Pressure Relief Valves

Low Side Valve:
Opens: 18.63 kg/cm@ (265 psig)

High Side Valve:
Opens: 35 kg/cm@ (500 psig)

l. Refrigerant Operating Level (after 20 minutes operation with unit in cooling)

Refer to section 4.6

m. Unit Weight

Refer to Table 1-1

n. Water Pressure Switch (Optional)

Cut-In: 0.5 ¦ 0.2 kg/cm@ (7 ¦ 3 psig)
Cutout: 1.6 ¦ 0.4 kg/cm@ (22 ¦ 5 psig)

o. Suction Solenoid Thermostat

Closes at: –12.2 ¦ 1.7_C (10 ¦ 3_F)
Opens at: –6.7 ¦ 3.3_C (20 ¦ 6_F)

1.4 ELECTRICAL DATA

a. Circuit Breaker(s)

CB-1 Trips at: 29 Amps
CB-2 Trips at: 62.5 Amps

b. Compressor Motor

Full Load Amps (FLA): 17.6 Amps@ 460 vac
(with current limiting switch in position B)

c. Condenser Fan Motor

Bearing Lubrication: Factory lubricated, additional grease not required.
Full Load Amps: 2.0/4.0 FLA
Nominal Horsepower: 0.43/0.75 hp
Rotation: CCW when viewed from shaft end.
Speed: 1425/1725
Voltage: 190/380/208/230/460 vac/1ph/50/60 hz

d. Drain Pan Heaters

Number of Heaters: 1
Rating: 750 watts +5 /–10 % at 460 Vac
Resistance (cold): 22.7 ¦ 5% ohms nominal
Type: Sheath

e. Evaporator Coil Heaters

Number of Heaters: 4
Rating: 750 watts each at 230 +5 /–10 volts
Resistance (cold) @ 20_C (68_F)
Ambient: 66.8 to 77.2 ohms
Type: Sheath

f. Evaporator Fan Motor(s)

Bearing Lubrication: Factory lubricated, additional grease not required.

Full Load Amps:
High Speed: 2.0/2.3 Amps
Low Speed: 0.4/0.6 Amps
Single Speed Motor: 2.0/4.0

Nominal Horsepower:
High Speed: 0.58/1.0 hp
Low Speed: 0.07/0.12 hp
Single Speed Motor: 0.58/1.0 hp

Rotation:
Evaporator Fan Motor #1 (See Figure 1-2):
CW when viewed from shaft end
CCW when viewed from end opposite shaft end
Evaporator Fan Motor #2 (See Figure 1-2):
CCW when viewed from shaft end
CW when viewed from end opposite shaft end.

Speed: 2850/3450 rpm

Voltage: 380/460 vac/1 ph/50/60 hz

g. Fuses

Control Circuit: 6 amp (F)

Unit Control Board: 3 amp (F1)

Table 1-3. Safety and Protective Devices

UNSAFE CONDITIONS	SAFETY DEVICES	DEVICE SETTING
1. Excessive current draw	1. Circuit Breaker (CB-1) – Manual Reset	1. Trips at 29 amps (460 vac)
	1. Circuit Breaker (CB-2) – Manual Reset	1. Trips at 62.5 amps (230 vac)
2. Excessive current draw on control circuit	2. Fuse (F)	2. Opens at 6 amps
3. Excessive condenser fan motor winding temperature	3. Internal Protection (IP-CM) – Automatic Reset	3. N/A
4. Excessive compressor motor winding temperature	4. Internal Protector (IP-CP) – Automatic Reset	4. N/A
5. Excessive evaporator fan motor(s) winding temperature	5. Internal Protector(s) (IP-EM) – Automatic Reset	5. N/A
6. Abnormal pressures in the low refrigerant side	6. Pressure Relief Valve – Low Side	6. Opens at 18.63 kg/cm@ (265 psig)
7. Abnormal pressures in the high refrigerant side	7. Pressure Relief Valve – High Side	7. Opens at 35 kg/cm@ (500 psig)
8. Abnormally high discharge pressures	8. High Pressure Switch (HPS)	8. Opens at 25 ¦ 0.7 kg/cm@ (350 ¦ 10 psig)
9. Solid state circuitry high voltage surge	9. Fuse (F1)	9. Opens at 3 amps
10. Excessive power transformer winding temperature	10. Internal Protector (IP-Trans) – Automatic Reset	10. Opens at 178 ¦ 5_C (350 ¦ 10_F) Closes at 150 ¦ 7_C (300 ¦ 12_F)

1.5 SAFETY AND PROTECTIVE DEVICES

System components are protected from damage by safety and protective devices listed in Table 1-3. These devices monitor the system operating conditions and open a set of electrical contacts when an unsafe condition occurs.

Open safety switch contacts of one or more of the following devices IP-CM, IP-CP, HPS, or IP-Trans (Auto) will shut down the compressor. The condenser fan motor will stop if contacts IP-CM, IP-CP, or IP-Trans (Auto) open.

The entire refrigeration system will shut down if one of the following safety devices open: (a) Circuit Breaker(s) or; (b) Fuse (6A) or; (c) Evaporator Fan Motor Internal Protector(s) – (IP-EM).

1.6 FRESH AIR MAKEUP VENT

The purpose of the vent is to provide ventilation for commodities that require fresh air circulation and *must be closed* when transporting frozen foods.

a. Full Open or Closed Positions

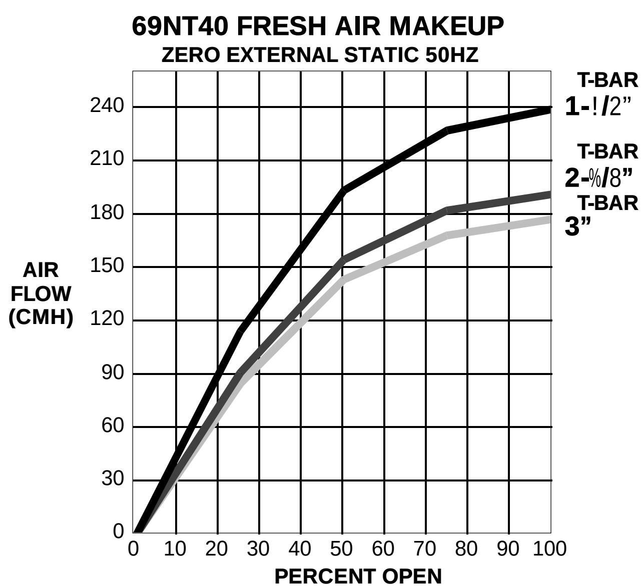
Maximum air flow is achieved by loosening the wing nuts and moving the cover to the maximum open position (100% position). The closed position is 0% air flow position.

The operator may also adjust the opening to increase or decrease the air flow volume to meet the required air flow. (See chart below.)

b. Air Sampling for Carbon Dioxide (CO_2) Level

Loosen wing nuts and move cover until the arrow on the cover is aligned with the "atmosphere sampling port" label. Tighten wing nuts and attach 3/8 tube to the sampling tube.

If the internal atmosphere content has reached an unacceptable level, the operator may adjust the cover opening to meet the required air flow volume to ventilate the container.



For 60HZ operation multiply curves by 1.2

1.7 DIGITAL DISPLAY

The digital display receives signals from the controller and normally displays temperature at the active controller probe (return temperature sensor RTS or supply temperature sensor STS).

Depressing the set display switch (SDS, momentary contact) will display the controller set point temperature while depressed.

Display is selectable in Celsius or Fahrenheit. Placing the scale selector switch in the down position causes the temperature to be displayed in degrees Fahrenheit (_F). Display will read in degrees Celsius (_C) with the switch in the up position.

With perishable cargo (set points above –10_C = 14_F) the digital display and recording thermometer may not agree as the recorder bulb is sensing the *return air* temperature and the digital display will indicate supply air temperature.

With a frozen load (set points below –10_C = 14_F), the recording thermometer and the digital display both indicate return air temperature and should be in close agreement.

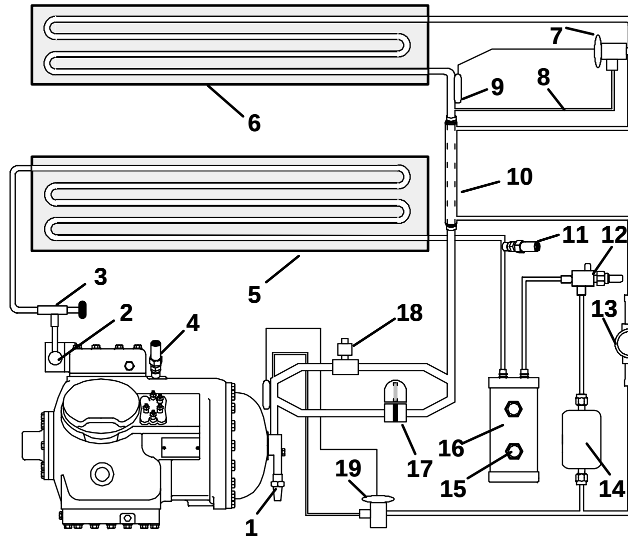
1.8 REFRIGERATION CIRCUIT

Starting at the compressor (see Figure 1-5), the suction gas is compressed to a higher temperature and pressure.

When operating with the *air-cooled condenser,* the gas flows through the discharge service valve into the pressure regulator valve that is normally open, however, if ambient conditions are low the pressure regulator valve restricts the flow of refrigerant to maintain a discharge pressure of 5 kg/cm@ (70 psig). Refrigerant gas then moves into the air-cooled condenser. Air flowing across the coil fins and tubes cools the gas to saturation temperature. By removing latent heat, the gas condenses to a hot liquid and then flows by a pressure relief valve which opens if the refrigerant pressure is abnormally high, to the receiver which stores the additional charge necessary for low temperature operation.

From the receiver or water-cooled condenser, the liquid refrigerant continues through a liquid line shutoff valve, filter-drier (which keeps refrigerant clean and dry), a moisture-liquid indicator, a heat exchanger (that increases subcooling of liquid refrigerant) to the thermostatic expansion valve. As the liquid refrigerant passes through the orifice of the expansion valve some of it vaporizes into a gas (flash gas). Heat is absorbed from the return air by the balance of the liquid causing it to vaporize in the evaporator coil. The vapor then flows through the suction modulation valve to the compressor.

The thermostatic expansion valve bulb on the suction line near the evaporator coil outlet, controls the valve, maintaining a relatively constant superheat at the coil outlet regardless of load conditions except at abnormally high container temperatures such as during pulldown (valve at maximum operating pressure condition).



1. Suction Service Valve
2. Discharge Service Valve
3. Pressure Regulator Valve
4. Pressure Relief Valve (Low Side)
5. Air-Cooled Condenser
6. Evaporator
7. Expansion Valve
8. External Equalizer Line
9. Expansion Valve Bulb
10. Heat Exchanger
11. Pressure Relief Valve (High Side)
12. Liquid Line Valve
13. Moisture-Liquid Indicator
14. Filter-Drier
15. Sight Glass
16. Receiver or Water-cooled Condenser
17. Suction Solenoid Valve
18. Suction Modulation Valve
19. Quench Expansion Valve

Figure 1-5. Refrigeration Circuit

1.9 REMOTE MONITORING RECEPTACLE AND CIRCUIT

When the remote monitor is connected to the remote monitoring receptacle, Figure 1-1, the following remote circuits are energized.

Circuit	Function
Sockets B to A	Energizes remote cool light
Sockets C to A	Energizes remote defrost light
Sockets D to A	Energizes remote in-range light

Note

The in-range light will be illuminated if the container return air temperature is within 2_C (3.6_F). Refer to paragraph 1.11.g.

1.10 SUCTION SOLENOID VALVE

The suction solenoid valve, shown in Figure 1-3 is controlled by the suction solenoid thermostat (located on the evaporator fan motor deck as shown in Figure 1-2).

In operation, if the return air temperature decreases to −12.2_C (10_F), the suction solenoid thermostat (SST) closes to energize the suction solenoid valve, which opens to increase the refrigerant flow rate and cooling capacity.

The thermostat opens with increasing return air temperature at −7 ¦ 3_C (20 ¦ 6_F) to de-energize the valve.

1.11 CONTROLLER

a. General Description (See Figure 1-4)

The Carrier Transicold controller is a modular assembly of electronic circuits that combines a number of refrigeration system control functions in a single unit.

The functions are: (1) temperature control; (2) current control; (3) temperature control function time delays; (4) selectable time interval defrost; and, (5) out-of-range indication time delay.

The controller consists of a programmed main circuit board, three plug-in control circuit boards, five or six plug-in relays, and remote located components which are: (1) temperature set point potentiometer; (2) two temperature sensing probes; (3) two switches for checking calibration; and, (4) current limiting transformer.

The controller has high precision components in critical circuits which result in the elimination of calibration adjustments. As long as component replacements are made using factory specified parts, calibration will be maintained.

b. Current Control (Capacity Override)

The current control function of the controller limits the maximum unit current draw to prevent possible overloading of limited power sources such as an engine-generator set when operating with high container temperatures and high ambient temperatures. Refer to Table 1-4.

The current control function, when required, will override the normal modulated capacity control function (described in paragraph 1.11.c.) to reduce cooling capacity sufficiently to prevent total unit current from exceeding a preset value. This is accomplished by circuitry on the timing and current control circuit board in response to the current sensed in one phase of the compressor power line by current limiting transformer (CLT). The current limit on the timing and current control board is factory set in switch position "B" (see Figure 1-6).

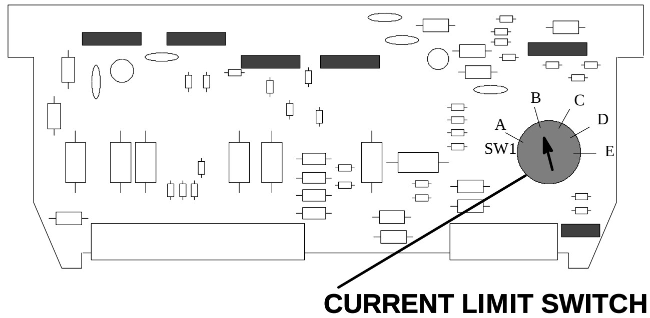


Figure 1-6. Current Control Printed Circuit Board

NOTES

1. If the current limiting switch is set too low, unit pulldown capacity may be reduced due to limitation of compressor amperage as determined by the timing and current control board.
2. Table 1-4 shows the approximate total unit amps for each position of the current limit control.

Table 1-4. Current Limiting Switch Positions and Amperages

Switch Position	A	B	C	D	E
460 vac Operation	15A	17A	19A	21A	23A
230 vac Operation	30A	34A	38A	42A	46A

c. Temperature Control (Capacity Control)

The temperature control portion of the controller consists of a temperature set point potentiometer (CSS), return air (RTS) and supply air (STS) temperature sensors (two thermistor probes), solid state circuitry (temperature control, timing and current control, power supply and IRS printed circuit boards), and associated control relays. Each temperature sensor is located in its respective air stream.

Operation at any desired temperature within the set point range (−25_C to +25_C or −15_F to +80_F) is achieved by turning the set point potentiometer knob to position the pointer at the desired temperature.

A change in sensed air temperature (supply or return air depending on set point) causes a corresponding change in electrical resistance of the thermistor sensor. This change is processed by the electronic circuitry of the controller which actuates control relays and the refrigerant suction modulation valve in accordance with the controller operating diagrams as shown in Figure 1-7 and Figure 1-8.

Units with Two-speed Evaporator Motors:

For set points *above* −10_C (14_F) relay TU will be energized along with contactor EF. The two-speed evaporator motors will be in high speed.

Units with Optional Humidistat:

Also, for set points above −10_C (14_F), the controller will maintain supply air at the set temperature by the following modes of operation:

1. Conventional, Humidity Control Switch (HCS) in position "O" − cooling by refrigeration with suction

modulation and the compressor cycling at light loads. Electric resistance heating.

2. Conventional plus Dehumidification, Humidity Control Switch in position “1” – cooling by refrigeration with suction modulation and compressor cycling at low humidities, suction modulation and simultaneous electric resistance heating at high humidities.

1. Operation in the Conventional Mode

Operation in the Conventional Mode (HCS in position “O”, that is if the optional humidistat is installed) with the set point setting below the air temperature at the supply air probe but above –10_C (14_F) the unit starts in cooling with controller relay TU (used only with two-speed evaporator fan motors) energized. Compressor and condenser fan contactors are energized through relay TC contacts T9 and T31 (now closed).

As the sensed temperature continues to fall, the modulating valve current will remain at minimum (under 0.2 amp) until the sensed temperature drops to 0.25_C (0.45_F) above set point.

With any further drop in sensed temperature, modulated (continuously variable) capacity reduction occurs to match cooling requirements that are less than the maximum capacity of the unit. This permits exact balancing of unit capacity with a wide range of cooling loads while maintaining continuous compressor operation and holding the temperature very close to set point. This variable cooling capacity is achieved by a suction modulation valve which provides a variable restriction in the compressor suction line. This valve varies the flow rate of the refrigerant pumped by the compressor.

For very small cooling requirements that are less than the minimum refrigeration capacity of the unit (fully closed modulating valve), the controller will cycle compressor on and off to match the load. De-energization of relay TC to stop the compressor is delayed to prevent nuisance cycling from brief low temperature swings. Once off, the compressor will not restart for 5 to 6 minutes. (Refer to paragraph d.)

In cold ambients when container heating is required, the sensed temperature will drop to 1.0_C (1.8_F) below set point and the controller will cycle electric resistance heating with a delay on energization similar to that associated with compressor cycling. The heat relay (contactor HR) is energized through the closed contacts (N.C.) of relay TC by controller relay TH energizing and closing the TH contacts (N.O.). Heat relay (contactor) HR energizes the defrost and drain pan heaters.

For set points below –10_C (14_F), return air temperature is sensed and the range of capacity reduction is more limited than for higher set points. When cooling requirements are less than the minimum continuous operating capacity of the unit, the unit reverts to on-off compressor cycling to match the load. When cooling, compressor and condenser fan contactors are energized through the normally open (N.O.) contacts of relay TC.

Also, for set points *below* –10_C (14_F), the controller will maintain *return air* at the set temperature by refrigeration. Electric resistance heating is electronically locked out in this temperature range. Units with two-speed evaporator fan motors will have the evaporator fan motors in low speed as relay TU will be de-energized. (Contactor ES energized.)

Electric resistance heating is locked out for set points below –10_C (14_F) by controller relay TH being locked out to prevent energizing the circuit.

Cargo temperatures will necessarily vary somewhat from controlled air temperatures. A simple numerical difference between product temperature and controlled air temperature cannot be stated because of the complex relationship of air flow variations within the container and temperature gradients of air and product. However, during cooling, it can be stated that with supply air control, a minimum product temperature will be effectively maintained and with return air control, a maximum product temperature will be effectively maintained.

2. Operation in the Dehumidification Mode

Operation in the Dehumidification Mode (HCS in position “1”, that is if the humidistat is installed). With the set point setting below the air temperature at the supply air probe (but above –10_C (14_F) starts with controller relay TU (used only with two-speed evaporator fan motors) energized. The compressor and condenser fan contactors are energized through normally closed TC relay contacts. The evaporator fan motors are as previously described.

Cooling capacity reduction by modulation is the same as described for the conventional operating mode when the return air relative humidity is below the setting on the humidity controller (HC) and as long as an out-of-range temperature condition exists, regardless of return air relative humidity.

For relative humidities higher than the HC setting, if the supply air temperature drops to 2_C (3.6_F) above set point, in-range relay (IRS) energizes and, in turn, energizes heat relay (contactor) HR thorough closed (N.O.) relay HC contacts. Also, the in-range and heat lights are illuminated at this time.

This applies power to the defrost and drain pan heaters. This added head load causes the controller to open the modulating valve to match the new total heat load while still holding the supply air temperature very close to set point.

Opening the modulating valve reduces the temperature of the evaporator coil surface which increases the rate water is condensed from the air passing through the coil. Removing water from the air reduces the relative humidity until the HC setting is reached and controller HC contacts open to de-energize heating.

Humidity controller HC will continue to cycle heating to maintain relative humidity below HC setting.

With set points below –10_C (14_F), operation is the same as previously described for conventional mode – heating and dehumidification are locked out.

d. Time Delays

TC relay operation is affected by a time delay function of the Timing and Current Control Board; its purpose is to prevent short cycling of the compressor.

To prevent short cycling of the compressor, a six minute compressor off time must be satisfied. When the timer completes its six minute cycle, the compressor will start if the sensed temperature is greater than 0.25_C (0.45_F) above setpoint.

Additional transient override time delays affect the operation of TC and TH relays. These delays are all overridden by pressing the time delay override switch (TDS).

e. Lockout Functions

Heating function lockout for set points below −10_C (14_F) is achieved by relay TH being prevented from energizing.

f. Selectable Time Interval Defrost

A selectable interval defrost initiation timer is included in the timing and current control board. The time interval between defrost initiations (90 second test, 3 hours, 6 hours, 12 hours, or 24 hours) is set with the defrost interval selector switch (DIS).

The controller initiates defrost (providing the evaporator coil temperature is below 13_C = 55_F required to close the defrost termination thermostat contacts) by:

1. Energizing defrost relay (DR) energizes the defrost light and stops the evaporator fan motors by de-energizing the evaporator fan motor contactor.

2. De-energizing cooling relay (TC) and energizing and heating relay (TH). This stops the compressor and condenser fan motor and energizes the defrost and drain pan heaters.

Defrosting is terminated by the defrost termination thermostat (DTT), which opens when the evaporator coil temperature rises to 24_C (75_F) after all frost has been melted from the coil.

Also, defrost may be manually initiated at any time by actuating the manual defrost switch (MDS) if DTT is closed.

NOTE

Defrost interval timing restarts at time zero whenever the time delay override switch (TDS) is depressed or control circuit power is restored after an interruption such as occurs when stopping or starting unit (ST switch) and when DTT opens.

g. Out-of-Range Indication Time Delay

During defrost, the temperature at the sensing probe rises above the upper in-range limit which would result in an out-of-range indication if the temporary condition were not overridden. Circuitry on the timing and current control board works in conjunction with the temperature control circuitry to delay de-energization of the in-range relay (IRS) until approximately 90 minutes after the temperature at the sensing probe goes beyond the in-range temperature limits. A normal operating unit will return from defrost to an in-range condition before expiration of the 90 minute delay and no interruption of in-range indication will occur. Indication of the instantaneous temperature condition (in or out-of-range) can be obtained by pressing the time delay overrride switch (TDS).

h. Function and Calibration Check

The controller has precision resistors that simulate sensing probe temperatures to permit readily checking controller functions and calibration without using temperature baths or other temperature measuring instruments.

Sensing probe temperature is simulated by holding the temperature simulator switch (TSS) in the desired position, 0_C (32_F) or −17.8_C (0_F).

When checking controller functions and calibration, it is also necessary to hold the time delay override switch (TDS) depressed to obtain immediate controller responses. Depressing switch TDS does the following:

1. Cancels 90 minute in-range delay (paragraph g.).

2. Cancels 6 minute compressor recycle delay (paragraph d.).

3. Cancels relay TH “ON” nuisance cycling delays.(Paragraphs c. and d.).

4. Resets defrost interval timing to zero (paragraph g.).

1.12 HUMIDISTAT (OPTIONAL)

NOTE

The supply air must be in-range or humidistat circuit will not energize.

The humidistat (Figure 1-2) is designed to operate when transporting a chill load (controller set above −10_C (14_F) and is locked out when the controller is set below −10_C (TU contacts T35 to T37 are open).

a. The humidistat will be in operation if:

1. Supply air is in-range (in-range light illuminated).
2. Humidistat control switch in the ON position.
3. Controller is set above −10_C (14_F).
4. Container relative humidity reaches setpoint of the users desired R.H. setting on the humidistat.

The above energizes the humidistat circuit as relay IRS contacts T24 to T23, TU relay contacts T35 to T37, HCS contacts 1-2, and HC contacts 1-3 close to energize the heaters and heat light.

b. For testing purposes:

WARNING

Beware of rotating evaporator fan when conducting following test.

1. Remove the front evaporator fan motor #1 access panel (see Figure 1-1). The humidistat is located behind this panel.

2. Move the controller set pointer within 2_C (3.6_F) of container supply air temperature.

3. Move the humidistat control switch to ON position (position 1).

4. Turn the humidistat control knob until heaters are energized (heat light ON) and then reset control to the users desired R.H. value. Replace access panel and lockwire.

1.13 VOLTAGE SWITCH AND POWER TRANSFORMER (OPTIONAL)

WARNING

Do not attempt to remove power plug(s) before turning OFF start-stop switch (ST), unit circuit breaker(S) and external power source. Make sure the power plugs are clean and dry before connecting to any power receptacle.

a. Step-Up Power Transformer

The transformer is located under the condenser coil (left-hand side of unit) and the purpose of this transformer is to provide 380 vac/3 ph/50 hz power when the 190/230 vac power cable (black) is connected to a 190 vac power supply or to provide 460 vac/3 ph/60 hz when the 190/230 vac power cable (black) is connected to a 230 vac power supply.

WARNING

Do not attempt to remove power plug before turning OFF voltage switch (VS), start-stop switch (ST), unit circuit breakers (CB-1 And CB-2), and external power source.

b. To Place Unit on 190/230 vac Power Supply

1. Make sure voltage switch (VS) is in the OFF position. Make sure start-stop switch (ST, on control panel) and circuit breakers CB-2 is in position "O" (OFF). (See Figure 1-4)

2. Connect 190/230 vac power cable plug (black cable). Place voltage switch (VS) in the 230 v position. Place circuit breaker (CB-2) in position "1". Close and secure control box door and then place the start-stop switch (ST) in position "1".

c. To Place Unit on 380/460 vac Power Supply

1. Make sure voltage switch (VS) is in the OFF position. Make sure start-stop switch (ST, on control panel) and circuit breaker (CB-1) is in position "O" (OFF).

2. Connect 380/460 vac power cable plug (yellow cable). Place voltage switch (VS) in the 460 v position. Place circuit breaker (CB-1) in position "1". Close and secure control box door and then place the start-stop switch (ST) in position "1".

1.14 WATER-COOLED CONDENSER AND WATER PRESSURE SWITCH (OPTIONAL)

The water-cooled condenser is used when heating the surrounding air is objectionable such as in a ship's hold and cooling water is available.

The water-cooled condenser is of the shell and coil type with circulating water through the cupro-nickel coil. The refrigerant vapor is admitted to the shell side and is condensed on the outer surface of the coil.

For operation of the refrigeration unit with the water-cooled condenser, do the following:

a. Connect water supply line to inlet side of condenser and discharge line to outlet side of condenser.

b. Maintain a flow rate of 11 to 26 liters (3 to 7 U.S. gallons) per minute. The water pressure switch will open to de-energize the condenser fan relay. The condenser fan motor will stop and will remain stopped until the water pressure switch closes.

The refrigeration unit operating with the water-cooled condenser will perform as outlined in section 2.4 except that the condenser fan motor is stopped in all modes.

To shift to air-cooled condenser operation, do the following:

Disconnect the water supply and the discharge line to the water-cooled condenser. The refrigeration unit will shift to air-cooled condenser operation when the water pressure switch closes. (Refer to paragraph 1.3.n.)

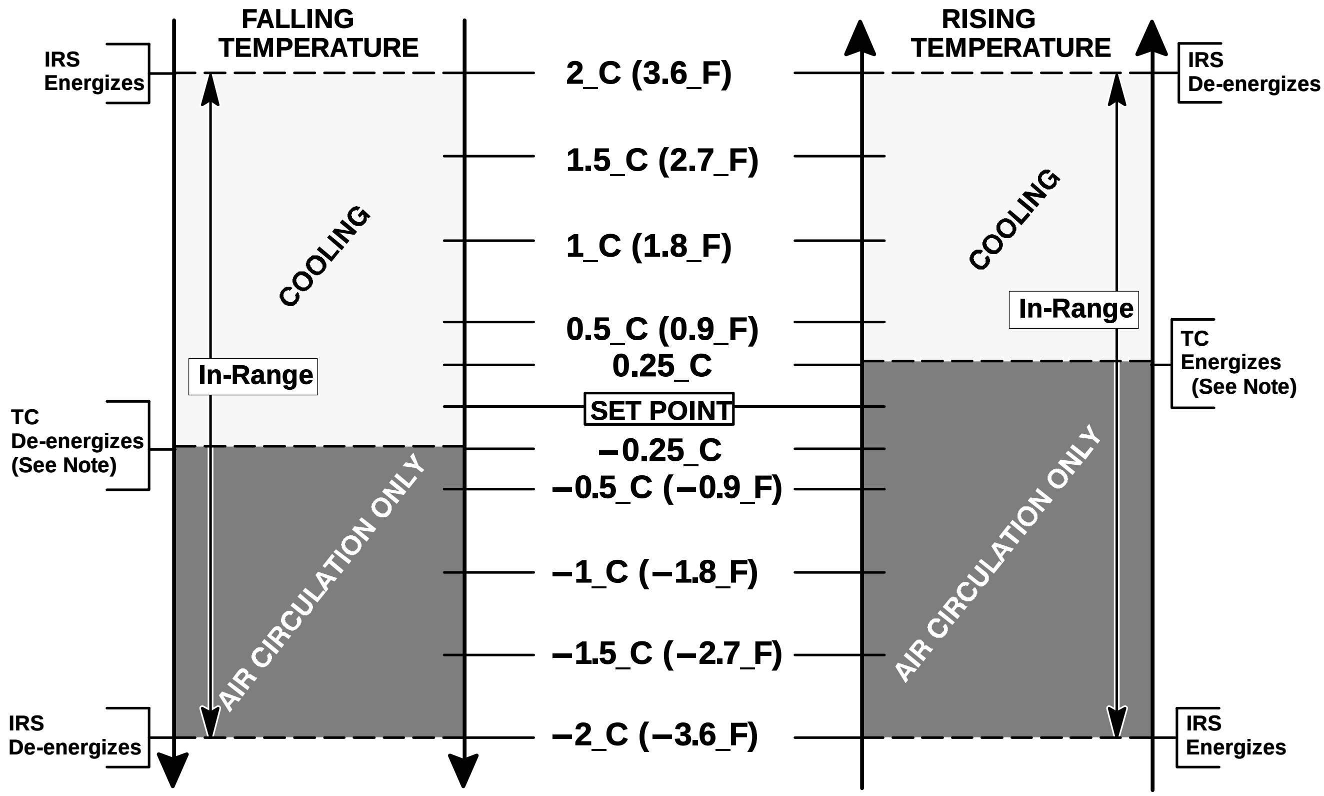


Figure 1-7. Controller Set Point Below –10_C (14_F) – Return Air Control

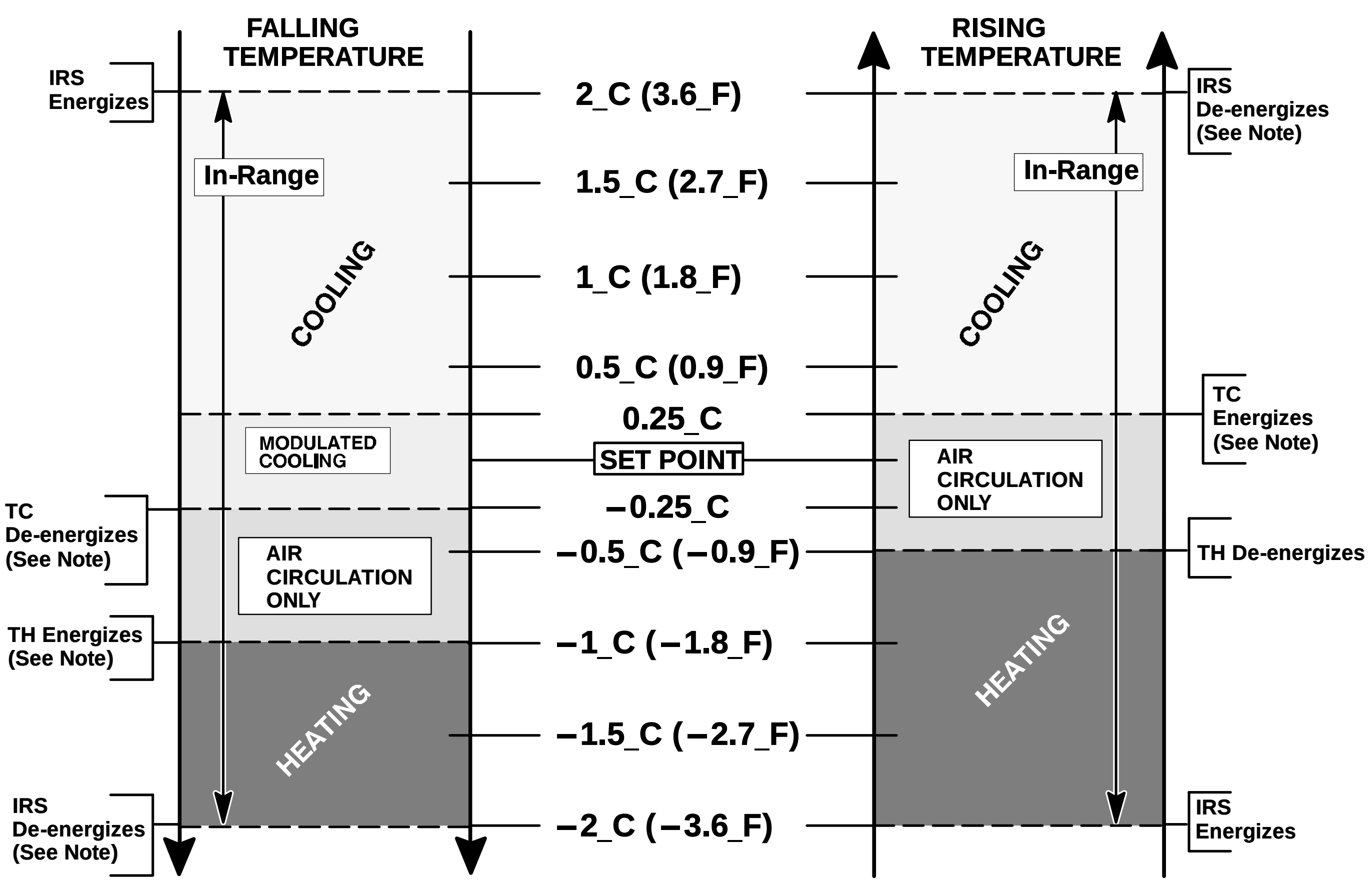


Figure 1-8. Controller Set Point Above –10_C (14_F) – Supply Air Control

NOTE

Switching functions are affected by time delays. (Refer to paragraph 1.11.d.)

SECTION 2

OPERATION

2.1 PRE-TRIP INSPECTION (Before Starting)

WARNING

Beware of unannounced starting of the evaporator and condenser fan.

a. If container is empty, check inside for the following:

1. Check channels or "T" bars on floor for cleanliness. Channels must be free of debris for proper air circulation.

2. Check container panels, insulation and door seals for damage. Effect permanent or temporary repairs.

3. Visually check evaporator fan motor mounting bolts for proper securement.

4. Check for dirt or grease on evaporator fan or fan deck and clean if necessary.

5. Check evaporator coil for cleanliness or obstructions. Wash with fresh water. (Refer to section 4.14)

6. Check defrost drain pans and drain lines for obstructions and clear if necessary. Wash with fresh water.

7. Check panels on refrigeration unit for loose bolts and condition of panels. Make sure T.I.R. devices are in place on access panels.

b. Check condenser coil for cleanliness. Wash with fresh water. (Refer to section 4.17)

c. Check position of fresh air makeup vent cover. Operator must determine if fresh air makeup vent cover is to be opened or closed.

d. Open **Partlow** recording thermometer (if so equipped) door and do the following:

1. Manually wind clock on recording thermometer (key is located in a clip.) KEY MUST STAY WITH THE THERMOMETER.

2. Lift stylus (pen) by pulling the marking tip outward until the stylus arm snaps into it's retracted position.

3. Install new chart on recording thermometer making sure chart is under the four corner tabs. Lower the stylus until stylus has made contact with chart. Then close and secure door.

e. Open the control box door. Check for loose electrical connections or hardware.

f. Check color of moisture-liquid indicator.

g. Check oil level in compressor sight glass.

h. Check suction modulation valve coil resistance. (Refer to section 4.21)

i. Start refrigeration unit. (Refer to section 2.3)

2.2 STARTING AND STOPPING INSTRUCTIONS

CAUTION

Make sure that the unit circuit breaker(S) (CB) and the start-stop switch are in the OFF position before connecting to any electrical power source.

i. Starting the Unit

1. Refer to Pre-Trip Inspection, section 2.1.

2. Make sure unit circuit breaker(s) and start-stop switch are in position "O" (OFF position).

3. Check power source for proper voltage. Connect unit power plug and turn main power ON.

4. Turn refrigeration unit circuit breaker(s), and the start-stop switch ON (position "1").

5. To adjust the temperature set point, depress SDS switch and turn temperature selector knob while looking at the digital temperature display. This procedure allows temperature settings within a tenth of a degree centigrade.

6. Refer to section 2.3 after unit is running.

j. Stopping the Unit

Turn the start-stop switch to position "O" (OFF).

2.3 AFTER STARTING INSPECTION

a. Check rotation of condenser and evaporator fans.

b. Check compressor oil level.

c. Check operation – determine if unit responds properly to setting of controller, cycling from heat to cool, at controller setting.

d. Feel filter-drier. Excessive temperature drop across drier indicates restriction.

2.4 UNIT OPERATION

2.4.1 Cooling – Controller Set Below –10_C (14_F)

On decreasing return air temperature the unit will be in cooling with the condenser fan motor and evaporator fan motors energized. With set points below –10_C (14_F), units with two-speed evaporator fan motors will be in low speed as relay TU will be de-energized (contactor ES energizes).

If the container return air is within 2_C (3.6_F) of set point, the in-range relay contacts (IRS) are closed and the in-range light (IRL) is illuminated.

When the return air temperature decreases to 0.25_C (0.5_F) below set point, a timing function commences which delays de-energizing of relay TC and resulting in de-energizing the compressor and condenser fan motor. Also, the cool light is de-energized. The evaporator fan motors continue to run to circulate air throughout the container.

When the return air temperature increases to 0.25_C (0.5_F) above set point, and providing a sufficient off period has elapsed, relay TC energizes to restart the compressor. Also, at this time, the condenser fan motor starts and the cool light is illuminated.

NOTES

1. When the return air temperature decreases to −12.2_C (10_F), the suction solenoid thermostat closes to energize the suction solenoid valve. The valve opens to increase the refrigerant flow rate and cooling capacity.

2. In the frozen range the suction modulation is limited to approximately 0.4 amp or valve is 25 percent closed.

3. Setting the controller below −10_C (14_F) on units with two-speed motors will place the motors in low speed (contactor ES energizes).

2.4.2 Controller Set Above −10_C (14_F)

a. Cooling (See Figure 2-1)

With decreasing supply air temperature and if the supply air is more than 2_C (3.6_F) above set point, the unit will be cooling with the condenser fan motor, compressor motor and evaporator fan motors energized. The two-speed evaporator fan motors will be in high speed as relay TU is energized (contactor ES de-energizes and contactor EF energizes).

Also, at this time, the cool light is illuminated. The in-range light is de-energized.

When the air temperature decreases to 2_C (3.6_F) above set point relay IRS energizes and the in-range light is illuminated.

If the air temperature continues to fall, modulating cooling starts at approximately 0.25_C (0.45_F) above set point. The modulating valve will have a variable current up to 1.45 amps at full modulation.

When the *supply air temperature decreases* to 0.25_C (0.5_F) below set point, a timing function commences which delays de-energizing of relay TC resulting in de-energizing the compressor and condenser fan motor. Also, the cool light is de-energized.

The evaporator fan motors continue to run to circulate air throughout the container. The in-range light remains illuminated as long as the return air is within 2_C (3.6_F) of set point.

If the unit is in the holding mode (neither heating or cooling) and the *supply air temperature increases* to 0.25_C (0.5_F) above set point, and providing a sufficient off time has elapsed, relay TC energizes to restart the compressor. Also, at this time, the condenser fan motor starts and the cool light is illuminated.

When the *supply air temperature increases* 2_C (3.6_F) above set point, relay IRS and the in-range light is off. The cool light remains energized.

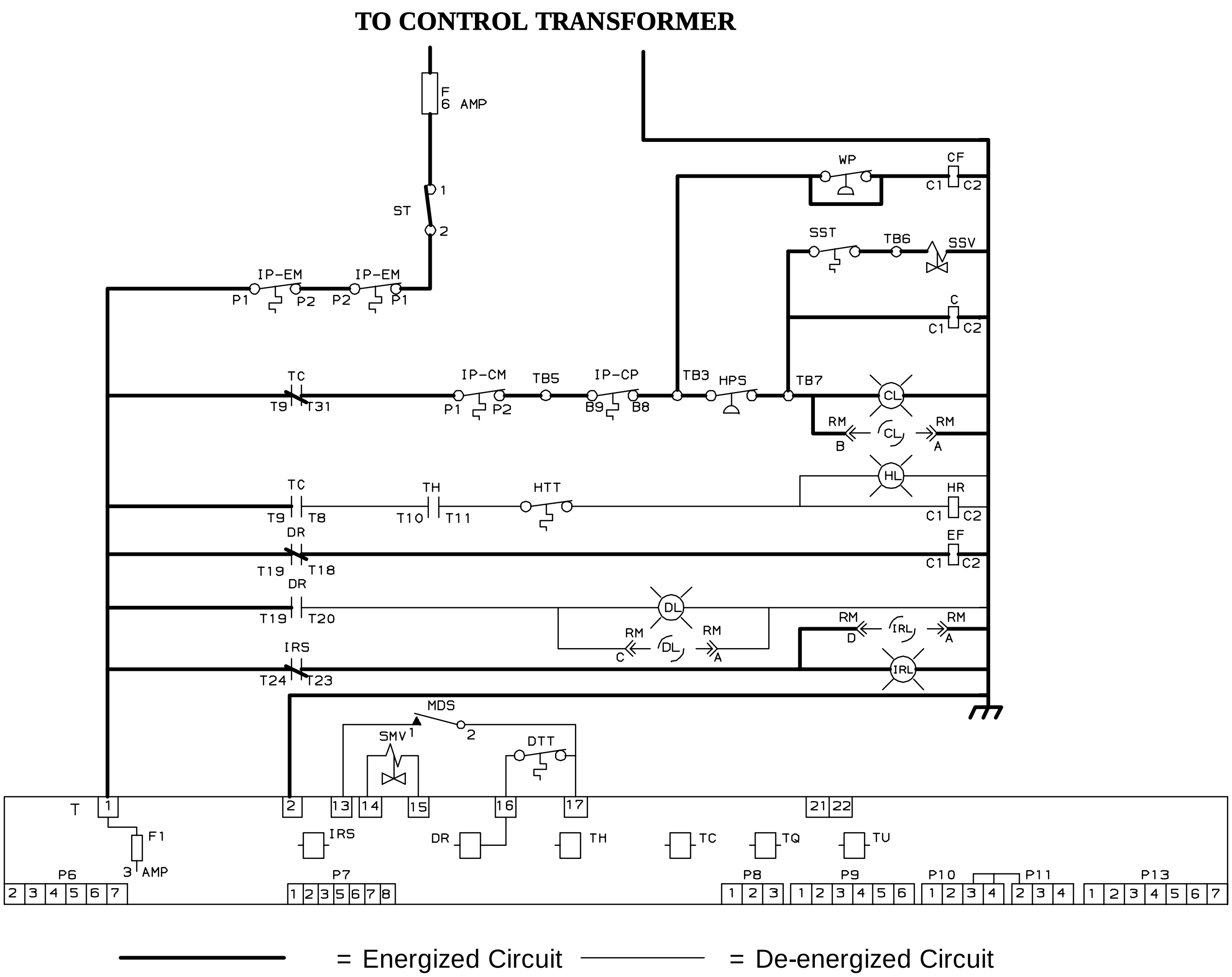


Figure 2-1. Cooling − Within 2_C (3.6_F) of Set Point

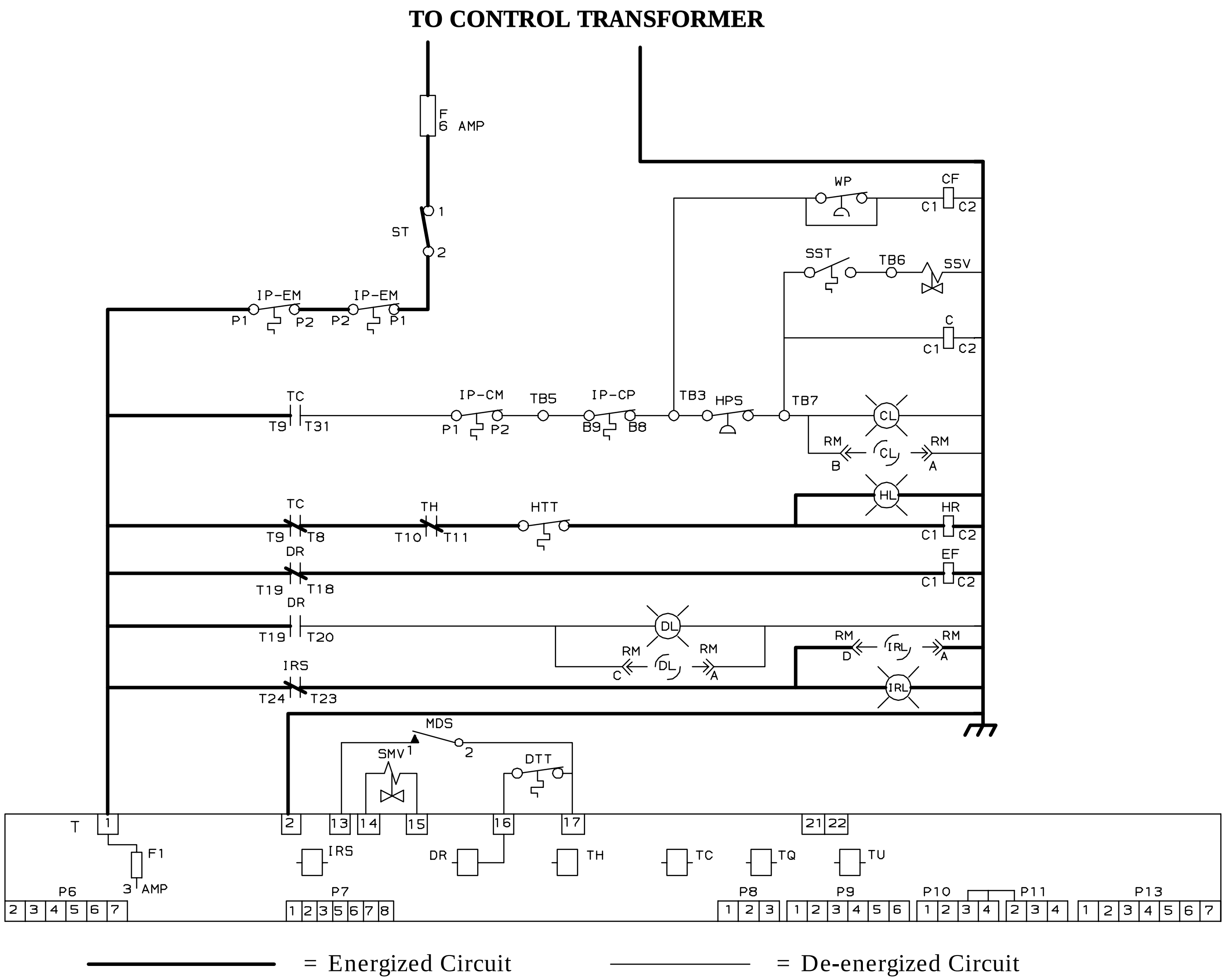


Figure 2-2. Heating – Within 2_C (3.6_F) of Set Point

b. Heating (See Figure 2-2)

The unit *will only heat* when the controller is set above –10_C (14_F) as relay TH is electronically locked out to prevent heating when the controller is *set below* –10_C (14_F).

If the supply air temperature decreases 1.0_C (1.8_F) below controller set point TH closes and the system enters the heating mode which is designed to raise the container air temperature. When TH closes, power flows through the TC contacts T9 and T8, TH contacts, the heat termination thermostat to energize the heat relay (HR). This in turn energizes the heaters and heat light. The evaporator fans continue to run in high speed to circulate air throughout the container.

As the supply air decreases to 2_C (3.6_F) below set point, relay IRS and the in-range light de-energize (after 90 minutes time delay) and will remain de-energized until the supply air increases to 2_C (3.6_F) below set point.

When the temperature rises to 0.5_C (0.9_F) below set point, TH opens (heating off) and the system again enters the holding zone. The compressor and condenser fan motor are not running as contactors C and CF remain de-energized. The evaporator fans continue to run in high speed to circulate air throughout the container.

A safety heater termination thermostat (HTT) attached to an evaporator coil support, set to open at 54.5_C (130_F) will open the heating circuit if overheating occurs.

2.4.3 Defrost (See Figure 2-3)

Refer to paragraph 1.11.f for description of the defrost interval selector and automatic defrost initiation.

When the defrost mode is initiated, the controller relay contacts (TH, T11 to T10) close to supply power to the heat relay and in turn energizes the defrost heaters.

Also, at the same time, the defrost relay contacts (T19 to T20) close to illuminate the defrost light.

Energizing the defrost relay also opens the normally closed contacts (T19 to T18) to stop the evaporator fan motors.

TC (T9 to T31) opens to de-energize the compressor contactor, cool light, and the condenser fan motor contactor.

The in-range light remains illuminated during defrost. (Refer to paragraph 1.11.g)

When the coil temperature reaches 24_C (75_F) defrost termination thermostat opens to interrupt the defrost cycle and the unit returns to its normal function.

The 54.5_C (130_F) heat termination thermostat will open the circuit if the defrost mode does not terminate at 24_C (75_F).

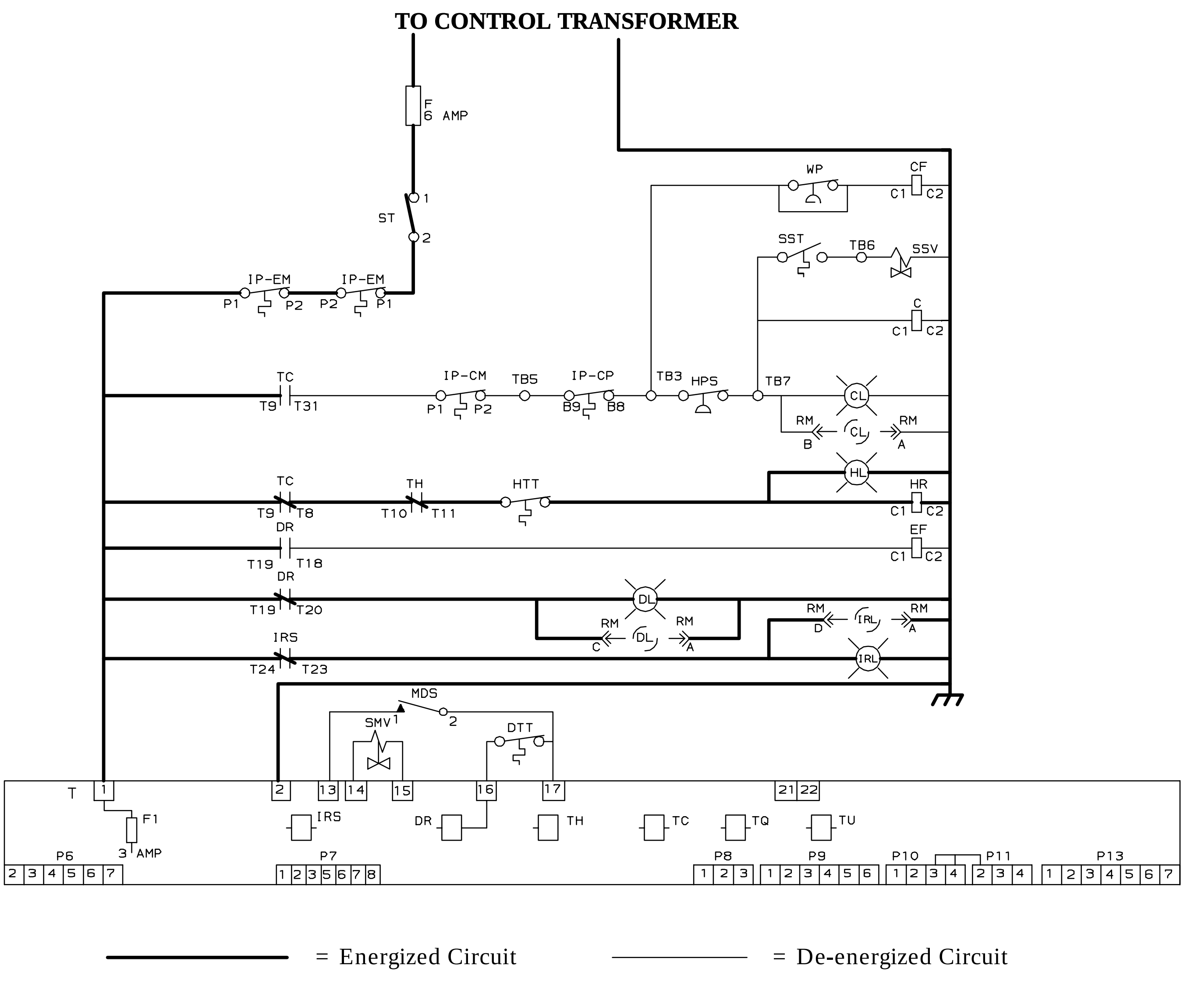


Figure 2-3. Defrost

Table 2-1. Electrical Control Positions – Above –10_C (14_F)

CONTROL CIRCUIT	COOLING	HOLDING ZONE	* Dehumidification	HEATING	DEFROST
Compressor Contactor (C)	Energized	De-energized	Energized	De-energized	De-energized
Condenser Fan Motor Contactor (CF)	Energized	De-energized	Energized	De-energized	De-energized
One Speed Evaporator Motor Relay (EF)	Energized	Energized	Energized	Energized	De-energized
Two Speed Evaporator Motor Relay (EF)	Energized at set points above –10_C (14_F) →				De-energized
Two Speed Evaporator Motor Relay (ES)	De-energized at set points above –10_C (14_F) →				
Defrost Relay (DR)	De-energized	De-energized	De-energized	De-energized	Energized
Heater Relay (HR)	De-energized	De-energized	Energized	Energized	Energized
CONTROLLER RELAYS					
DR (Defrost)	OFF	OFF	OFF	OFF	ON
IRS (In-Range)	Closed – If supply air is within 2_C (3.6_F) of set point →				
TC (Cooling)	ON	OFF	ON	OFF	OFF
TH (Heating)	OFF	OFF	ON	ON	ON
TU (Utility) (Two-Speed Motors)	Energized with controller settings above –10_C (14_F) →				
INDICATING LIGHTS					
Cool	ON	OFF	ON	OFF	OFF
Defrost	OFF	OFF	OFF	OFF	ON
In-Range	On – If supply air is within 2_C (3.5_F) of set point →				
Heat	OFF	OFF	ON	ON	ON
POWER CIRCUIT					
Compressor	Energized	De-energized	Energized	De-energized	De-energized
Condenser Fan Motor	Energized	De-energized	Energized	De-energized	De-energized
Heaters	De-energized	De-energized	Energized	Energized	Energized
Evaporator Fan Motors	Energized	Energized	Energized	Energized	De-energized

***** Unit with optional Humidistat (Refer to section 1.12)

N/A – Not Applicable

Table 2-2. Electrical Control Positions – Below –10_C (14_F)

CONTROL CIRCUIT	COOLING	HOLDING ZONE	**Dehumidification	HEATING	DEFROST
Compressor Contactor (C)	Energized	De-energized	**	**	De-energized
Condenser Fan Motor Contactor (CF)	Energized	De-energized	**	**	De-energized
One Speed Evaporator Motor Relay (EF)	Energized	Energized	**	**	De-energized
Two Speed Evaporator Motor Relay (EF)	De-energized at set points below –10_C (14_F) →				
Two Speed Evaporator Motor Relay (ES)	Energized at set points below –10_C (14_F) →				De-energized
Defrost Relay (DR)	De-energized	De-energized	**	**	Energized
Heater Relay (HR)	De-energized	De-energized	**	**	Energized
CONTROLLER RELAYS					
DR (Defrost)	OFF	OFF	**	**	ON
IRS (In-Range)	Closed – If supply air is within 2_C (3.6_F) of set point →				
TC (Cooling)	ON	OFF	**	**	OFF
TH (Heating)	OFF	OFF	**	**	ON
TU (Utility) (Two-Speed Motors)	Energized with controller settings below –10_C (14_F) →				
INDICATING LIGHTS					
Cool	ON	OFF	**	**	OFF
Defrost	OFF	OFF	**	**	ON
In-Range	On – If supply air is within 2_C (3.5_F) of set point →				
Heat	OFF	OFF	**	**	ON
POWER CIRCUIT					
Compressor	Energized	De-energized	**	**	De-energized
Condenser Fan Motor	Energized	De-energized	**	**	De-energized
Heaters	De-energized	De-energized	**	**	Energized
Evaporator Fan Motors	Energized	Energized	**	**	De-energized

** Dehumidification and heating modes do not operate at set points below –10_C (14_F)

N/A – Not Applicable

SECTION 3

TROUBLESHOOTING

INDICATION/ TROUBLE	POSSIBLE CAUSES	REFERENCE SECTION
3.1 UNIT WILL NOT START OR STARTS THEN STOPS		
No power to unit	External power source OFF	Turn on
	Start-Stop switch OFF or defective	Check
	Circuit breaker tripped or OFF	Check
Loss of control power	Circuit breaker OFF or defective	Check
	Control transformer defective (TR)	Replace
	Fuse blown (3A or 6A)	Check
	Start-Stop switch OFF or defective	Check
	Evaporator fan motor internal protector open	4.15
	Condenser fan motor internal protector open	4.18
	Compressor internal protector open	4.7
	High pressure switch open	4.13
Compressor hums, but does not start	Low line voltage	Check
	Single phasing	Check
	Shorted or grounded motor windings	4.7
	Compressor seized	4.7
	Voltage Switch (VS) not wired properly	Check
3.2 UNIT RUNS BUT HAS INSUFFICIENT COOLING		
Compressor	Compressor valves defective	4.7
Refrigeration System	Abnormal pressures	3.7
	Temperature controller malfunction	3.9
	Evaporator fan or motor defective	4.15
	Suction modulation valve malfunction	4.21
	Suction solenoid valve malfunction	1.10
3.3 UNIT OPERATES LONG OR CONTINUOUSLY IN COOLING		
Container	Hot load	Normal
	Defective box insulation or air leak	Repair
Refrigeration System	Shortage of refrigerant	4.4/4.6
	Evaporator coil covered with ice	3.6
	Evaporator coil plugged with debris	4.14
	Evaporator fan(s) rotating backwards	4.15/4.24
	Defective evaporator fan motor/capacitor	4.15/4.24
	Air bypass around evaporator coil	Check
	Controller set too low	Reset
	Compressor service valves or liquid line shutoff valve partially closed	Open valves completely
	Dirty condenser	4.17 or 4.27
	Compressor worn	4.7
	Current limit switch set to wrong value	1.11.b

INDICATION/ TROUBLE	POSSIBLE CAUSES	REFERENCE SECTION

3.4 UNIT WILL NOT HEAT OR HAS INSUFFICIENT HEATING

No power to unit	Start-Stop switch OFF or defective	Check
	Circuit breaker OFF or defective	Check
	External power source OFF	Turn on
No control power	Circuit breaker or fuse defective	Replace
	Transformer defective (TR)	Replace
	Condenser fan internal motor protector open	4.18
	Evaporator fan internal motor protector open	4.15
	Heat relay defective	Check
	Heater termination switch open	4.14
Unit will not heat or has insufficient heat	Heater(s) defective	4.16
	Heater contactor or coil defective	Replace
	Evaporator fan motor(s) defective or rotating backwards	4.15/4.24
	Evaporator fan motor contactor defective	Replace
	Temperature controller malfunction	3.9
	Defective wiring	Replace
	Loose terminal connections	Tighten
	Low line voltage	1.13

3.5 UNIT WILL NOT TERMINATE HEATING

Unit fails to stop heating	Temperature controller improperly set	Reset
	Temperature controller malfunction	3.9
	Heater termination switch remains closed along with the heat relay	4.14

3.6 UNIT WILL NOT DEFROST PROPERLY

Will not initiate defrost automatically	Defrost timer malfunction	1.11.f
	Loose terminal connections	Tighten
	Defective wiring	Replace
	Defrost termination or heat termination switch open	4.14
	Heater contactor or coil defective	Replace
Will not initiate defrost manually	Manual defrost switch defective	Replace
	Defrost termination switch open	2.4.3
Initiates but defrost relay (DR) drops out	Defective timing and current control board	Replace
	Low line voltage	1.13
Initiates but does not defrost	Heater contactor or coil defective	Replace
	Heater(s) burned out	4.16
Frequent defrost	Wet load	Normal

INDICATION/ TROUBLE	POSSIBLE CAUSES	REFERENCE SECTION

3.7 ABNORMAL PRESSURES (COOLING)

INDICATION/ TROUBLE	POSSIBLE CAUSES	REFERENCE SECTION
High discharge pressure	Condenser coil dirty	4.17 or 4.27
	Condenser fan rotating backwards	4.18
	Condenser fan inoperative	4.18
	Refrigerant overcharge or noncondensibles	4.6
	Pressure regulator valve	Replace
Low suction pressure	Suction service valve partially closed	Open
	Filter-drier partially plugged	4.12
	Low refrigerant charge	4.4/4.6
	Expansion valve defective	4.23
	No evaporator air flow or restricted air flow	3.10
	Excessive frost on evaporator coil	3.6
	Evaporator fan(s) rotating backwards	4.15/4.24
Suction and discharge pressures tend to equalize when unit is operating	Heat exchanger defective	Replace
	Compressor valves defective	4.8

3.8 ABNORMAL NOISE OR VIBRATIONS

INDICATION/ TROUBLE	POSSIBLE CAUSES	REFERENCE SECTION
Compressor	Loose mounting bolts	Tighten
	Worn bearings	4.7
	Worn or broken valves	4.7
	Liquid slugging	3.11
	Insufficient oil	4.10
Condenser or Evaporator Fan	Bent, loose or striking venturi	Check
	Worn motor bearings	4.15/4.18
	Bent motor shaft	4.15/4.18

3.9 TEMPERATURE CONTROLLER MALFUNCTION

INDICATION/ TROUBLE	POSSIBLE CAUSES	REFERENCE SECTION
Will not control or relay(s) do not actuate at proper temperature	Controller relay(s) defective	4.22
	Defective Sensor	4.22.6
	Defective wiring	4.22
	Controller malfunction	4.22
Compressor does not start or stop at specified temperature	Time delay period not elapsed	1.11.d

3.10 NO EVAPORATOR AIR FLOW OR RESTRICTED AIR FLOW

INDICATION/ TROUBLE	POSSIBLE CAUSES	REFERENCE SECTION
Evaporator coil blocked	Frost on coil	3.6
	Dirty coil	4.14
No or partial evaporator air flow	Evaporator fan motor internal protector open	4.15
	Evaporator fan motor(s) defective	4.15/4.24
	Evaporator fan(s) loose or defective	4.15

INDICATION/ TROUBLE	POSSIBLE CAUSES	REFERENCE SECTION

3.11 EXPANSION VALVE MALFUNCTION

Low suction pressure with high superheat	Low refrigerant charge	4.4/4.6
	External equalizer line plugged	Open
	Wax, oil or dirt plugging valve or orifice	4.23
	Ice formation at valve seat	4.4/4.5
	Superheat too high	4.23.c
	Power assembly failure	4.23
	Loss of element/bulb charge	4.23
	Broken capillary	4.23
	Foreign material in valve	4.23
High suction pressure with low superheat	Superheat setting too low	4.23.c
	External equalizer line plugged	Open
	Ice holding valve open	4.4/4.5
	Foreign material in valve	4.23
Liquid slugging in compressor	Pin and seat of expansion valve eroded or held open by foreign material	4.23
Fluctuating suction pressure	Improper bulb location or installation	4.23
	Low superheat setting	4.23.c

3.12 WATER-COOLED CONDENSER OR WATER PRESSURE SWITCH MALFUNCTION

High discharge pressure	Dirty coil	4.27
	Noncondensibles	4.27
Condenser fan starts and stops	Water pressure switch malfunction	Check
	Water supply interruption	Check

3.13 STEP-UP POWER TRANSFORMER MALFUNCTION

Unit will not start	Circuit breaker (CB2) tripped	Check
	Step-up transformer internal protector open	4.26
	Step-up transformer defective	4.26
	Power source not turned ON	Check

SECTION 4

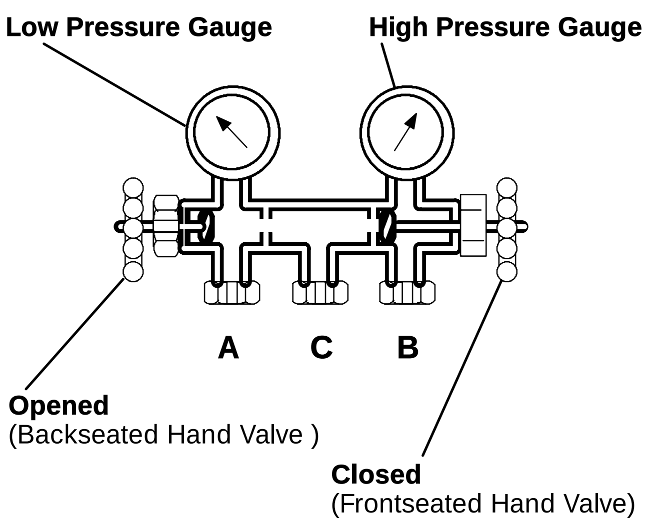
SERVICE

4.1 MANIFOLD GAUGE SET

The manifold gauge set can be used to determine system operating pressure, add a refrigerant charge, equalize or evacuate the system.

The manifold gauge in Figure 4-1 shows hand valves, gauges and refrigerant openings. When the low pressure hand valve is frontseated (turned all the way in), the low (evaporator) pressure can be checked. When the high pressure hand valve is frontseated, high (condensing) pressure can be checked. When both valves are open (turning counter clockwise), high pressure vapor will flow into the low side. When the low pressure valve is open, the system can be charged. Oil can also be added to the system.

Only a R-134a manifold gauge set with self-sealing hoses as shown in Figure 4-2 (CTD P/N 07-00294-00, which includes items 1 through 6) can be used when working on the models covered within this manual.



A. Connection to Low Side of System
B. Connection to High Side of System
C. Connection to Either:
Refrigerant Cylinder or
Oil Container

Figure 4-1. Manifold Gauge Set

a. Connecting the Manifold Gauge Set (See Figure 4-2)

1. Remove service valve stem caps and check both service valves to make sure they are backseated (counter clockwise). Remove service port caps.

NOTE

If a manifold gauge set is new or was exposed to the atmosphere. Due to repair, it will need to be evacuated to remove contaminants and air as follows:

a. Midseat both hand valves.

b. Connect the utility hose (yellow) to a vacuum pump.

c. Evacuate to 10 inches of vacuum.

d. Charge with R-134a to a slightly positive pressure of 0.1 kg/cm@ (1.0 psig).

e. The gauge set is now ready for use.

2. Connect the high side field service coupling (backseated) to the discharge service valve port (or the manual liquid line valve port, whichever is applicable).

3. Turn the high side field service coupling (red knob) clockwise, which will open the high side of the system to the gauge set.

4. Connect the low side field service coupling to the suction service valve port.

5. Turn the low side field service coupling (blue knob), which will open the low side of the system to the gauge set.

6. To read system pressures; slightly midseat the discharge and suction service valves, and frontseat both manifold gauge set hand valves.

CAUTION

To prevent trapping liquid refrigerant in the service valve after charging, while the compressor is ON and before disconnecting the manifold gauge set, perform the following steps:

a. Backseat applicable discharge or manual liquid line valve.
b. Midseat manifold gauge set hand valves.
c. Allow the gauge set to pull down to suction pressure.

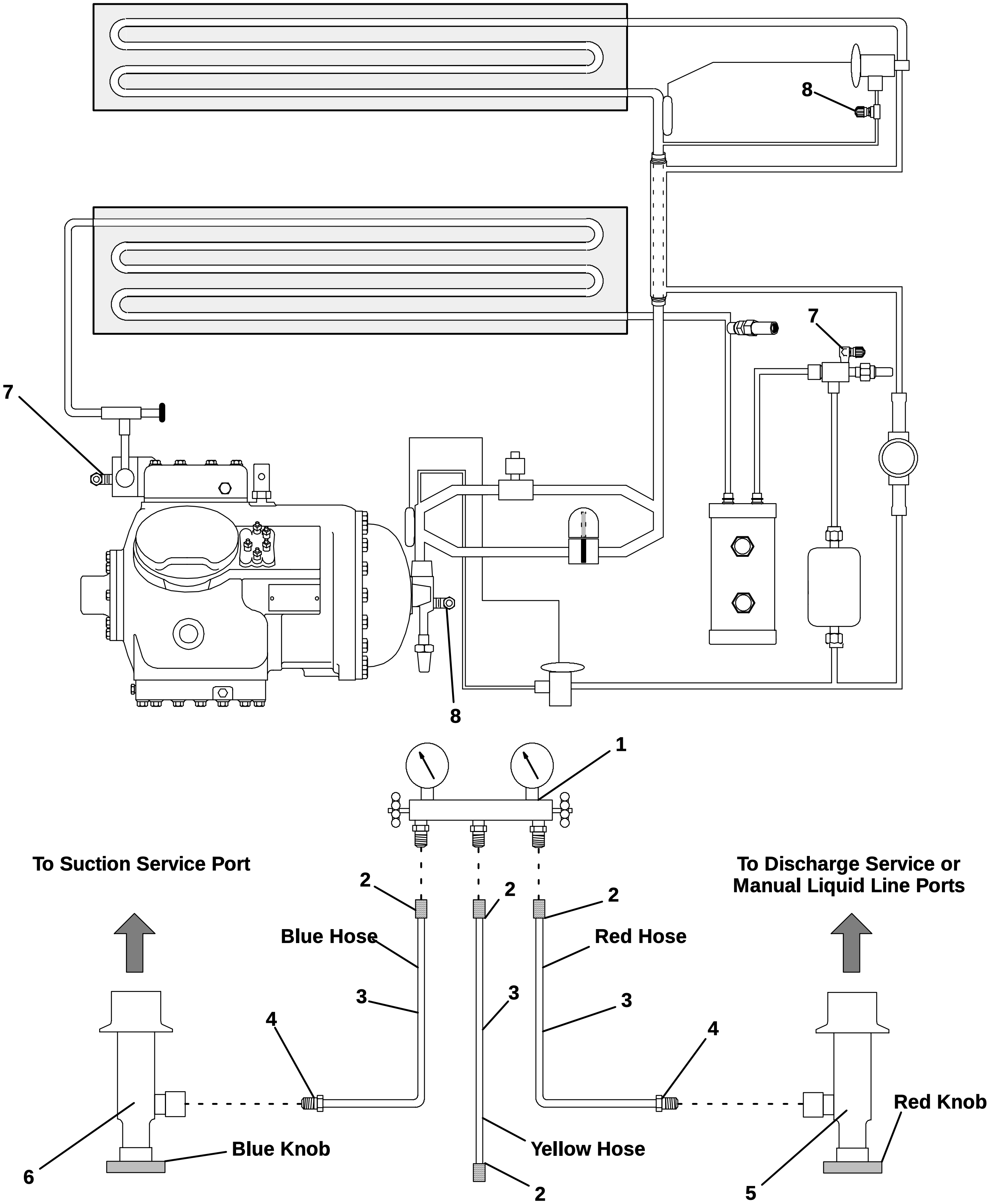
b. Removing the Manifold Gauge Set

1. While the compressor is still ON, backseat the discharge service valve.

2. Midseat both hand valves on the manifold gauge set and allow the pressure in the manifold gauge set to be drawn down to suction pressure. This enables the liquid that condensed in the high side hose to be returned to the system.

3. Backseat the suction service valve. Backseat both field service couplings, and remove the couplings from the service ports.

4. Install both service valve stem caps and service port caps (finger-tight only).



1. Manifold Gauge Set
2. Hose Fitting (0.500-16 Acme)
3. Refrigeration or Evacuation Hoses (SAE J2196/R-134a)
4 Hose Fitting w/O-ring (M14 x 1.5)
5. High Side Field Service Coupling
6. Low Side Field Service Coupling
7. High Side Service Port (SAE J639 Male)
8. Low Side Service Port (SAE J639 Male)

Figure 4-2. R-134a Manifold Gauge Set Connection

4.2 SUCTION AND DISCHARGE SERVICE VALVES

The suction and discharge service valves used on the compressor are equipped with mating flanges for connection to flanges on the compressor. These valves are provided with a double seat and a gauge connection, which enable servicing of the compressor and refrigerant lines.

Turning the valve stem clockwise (all the way forward) will frontseat the valve to close off the suction or discharge line and opens the gauge connection to the compressor. See Figure 4-3. Turning the valve stem counterclockwise (all the way out) will backseat the valve to open the suction or discharge line to the compressor and close off the gauge connection.

With the valve stem midway between frontseated and backseated positions, suction or discharge line is open to both the compressor and the gauge connection.

For example, when connecting a manifold gauge to measure suction or discharge pressure, the valve stem is fully backseated. Then, to measure suction or discharge pressure, crack open the valves 1/4 to 1/2 turn.

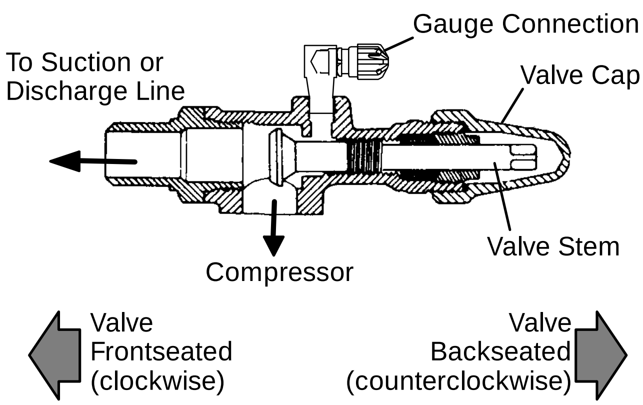


Figure 4-3. Suction or Discharge Service Valve

4.3 PUMPING THE UNIT DOWN OR REMOVING THE REFRIGERANT

NOTE

To avoid damage to the earth's ozone layer, use a refrigerant recovery system whenever removing refrigerant.

a. Pumping the Unit Down

To service the filter-drier, moisture-liquid indicator, expansion valve, suction modulation valve, suction solenoid valve or evaporator coil, pump most of the refrigerant into the condenser coil and receiver as follows:

1. Backseat the suction and discharge valves (turn counterclockwise) to close off gauge connections and attach manifold gauges to valves. Refer to section 4.1.a.

2. Allow the compressor to run 10 to 15 minutes before frontseating the liquid line valve. Then close (front seat) liquid line valve by turning clockwise. Start the unit and run in a cooling mode. Place start-stop switch in the OFF position when the unit reaches a positive pressure of 0.1 kg/cm@ (1.0 psig).

3. Frontseat (close) the suction service valve and the refrigerant will be trapped between the compressor suction service valve and the liquid line valve.

4. Before opening up any part of the system, a slight positive pressure should be indicated on the pressure gauge. If a vacuum is indicated, emit refrigerant by cracking the liquid line valve momentarily to build up a slight positive pressure.

5. When opening up the refrigerant system, certain parts may frost. Allow the part to warm to ambient temperature before dismantling. This avoids internal condensation which puts moisture in the system.

6. After repairs have been made, be sure to perform a refrigerant leak check (section 4.4), and evacuate and dehydrate the system (section 4.5).

7. Check refrigerant charge (Refer to section 4.6).

4.4 REFRIGERANT LEAK CHECKING

WARNING

Never mix refrigerants with air for leak testing. It has been determined that pressurized, air-rich mixtures of refrigerants and air can undergo combustion when exposed to an ignition source.

a. The recommended procedure for finding leaks in a system is with a R-134a electronic leak detector. Testing joints with soapsuds is satisfactory only for locating large leaks.

b. If the system is without refrigerant, charge the system with refrigerant to build up pressure between 2.1 to 3.5 kg/cm@ (30 to 50 psig). Remove refrigerant drum and leak check all connections.

NOTE

It must be emphasized that only the correct refrigerant drum be connected to pressurize the system. Any other gas or vapor will contaminate the system which will require additional purging and evacuation of the system.

c. Remove refrigerant using a refrigerant recovery system and repair any leaks.

d. Evacuate and dehydrate the unit. (Refer to section 4.5)

e. Charge unit per section 4.6.

4.5 EVACUATION AND DEHYDRATION

4.5.1 General

Moisture is the deadly enemy of refrigeration systems. The presence of moisture in a refrigeration system can have many undesirable effects. The most common are copper plating, acid sludge formation, "freezing-up" of metering devices by free water, and formation of acids, resulting in metal corrosion.

4.5.2 Preparation

a. Evacuate and dehydrate only after pressure leak test. (Refer to section 4.4)

b. Essential tools to properly evacuate and dehydrate any system include a vacuum pump (8 m^3H = 5 cfm volume displacement, P/N 07-00176-01) and electronic vacuum gauge.

c. If possible, keep the ambient temperature above 15.6_C (60_F) to speed evaporation of moisture. If ambient temperature is lower than 15.6_C (60_F) ice might form before moisture removal is complete. Heat lamps or alternate sources of heat may be used to raise the system temperature.

d. Replace the filter-drier with a section of copper tubing with the appropriate fittings. This idea will help speed up the evacuation procedure.

4.5.3 Procedure

a. Remove all refrigerant using a refrigerant recovery system.

b. The recommended method to evacuate and dehydrate the system is to connect three evacuation hoses (Do not use standard service hoses, as they are not suited for evacuation purposes.) as shown in Figure 4-4 to the vacuum pump and refrigeration unit. Also, as shown, connect a evacuation manifold, with evacuation hoses only, to the vacuum pump, electronic vacuum gauge, and refrigerant recovery system.

c. With the unit service valves closed (back seated) and the vacuum pump and electronic vacuum gauge valves open, start the pump and draw a deep vacuum. Shut off the pump and check to see if the vacuum holds. This operation is to test the evacuation setup for leaks, repair if necessary.

d. Midseat the refrigerant system service valves.

e. Then open the vacuum pump and electronic vacuum gauge valves, if they are not already open. Start the vacuum pump. Evacuate unit until the electronic vacuum gauge indicates 2000 microns. Close the electronic vacuum gauge and vacuum pump valves. Shut off the vacuum pump. Wait a few minutes to be sure the vacuum holds.

f. Break the vacuum with clean dry refrigerant gas. Use refrigerant that the unit calls for. Raise system pressure to approximately 2 psig by monitoring it with the compound gauge.

g. Remove refrigerant using a refrigerant recovery system.

h. Repeat steps e through g one time.

i. Remove the copper tubing and change the filter-drier. Evacuate unit to 500 microns. Close the electronic vacuum gauge and vacuum pump valves. Shut off the vacuum pump. Wait five minutes to see if vacuum holds. This checks for residual moisture and/or leaks.

j. With a vacuum still in the unit, the refrigerant charge may be drawn into the system from a refrigerant container on weight scales. The correct amount of refrigerant may be added by observing the scales. (Refer to section 4.6)

4.6 ADDING OR CHECKING THE REFRIGERANT CHARGE

4.6.1 Checking the Refrigerant Charge

NOTES

1. Set the controller set point to −25_C (−13_F) to ensure that the suction modulation valve is fully open when checking operation of unit.

2. The refrigerant level should only be checked when the unit is running with the suction modulation valve fully open. The container temperature should be approximately 1.7_C (35_F) or −17.8_C (0_F).

a. Connect the gauge manifold to the compressor discharge and suction service valves.

b. *Units equipped with the receiver;* partially block the condenser coil inlet air starting from the front of the condenser coil. Increase the area blocked until the compressor discharge pressure is raised to approximately 12 kg/cm@ (175 psig). Refrigerant level on the receiver will normally be between the sight glasses. If not, refer to section 4.6.3.

c. *Units equipped with the water-cooled condenser*; check charge only on air-cooled operation. Refrigerant level in the water-cooled operation will be normally above sight glass. Partially block the condenser coil inlet air starting from the front of the condenser coil. Increase the area blocked until the compressor discharge pressure is raised to approximately 12 kg/cm@ (175 psig). Refrigerant should appear at center line of sight glass on the water-cooled condenser. If not, refer to section 4.6.3.

4.6.2 Adding Refrigerant to System (Full Charge)

a. Evacuate unit and leave in deep vacuum. (Refer to section 4.5)

b. Place drum of R-134a on scale and connect charging line from drum to liquid line valve. Purge charging line at liquid line valve and then note weight of drum and refrigerant.

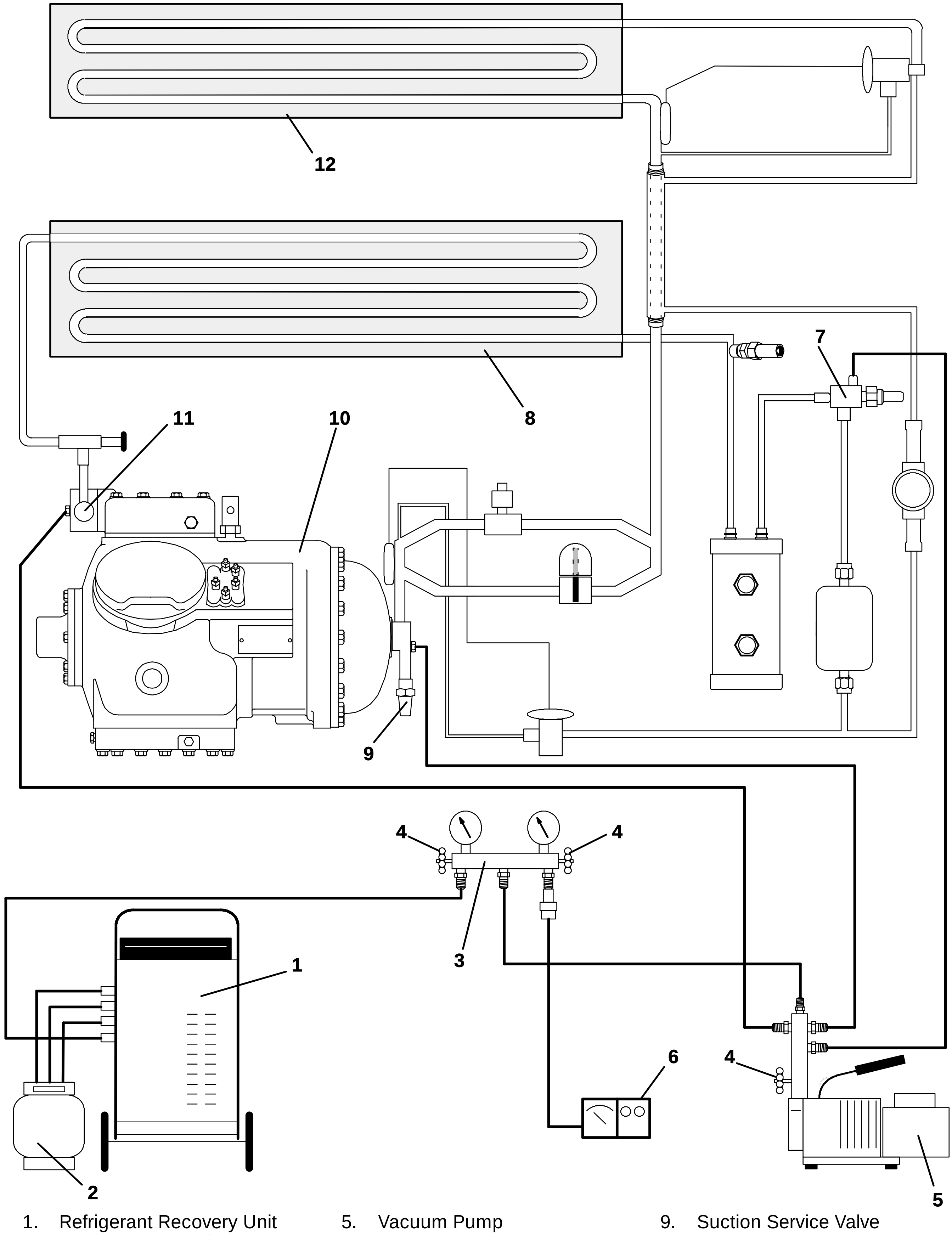
c. Open liquid valve on drum. Open liquid line valve half-way and allow the liquid refrigerant to flow into the unit until the correct weight of refrigerant has been added as indicated by scales. Correct charge is noted in Table 1-1.

NOTE

It may be necessary to finish charging unit through suction service valve in gas form, due to pressure rise in high side of the system. (Refer to section 4.6.3)

d. Backseat liquid line valve (to close off gauge port). Close liquid valve on drum. Crack connection on charging line at liquid line valve to vent charging line.

e. Start unit in cooling mode. Run approximately ten minutes and check the refrigerant charge. (Refer to section 4.6.1)



1.	Refrigerant Recovery Unit	5.	Vacuum Pump	9.	Suction Service Valve
2.	Refrigerant Cylinder	6.	Electronic Vacuum Gauge	10.	Compressor
3.	Evacuation Manifold (R-134a)	7.	Manual Liquid Line Valve	11.	Discharge Service Valve
4	Hand Valve	8.	Condenser Coil	12.	Evaporator Coil

Figure 4-4. Vacuum Pump Connections

4.6.3 Adding Refrigerant to System (Partial Charge)

a. Examine the unit refrigerant system for any evidence of leaks. Repair as necessary. (Refer to section 4.4)

b. Maintain the conditions outlined in section 4.6.1.

c. Fully backseat (to close off gauge port) the suction service valve (see Figure 1-3) and remove the service port cap.

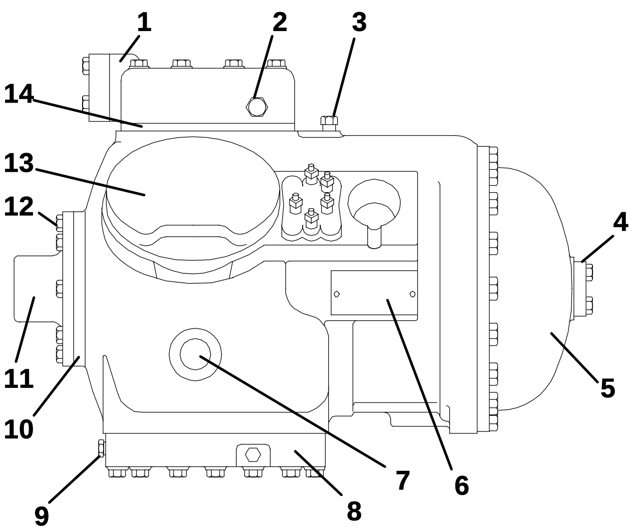
d. Connect charging line between suction service valve port and drum of Refrigerant-12. Open VAPOR valve on drum. Purge charging line.

e. Partially frontseat (turn clockwise) the suction service valve and slowly add charge until the refrigerant appears at the proper level (refer to section 4.6.1).

4.7 REPLACING THE COMPRESSOR (See Figure 4-5)

WARNING

Make sure power to the unit is OFF and power plug disconnected before replacing the compressor.



1. Discharge Valve Flange
2. High Pressure Switch Connection
3. Low Pressure Connection
4. Suction Valve Flange
5. Motor End Cover
6. Serial/Model No. Plate
7. Sight Glass
8. Bottom Plate
9. Oil Drain Plug
10. Bearing Head
11. Oil Pump
12. Oil Fill Plug (Refer to paragraph 4.10.c)
13. Cylinder Head
14. Valve Plate

Figure 4-5. Compressor – Model 06DR

NOTES

1. Check the compressor Serial/Model Number plate for CFM displacement, refer to Table 1-2.

2. The compressor should not operate in a vacuum greater than 50.80 cm Hg vacuum (20 inches Hg vacuum).

3. The service replacement compressor is sold without shutoff valves (but with valve pads), and without terminal box and cover. Customer should retain the original terminal box, cover, and high pressure switch for use on replacement compressor.

4. Check oil level in service replacement compressor. (Refer to paragraph 1.3.b. and section 4.10)

5. A compressor terminal wiring kit must be ordered as a separate item when ordering replacement compressor. Appropriate installation instructions are included with kit.

6. Refer to Table 4-4 and Table 4-5 for applicable compressor wear limits and torque values.

7. Refer to Figure 4-26 for charts on compressor pressure-temperature and motor current curves.

a. Remove protective guard from lower section of the unit.

b. If compressor is inoperative and unit still has refrigerant pressure, remove refrigerant (refer to section 4.3).

c. Disconnect wiring in the compressor junction box after identifying same. Disconnect wiring from compressor terminals and remove compressor junction box.

d. Remove bolts from service valve flanges.

e. Remove compressor plate mounting bolts.

f. Remove compressor and mounting plate. The compressor weighs approximately 118 kg (260 pounds).

g. Remove high pressure switch (HPS) from compressor and check operation of switch (section 4.13).

h. Remove compressor mounting bolts from mounting plate and install mounting plate on replacement compressor.

i. Install replacement terminal block kit (following instructions included with kit).

j. Install high pressure switch on compressor.

k. Install compressor and mounting plate in unit.

l. Install junction box to compressor and connect all wiring per wiring diagram (refer to section 5) and then install junction box cover.

m. Install new gaskets on service valves.

n. Install mounting bolts in service valves and torque to a value of 2.77 to 4.15 mkg (20-30 ft/lb).

o. Change filter-drier. (Refer to section 4.12)

p. Attach two lines (with hand valves near vacuum pump) to the suction and discharge service valves. Dehydrate and evacuate compressor to 500 microns (75.9 cm HG vacuum = 29.90 inches Hg vacuum). *Turn off valves on both lines to pump.*

q. Fully backseat (open) both suction and discharge service valves.

r. Remove vacuum pump lines.

s. Start unit and check refrigerant charge. (Refer to section 4.6)

t. Check moisture-liquid indicator for wetness. Change filter-drier if necessary. (Refer to sections 4.11 and 4.12)

u. Check compressor oil level per section 4.10. Add oil if necessary.

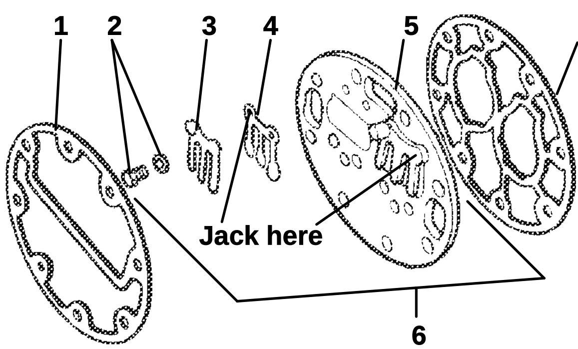
4.8 COMPRESSOR DISASSEMBLY

NOTE

Removing the press fit stator in the field is not recommended. The rotor and stator are a matched pair and should not be separated.

When disassembling compressor, matchmark parts so they may be replaced in their same relative positions. (See Figure 4-5 for an illustration of the compressor.) Refer to Table 4-4 and Table 4-5 for applicable compressor wear limits and torque values.

a. Place the compressor in a position where it will be convenient to drain the oil. Remove the oil plug on oil pump inlet passage (see Figure 4-8 for location) to vent the crankcase. Loosen the drain plug (see Figure 4-5) in bottom plate and allow the oil to drain out slowly. Remove the plug slowly to relieve any crankcase pressure. A plug in the bottom center of the crankcase may also be removed for draining the motor end more quickly. (Some units do not have this plug.)



1. Cylinder Head Gasket
2. Discharge Valve Screw and Lockwasher
3. Discharge Valve Stop
4. Discharge Valve
5. Valve Plate
6. Valve Plate Assembly
7. Valve Plate Gasket

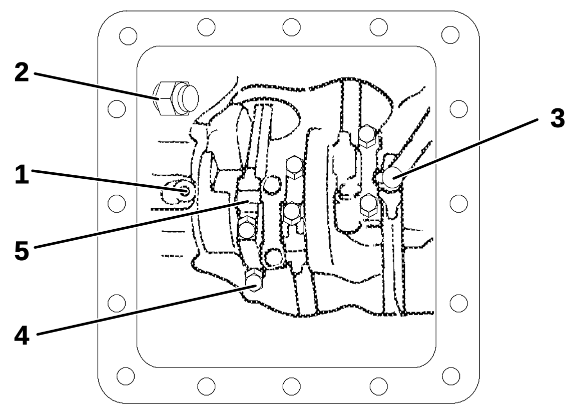
Figure 4-6. Exploded View of Valve Plate Assembly

b. Remove cylinder head capscrews. If the cylinder head is stuck, tap the center of the cylinder head with a wooden or lead mallet. DO NOT STRIKE THE SIDE OF THE CYLINDER HEAD! Be careful not to drop the head or damage the gasket sealing surface. (See Figure 4-5 and Figure 4-6) Remove cylinder head gasket.

c. Free the valve plate from the cylinder deck by using the discharge valve hold down capscrews as jack screws through the tapped holes of the valve plate after the valve stops and valves have been removed. Remove valve plate gasket. (See Figure 4-6)

d. Turn the compressor over on its side and remove the bottom plate. Match mark each connecting rod cap and connecting rod for correct assembly. Remove the capscrews and connecting rod caps (see Figure 4-7). Push the piston rods up as far as they will go without having the piston rings extend above the cylinders.

e. If necessary, remove the oil return check valve. Inspect it for check valve operation (flow in one direction only). Replace assembly if its check valve operation is impaired. (See Figure 4-7)



1. Oil Pressure Relief Valve
2. Oil Return Check Valve
3. Oil Suction Tube
4. Capscrew
5. Connecting Rod and Cap Assembly

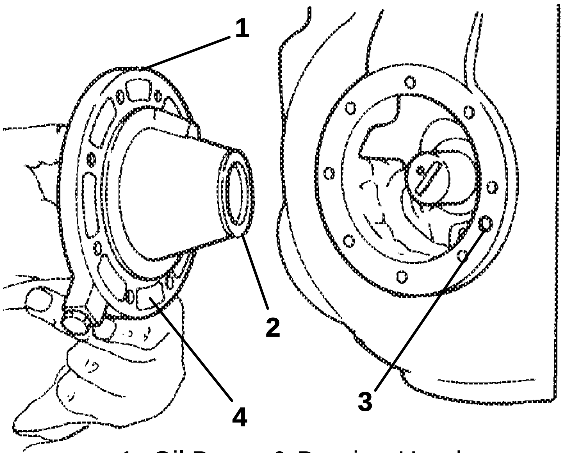
Figure 4-7. Bottom Plate Removed

CAUTION

The copper tube which connects to the oil suction strainer extends out the bottom with the bottom plate removed. Take precautions to avoid bending or breaking it while changing crankcase positions.

f. Remove eight capscrews and remove oil pump bearing head assembly, gasket and thrust washer. (See Figure 4-8)

If it was determined that the oil pump was not operating properly, the entire oil pump and bearing head assembly must be replaced. Replacement parts for the pump are not available.

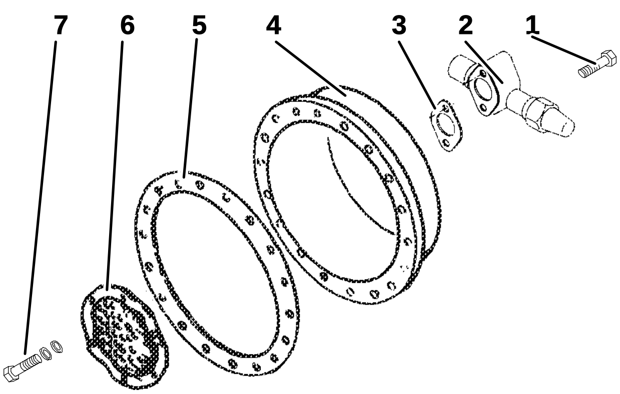


1. Oil Pump & Bearing Head
2. Thrust Washer (Gear Pump Only)
3. Oil Pickup Tube
4. Oil Inlet Port

Figure 4-8. Gear Oil Pump and Bearing Head

g. Be very careful not to damage the motor windings when removing the motor end cover as the cover fits over the winding coils. Remove all capscrews except one in the top of the cover. Then, while holding the cover in place, remove the remaining capscrew. Do not allow the cover to drop from its own weight. To prevent striking the winding, move the cover off horizontally and in line with the motor axis.

h. Remove the refrigerant suction strainer and if it is removed with ease it may be cleaned with solvent and replaced. (See Figure 4-9) If the strainer is broken, corroded or clogged with dirt that is not easily removed, replace the strainer. Install new gaskets upon reassembly.

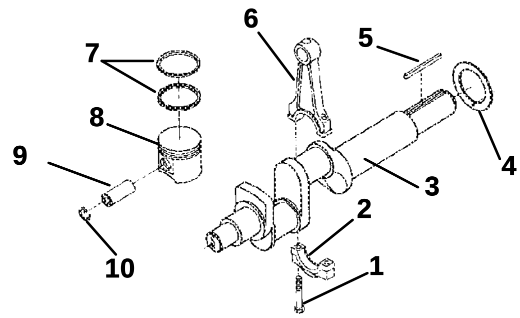


1. Valve Capscrew
2. Suction Service Valve
3. Valve Gasket
4. Motor End Cover
5. Motor End Cover Gasket
6. Suction Strainer
7. Strainer Screws and Washers

Figure 4-9. Motor End Cover

i. Block the compressor crankshaft so that it cannot turn. Use a screw driver to bend back the tabs on the lockwasher and remove the equalizer tube. (See Figure 4-11) The slinger at the end of the shaft draws vapor from the crankcase. It may discharge through a tee or a single equalizer tube.

j. If the piston rings extend beyond the cylinder tops, the pistons can be pulled through the bottom plate opening after the piston rings are compressed. A piston ring squeezer made from sheet metal which almost encircles the periphery of the rings, will facilitate removal. Each piston pin is locked in place by lock rings which are snapped into grooves in the piston wall.

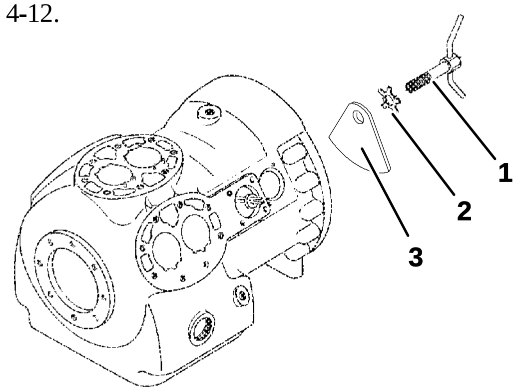


1. Capscrew
2. Cap
3. Crankshaft
4, Thrust Washer
5. Rotor Drive Key
6. Connecting Rod
7. Compression Ring
8. Piston
9. Pin
10. Retainer

Figure 4-10. Crankshaft Assembly

k. Since the stator is not replaced in the field, the terminal plate assembly need not be disturbed unless a leak exists or a terminal part requires replacing.

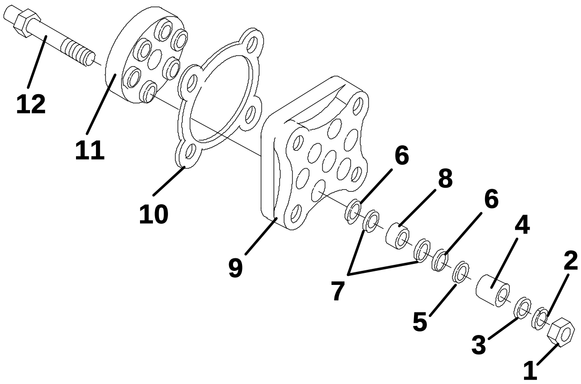
Disassemble and assemble the terminal plate as shown in Figure 4-12.



1. Equalizer Tube and Lockscrew Assembly
2. Lockwasher
3. Counterweight – Motor End

Figure 4-11. Removing Equalizing Tube and Lock Screw Assembly

The terminal mounting plate assembly as originally installed is assembled so as to leave a small space between the outer terminal bushing and the surface of the mounting plate. This is to provide further crush of the terminal bushing in case a leak should occur. To stop leak, tighten the terminal bushing nut only enough to stop the escape of gas. Do not tighten until terminal bushing is flush with the mounting plate. The tightening torque used at the factory is 0.21 to 0.23 mkg (18 to 20 inch pounds) maximum to prevent damage to the plastic parts.



NOTE: Parts shown are for one terminal.

1. Terminal Bushing Nut
2. Lock Washer
3. Terminal Washer
4. Outer Terminal Bushing
5. O-Ring
6. Terminal Bushing Washers (Grey)
7. Terminal Bushing Washers (Red)
8. Inner Terminal Bushing
9. Terminal Mounting Plate
10. Cover Gasket
11. Inner Terminal Block
12. Terminal Screw

Figure 4-12. Terminal Mounting Assembly

4.9 COMPRESSOR REASSEMBLY

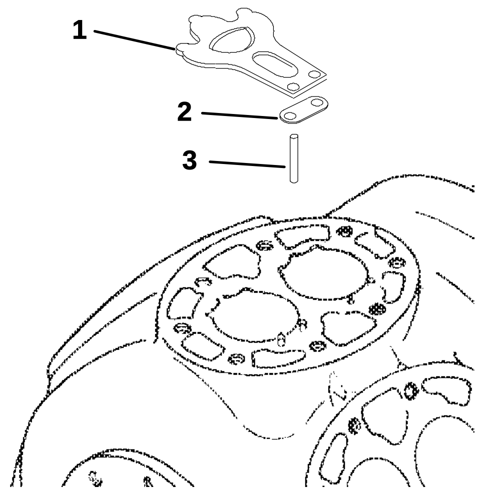
To clean compressor parts, use a suitable solvent with proper precautions. Coat all moving parts with compressor oil before assembly. Refer to Table 4-5, for applicable compressor torque values.

a. Suction and Discharge Valves

If the valve seats look damaged or worn, replace valve plate assembly. Always use new valves because it is difficult to reinstall used discharge valves so that they will seat as before removal. Any valve wear will cause leakage for this reason.

Suction valves are positioned by dowel pins (see Figure 4-13) and will assume their original position when reinstalled. No two valves are likely to wear exactly the same. Never interchange used valves.

Do not omit the suction valve positioning springs. (See Figure 4-13) Place the springs so that the ends bear against the cylinder deck (middle bowed away from cylinder deck). Use new gaskets when reinstalling valve plates and cylinder heads.



1. Suction Valve Positioning Spring
2. Suction Valve
3. Valve Plate Dowel Pin

Figure 4-13. Suction Valve and Positioning Springs

b. Compression Rings

The compression ring is chamfered on the inside circumference. This ring is installed with the chamfer towards the top. Stagger the ring end gaps so they are not aligned.

The gap between the ends of the piston rings can be checked with a feeler gauge by inserting the ring into the piston bore about one inch below the top of the bore. Square the ring in the bore by pushing it slightly with a piston. The maximum and minimum allowable ring gaps are 0.33 and 0.127 mm (0.013 and 0.005 inch)

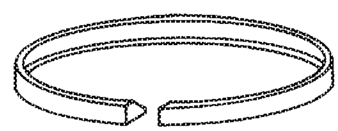


Figure 4-14. Piston Rings

C. Installing the Components

1. Install the crankshaft through the pump end of the compressor. Do not damage main bearings. Push pistons from the inside of the crankcase through the cylinders being careful not to break the rings. Place chamfered side of connecting rod against radius of crankpins. Install matching connecting rod caps through bottom cover plate.

2. The oil screen (located in the bottom of the crankcase), is connected to the inlet of the oil pump. Whenever the compressor crankcase is opened, inspect the screen for holes or an accumulation of dirt. The screen can be cleaned with a suitable solvent.

3. Install the pump end thrust washer on the two dowel pins located on the bearing head.

CAUTION

Ensure that the thrust washer does not fall off the dowel pins while installing the oil pump.

4. Install the bearing head assembly with a new gasket on the compressor crankshaft. Carefully push the oil

pump on by hand ensuring that the thrust washer remains on the dowel pins, the tang on the end of the drive segment engages the slot in the crankshaft, and the oil inlet port on the pump is aligned with the oil pickup tube in the crankcase. The pump should mount flush with the crankcase.

5. Align the gasket and install the eight capscrews in the mounting flange.

6. Install rotor with key. Screw on equalizer tube and lock screw assembly with lock washer and bend over tabs of lock washer. Assemble suction strainer to motor and cover and bolt cover to crankcase. Assemble valve plates and gaskets. Assemble cylinder heads and gaskets. Feel if the shaft will turn by hand.

7. Install oil suction screen and bottom plate.

4.10 CHECKING THE COMPRESSOR OIL LEVEL

CAUTION

Use only Carrier Transicold approved Polyol Ester Oil (POE) -- Castrol-Icematic SW20 compressor oil with R-134a. Buy in small quantities (one quart). When using this hygroscopic oil, immediately reseal. Do not leave container of oil open or contamination will occur.

a. To Check the Oil Level in the Compressor:

1. Operate the unit in cooling for at least 20 minutes.

2. Check the front oil sight glass on the compressor to ensure that no foaming of the oil is present after 20 minutes of operation. If the oil is foaming excessively after 20 minutes of operation, check the refrigerant system for flood-back of liquid refrigerant. Correct this situation before performing step a.3.

3. Turn unit off and the correct oil level should be between 1/8 and 1/4 of the sight glass. If the level is above 1/4, oil must be removed from the compressor. To remove oil from the compressor, follow step d. If the level is below the bottom of the sight glass, add oil to the compressor following step b. below.

b. Adding Oil with Compressor in System

Where an oil pump is not available, oil may be drawn into the compressor through the suction service valve.

CAUTION

Extreme care must be taken to ensure the manifold common connection remains immersed in oil at all times. Otherwise air and moisture will be drawn into the compressor.

Connect the suction connection of the gauge manifold to the compressor suction service valve port, and immerse the common connection of the gauge manifold in an open container of refrigeration oil. Crack the suction service valve and gauge valve to vent a small amount of refrigerant through the common connection and the oil to purge the lines of air. Close the gauge manifold valve.

With the unit running, frontseat the suction service valve and pull a vacuum in the compressor crankcase. SLOWLY crack the suction gauge manifold valve and oil will flow through the suction service valve into the compressor. Add oil as necessary.

Run unit for 20 minutes, in cooling, and check the oil level.

c. Adding Oil to Service Replacement Compressor

NOTES

1. The correct oil charge is 3.6 liters (7.6 U.S. pints).

2. Service replacement compressors are shipped without oil.

3. When at first adding oil to the compressor, add only 3 liters (6.3 pints) to the compressor. Run the unit for 20 minutes, in cooling, and check the oil level in the compressor sight glass. Add oil as necessary. This procedure is suggested due to the oil that has migrated with refrigerant to other parts of the system.

If compressor is without oil:

Add oil, (paragraphs 1.3.b and 4.10.b) through the suction service valve flange cavity or by removing the oil fill plug (see Figure 4-5). Some compressors have the oil plug located on the crankcase, at the right or left side of the oil pump.

d. To Remove Oil From an 06DR Compressor:

1. If the oil level recorded in step a.3 is above 1/4 of the sight glass, oil must be removed from the compressor.

2. Close (frontseat) suction service valve and pump unit down to 0.2 to 0.3 kg/cm@ (2 to 4 psig). Frontseat discharge service valve and slowly bleed remaining refrigerant.

3. Remove the oil drain plug on the bottom plate of the compressor and drain the proper amount of oil from the compressor to obtain the 1/2 sight glass maximum level. Replace the plug securely back into the compressor. *DO NOT FORGET TO OPEN SUCTION AND DISCHARGE SERVICE VALVES.*

4. Repeat Step a. to ensure proper oil level.

4.11 CHECKING OR REPLACING MOISTURE-LIQUID INDICATOR

When the refrigeration system is operating, the moisture-liquid indicator provides an indication of moisture in the system.

The indicator element is highly sensitive to moisture and will gradually change color in direct relation to an increase or decrease in the moisture content of the system. The safe, caution, and unsafe system operating conditions are then easily determined by matching the element color with the colors displayed on the reference label.

To change indicator or lens:

a. Pump down the unit per section 4.3 and install new indicator or lens. Replace the filter-drier per section 4.12.

b. Evacuate the unit per section 4.5 and add refrigerant charge per section 4.6.

c. Start unit and after twelve hours re-check indicator. If indicator does not indicate a safe condition, pump unit down and change filter-drier. (Refer to section 4.11)

4.12 CHECKING OR REPLACING THE FILTER-DRIER

If the sight glass appears to be flashing or bubbles are constantly moving through the sight glass, the unit may have a low refrigerant charge, or the filter-drier could be partially plugged.

To Check Filter-Drier:

a. One test for a restricted or plugged filter-drier is by feeling the liquid line inlet and outlet connections of the drier cartridge. If the outlet side feels cooler than the inlet side, then the filter-drier should be changed.

b. Another test is that the moisture-liquid indicator shows moisture in the system (refer to section 4.11).

To Replace Filter-Drier:

a. Remove the refrigerant (refer to section 4.3).

b. Remove filter-drier clamp, then replace drier.

c. Evacuate the unit per section 4.5.

d. Charge unit with refrigerant per section 4.6.

e. After unit is in operation, inspect for moisture in system. (Refer to section 4.11)

4.13 CHECKING OR REPLACING HIGH PRESSURE SWITCH

4.13.1 Replacing High Pressure Switch

a. Remove the refrigerant (refer to section 4.3). Frontseat both suction and discharge service valves to isolate compressor.

b. Disconnect wiring from defective switch. The high pressure switch is located on the center head and is removed by turning counterclockwise. (See Figure 1-1)

c. Install new cutout switch after verifying switch settings. (Refer to section 4.13.2)

d. Evacuate and dehydrate the compressor per paragraph 4.5.1.o through 4.5.1.u.

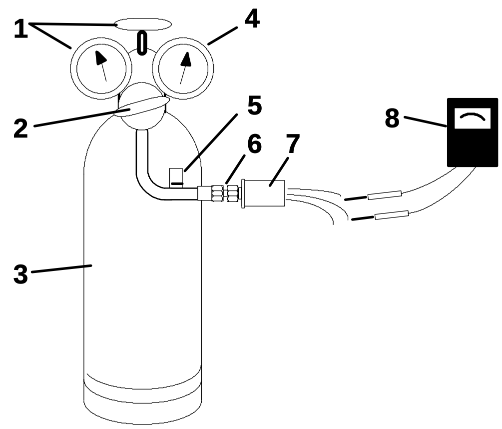
4.13.2 Checking High Pressure Switch

WARNING

Do not use a nitrogen cylinder without a pressure regulator because cylinder pressure is approximately 165 kg/cm@ (2350 psi). Do not use oxygen in or near a refrigeration system as an explosion may occur.

NOTE

The high pressure switch (HPS) is non-adjustable.



1. Cylinder Valve and Gauge
2. Pressure Regulator
3. Nitrogen Cylinder
4. Pressure Gauge (0 to 36 kg/cm@ = 0 to 500 psig)
5. Bleed-Off Valve
6. 1/4 inch Connection
7. High or Low Pressure Switch
8. Ohmmeter

Figure 4-15. Typical Setup for Testing High Pressure Switch

a. Remove switch as outlined in paragraph 4.13.1.

b. Connect ohmmeter or continuity light across switch terminals. Ohm meter will indicate resistance and continuity light will be illuminated if switch closed after removing compressor pressure.

c. Connect capillary to a cylinder of dry nitrogen. (See Figure 4-15)

d. Set nitrogen pressure regulator at 21kg/cm@ (300 psig) with bleed-off valve closed.

e. Close valve on cylinder and open bleed-off valve.

f. Open cylinder valve. Slowly close bleed-off valve to increase pressure on switch. The switch will open at a static pressure up to 25 kg/cm@ (350 psig). If light is used, light will go out and if ohmmeter is used, the meter will indicate open.

g. Slowly open bleed-off valve to decrease the pressure. The switch will close at 18 kg/cm@ (250 psig).

4.14 REPLACING THE EVAPORATOR COIL AND HEATER ASSEMBLY

The evaporator section, including the coil, should be cleaned with fresh water or steam, preferably. Another recommendation is to use Oakite 202 or similar cleaner following *manufacturer's instructions.*

The two drain pan hoses connected to the drain pan, are routed behind the condenser fan motor and compressor. The drain pan line(s) must be open to ensure adequate drainage.

To Replace the Evaporator Coil:

a. Recover the refrigerant charge or pump the unit down per section 4.3.

b. With power OFF and power plug removed, remove the screws securing the panel covering the evaporator section (upper panel).

c. Disconnect the defrost heater wiring.

d. Disconnect the klixon from the coil. The defrost termination thermostat (DTT) is located on the middle coil support as shown in Figure 1-2.

e. Remove middle coil support.

f. Remove the mounting hardware from the coil.

g. Unsolder the two coil connections, one at the distributor and the other at the coil header.

NOTE

It may be necessary to raise the fan deck to break the solder connections (to raise coil).

h. After defective coil is removed from unit, remove defrost heaters and install on replacement coil.

i. Install coil assembly by reversing above steps.

j. Leak check connections per section 4.4. Evacuate the unit per section 4.5 and add refrigerant charge per section 4.6.

4.15 REPLACING THE EVAPORATOR FAN AND MOTOR ASSEMBLY

The evaporator fans circulate air throughout the container by pulling air in the top of the unit. The air is forced through the evaporator coil where it is either heated or cooled and then discharged out the bottom of the refrigeration unit into the container. (Refer to paragraph 1.4.f) The fan motor bearings are factory lubricated and do not require additional grease.

WARNING

Always turn OFF the unit circuit breaker (CB1) and disconnect main power supply before working on moving parts.

a. Remove upper access panel (See Figure 1-1) by removing mounting bolts and T.I.R. locking device. Reach inside of unit and remove Ty-Rap securing wire harness loop.

b. Remove the two lower mounting bolts that secure the motor-fan assembly to the unit. Loosen the two upper bolts as the motor mount upper holes are slotted.

c. Remove motor, fan, and wiring from unit. Place fan motor and fan on a support. Remove the wiring and fan.

d. Lubricate fan motor shaft with a graphite-oil solution (Never-Seez). Apply thread sealer (Loctite H, brown in color) to the two fan set screws. Install fan on motor. The evaporator fan locating dimension is shown in Figure 4-16.

e. Connect wiring per applicable wiring diagram (refer to section 5) and install motor and fan assembly in unit. Apply power, momentarily, to check fan rotation. (Refer to paragraph 1.4.f) If fan spins backwards, refer to section 4.24 for two-speed motors.

Replace access panel, making sure panel does not leak. Make sure T.I.R. locking device is lockwired.

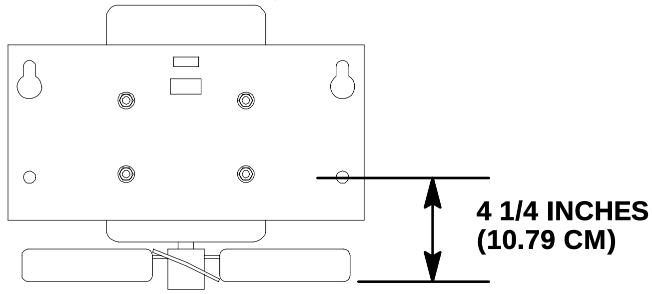


Figure 4-16. Evaporator Fan Locating Dimension

4.16 SERVICING THE EVAPORATOR COIL HEATERS

WARNING

Before servicing unit, make sure the unit circuit breaker (CB1) and the start-stop switch are in the OFF position. Also disconnect power plug and cable.

a. Remove the lower access panel (Figure 1-1) by removing the T.I.R. locking device lockwire and mounting screws.

b. Determine which heater(s) need replacing by checking resistance on each heater as shown in paragraph 1.4.e.

c. Remove hold-down clamp securing heaters to coil.

d. Lift the "U" portion of the heater (with opposite end down and away from coil). Move heater left (or right) enough to clear the heater end support.

4.17 CONDENSER COIL

The condenser consists of a series of parallel copper tubes expanded into copper fins. The condenser coil must be cleaned with fresh water or steam so the air flow is not restricted. Fan rotation is counterclockwise when viewed from shaft end of motor.

WARNING

Do not open condenser fan grille before turning power OFF and disconnecting power plug.

To Replace the Condenser Coil:

a. Recover the refrigerant charge per section 4.3.

b. Remove the condenser coil guard.

c. Unsolder discharge line and remove the line to the water-cooled condenser (if so equipped).

d. Remove coil mounting hardware and then remove the coil.

e. Install replacement coil. Solder connections.

f. Leak check the coil per section 4.4. Evacuate the unit per section 4.5 and then, charge the unit with refrigerant per section 4.6.

4.18 CONDENSER FAN AND MOTOR ASSEMBLY

WARNING

Do not open condenser fan grille before turning power OFF and disconnecting power plug.

NOTE

The replacement motor should be degreased and sprayed with a coat of Tectyl before installing in unit.

The condenser fan rotates counterclockwise (viewed from front of unit) and pulls air through the the condenser coil and discharges horizontally out the front of the unit.

a. Open condenser fan screen guard.

b. Loosen square head set screws (2) on fan. (Thread sealer has been applied to set screws at installation.) Then disconnect wiring from motor junction box.

CAUTION

Take necessary steps (place plywood over coil or use sling on motor) to prevent motor from falling into condenser coil.

c. Remove motor mounting hardware and replace the motor. It is recommended that new locknuts be used when replacing motor. Connect wiring per wiring diagram (refer to section 5).

d. Install fan loosely on motor shaft (hub side in). Install venturi. Apply "Loctite H" to fan set screws. Adjust fan within venturi so that the outer edge of the fan projects 7.9 mm (5/16 inches) out from edge of venturi. Spin fan by hand to check clearance.

e. Close and secure condenser fan screen guard.

f. Apply power to unit and check fan rotation. If fan motor rotates backwards, reverse wires 5 and 8.

4.19 RECORDING THERMOMETER (PARTLOW)

CAUTION

The inside mechanism of the control, particularly the inside of the element housing should never be oiled, however, control mechanisms should be sprayed periodically (every 60 days) with corrosion-inhibiting CRC 3-36a or 6-66 or LPS no. 2.

a. Instruments for Checking Bulb Temperature

The recording thermometer may be equipped with one or two Simpson accessories (#344 units), each consisting of a thermistor probe and receptacle (mounted to instrument case) Single probe is attached to the element (bulb) capillary which senses the container return air temperature. If using two probes, the other probe is attached to the supply air temperature sensor.

In the event of a failure with the #344 test lead, other instruments for checking bulb temperatures are:

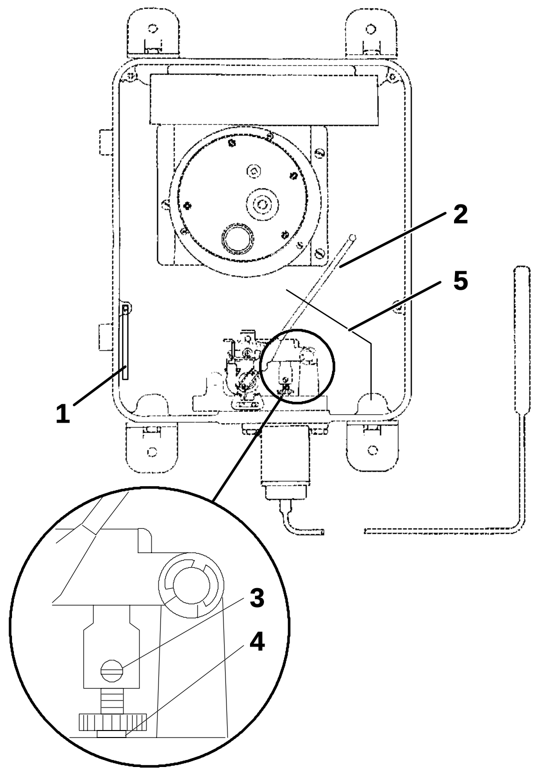
1. *Simpson Meter, CTC P/N 07-00013 or Robinair Thermistor Temperature Tester, Model 12860.*

A resistance thermometer and a RCA lead with a phono-plug at each end may be used to compare bulb temperature and stylus indicated temperature on chart by inserting one end of the lead into receptacle provided on the controller and other end in the meter. Always check resistance thermometer before using, refer to paragraph b.

2. *Ohmmeter*

a. Place one probe of ohmmeter in the middle of the receptacle provided on the chart platen and ground other probe to unit.

b. Note reading of meter and using Table 4-1, convert resistance to temperature.



1. Wind-up Key
2. Stylus
3. Set Screw
4. Pinion Shaft
5. Stylus Lifter

Figure 4-17. Partlow Recording Thermometer

b. Checking Resistance Thermometer

Calibrate the resistance thermometer by completely filling a thermos container full of ice cubes or chips and filling the voids between the ice with plain water. Stir the solution until the mixture registers 0.0 to 0.3_C (32 to 32.5_F), as indicated by a laboratory thermometer. Immerse the resistance thermometer in the 0_C (32_F) solution and check its accuracy at this temperature. With this instrument, be certain that the recommended length of the check probe is immersed so that it accurately will reflect temperature. Bear in mind that this measurement checks the test probe at 0_C (32_F) only; it is possible for this type of instrument to be inaccurate at other temperatures. Rezero check thermometer, if necessary, by manufacturer's instructions.

c. Checking the Recording Thermometer Bulb Temperature

Checking temperature is accomplished by comparing the instrument's indicated temperature (stylus) with the known temperature existing at the element sensing bulb. To properly check the temperature of the recorder, the element sensing bulb should be stabilized at a temperature of 0_C (32_F). This is accomplished by using one of the two following methods, whichever is more convenient.

1. *Unit Running:*

Place set point at 0_C (32_F). After unit has pulled down to this temperature, allow compressor to cycle ON-OFF 3 to 5 times to be certain temperature has stabilized at 0_C (32_F) as verified by the resistance thermometer. If the temperature indicated by the thermometer differs from 0_C (32_F) by more than 0.6_C (1_F) when compressor cycles off, rezeroing must be performed.

2. *Unit Off:*

Place the recording thermometer element (sensing bulb) in 0_C (32_F) ice-water bath. Ice-water bath is prepared by filling an insulated container (of sufficient size to completely immerse bulb) with ice cubes or chipped ice, then filling voids between ice with water, and agitating until mixture reaches 0_C (32_F) as shown by a laboratory thermometer.

When the temperature at the element sensing bulb has stabilized at 0_C (32_F), as indicated by stable stylus indication, compare temperature indicated by stylus with temperature shown by a laboratory thermometer. If the two readings do not agree, the recording thermometer should be rezeroed. (Refer to paragraph d)

d. Rezeroing the Recording Thermometer

1. Be certain that element bulb temperature has stabilized at 0_C (32_F). Note the amount of temperature difference between the test meter or thermometer reading and the stylus indicated temperature.

If the difference noted between the known element temperature and indicated temperature is within acceptable limits (0.3 of 0_C = 1/2_ of 32_F), do not attempt to rezero. If more than 0.3_C (1/2_F) in variation, carefully note the number of degrees.

2. If recording thermometer is found to require rezeroing:

a. Loosen set screw, item 3, Figure 4-17 and zero thermometer by turning pinion shaft, item 4. Lengthening pinion shaft (counterclockwise) raises stylus indicated temperature reading: shortening shaft (clockwise) lowers stylus reading. Then retighten set screw.

b. Reset control at 0_C (32_F), start refrigeration unit and repeat accuracy check. After temperature stabilization, recording thermometer should be within 0.3_C (1/2_F) limits.

e. Replacing Recording Thermometer Element (Bulb and Capillary)

The element is mercury-filled and the temperature-pressure of the element controls the stylus which moves across the chart in response to temperature changes as sensed by the bulb located in the evaporator supply air.

The element flange contains three O-rings. Care should be taken to install the new element flange without damaging the O-rings. It is possible for a mercury leak to develop at the flange if O-ring damage occurs.

The stylus will continue to fall (container temperature will actually be higher) if a leak develops in the flange, capillary or bulb.

To replace the recording thermometer element:

1. Turn unit OFF and disconnect power source.

2. Remove middle back panel. Remove bulb clamps securing bulb to unit.

3. Remove two flange screws from recording thermometer and feed capillary and element through the unit.

4. Push replacement bulb end and capillary through the unit.

5. Fill slots with silastic (RTV432, Dow Corning).

6. Attach bulb clamps tightly to bulb.

7. Connect element flange to recorder making sure hub of flange faces out to fit into the hole in instrument case (recording thermometer).

8. Rezero the recorder. (Refer to paragraph 4.19.d)

9. Install inlet air grille and lower panel. Start unit and check recorder calibration.

CAUTION

Capillary tubing may be bent, but never sharper than 1/2 inch radius: extra care should be taken when bending adjacent to welds. The sensing bulb should never be bent, as this will affect calibration.

4.20 MAINTENANCE OF PAINTED SURFACES

The refrigeration unit is protected by a special paint system against the corrosive atmosphere in which it normally operates. However, should the paint system be damaged, the base metal can corrode. In order to protect the refrigeration unit from the highly corrosive sea atmosphere or if the protective paint system is scratched or damaged, clean area to bare metal using a wire brush, emery paper or equivalent cleaning method. Immediately following cleaning, spray or brush on zinc rich primer. After the primer has dried, spray or brush on finish coat of paint to match original unit color.

4.21 SERVICING THE SUCTION MODULATION VALVE

a. Valve Checkout Procedure

Modulation for 0_C (32_F) simulated temperature can be verified in several ways. Without use of test equipment, listen for a change in compressor sound. Feel for a drop in condensing air temperature as the suction modulation valve closes. If a gauge manifold is connected to unit, pressures will drop as modulating valve closes.

The preferred method of monitoring controller output to the modulating valve is by reading the DC voltage between terminals 12 and 14 on the main circuit board (temperature controller). Readings under 0.2 vdc correspond with valve wide open. Full closure of valve corresponds with 1.1 and 1.3 vdc.

NOTE

Above voltages are numerically equal to valve currents (0.2 vdc = 0.2 amp DC).

When cooling a chill load and with unit in operation, turn set pointer downscale to –17.8_C (0_F) and note suction pressure. (Pressure should increase after approximately one minute.) Slowly raise set point and just before compressor shuts off, a significant drop in suction pressure should be noted. If no pressure change is noticed, valve or controller malfunctioned.

b. To Replace Valve

1. Recover the refrigerant charge or pump the unit down per section 4.3.

2. Remove two bolts from suction service valve.

3. Melt solder at the y-connection to the right of the modulating valve and rotate valve and tubing enough to clear compressor. Remove valve and tubing. Replace defective suction modulation valve being careful to wrap body of replacement valve with a wet cloth while brazing. The coil need not be removed.

4. Install new suction service valve gasket and install bolts in suction service valve. Torque to a value of 2.77 to 4.15 mkg (20 to 30 ft/lb).

5. Solder all connections and leak check same.

6. Dehydrate and evacuate the unit per section 4.5 and then add refrigerant charge per section 4.6.

NOTE

When repairing the suction modulation valve with the enclosing tube kit (CTD P/N 14-50021-01) be sure not to remove items 7, 8 & 10. (See Figure 4-18) Proper alignment of these items is achieved only at the factory.

c. Coil Checkout Procedure

WARNING

Make sure power to unit is OFF and power plug disconnected before replacing the coil.

1. Disconnect the modulation valve coil wires from their terminal locations (T14 & T15) on the units main control board (refer to section 5).

2. Using a reliable digital ohmmeter, test each lead's resistance to ground. If the resistance indicates a ground short is present, inspect the length of wiring for damaged or exposed wires. Replace where necessary.

3. Setting the digital ohmmeter for low range, check coil's resistance. If coil's resistance is below 5 ohms it is recommended to be replaced. New coils have an approximate resistance of 7.6 ohms at 25_ C (77_ F). The chart below gives the resistance of a new coil at various ambient temperatures.

Ambient Temperature	Cold Coil
10_ F	6.45 ohms
40_ F	6.90 ohms
70_ F	7.40 ohms
100_ F	7.90 ohms

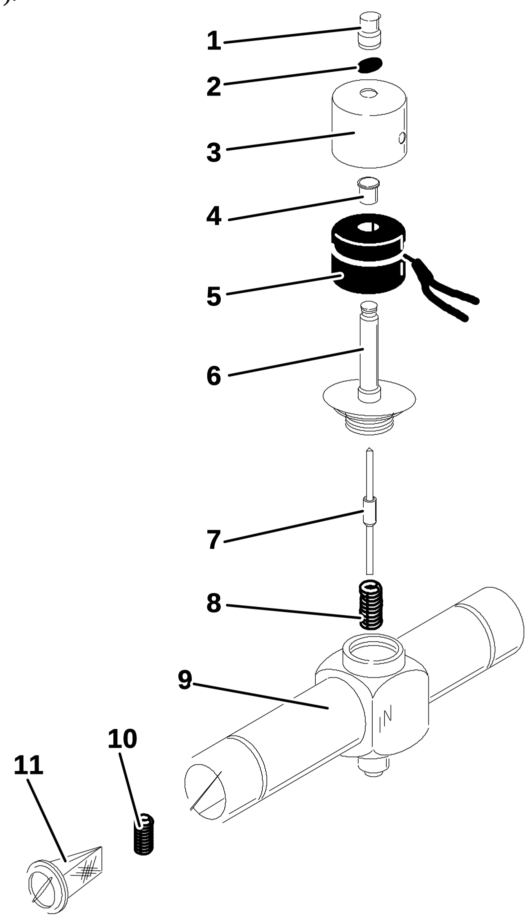
NOTE

A cold coil is a coil which had not been operating and is assumed to be at ambient temperature. Hot coil temperatures, taken after the unit has been operating in deep modulation for a long period of time, may give higher resistance readings.

4. Reconnect the modulation valve coil wires to their correct terminal locations.

d. Replacing the Coil

Remove coil nut and remove coil after disconnecting wiring. When replacing nut, torque to a value of 0.41 mkg (3 ft-lb).



1. Coil Nut
2. Coil Nut O-ring
3. Coil Housing
4. Solenoid Coil Sleeve
5. Solenoid Coil
6. Enclosing Tube Assembly
7. Piston
8. Top Return Spring
9. Valve Body
10. Bottom Return Spring
11. Filter

Figure 4-18. Suction Modulation Valve

4.22 CONTROLLER CHECKOUT PROCEDURE

NOTE

If the unit is equipped with a Digital Display or a service accessory Digital Display is available, this should be used for reading set point settings.

4.22.1 Controller Pre-Trip

a. Equipment Required

1. Digital volt-ohmmeter (capable of accurately reading 0 to 2 vdc).

2. Manifold gauge set.

b. Preparation

1. Set volt-ohmmeter to read DC volts of approximately 0 to 2 vdc.

2. Connect volt-ohmmeter common lead to terminal 12 (DC common) of unit control board. (Refer to section 5)

3. Connect volt-ohmmeter positive lead to terminal 14 of unit control board.

5. Install the manifold gauge set on compressor suction service port.

6. Set temperature selector below container temperature and run unit 6 to 10 minutes in full cooling.

7. Set temperature selector to –6_C (21_F).

8. Position temperature simulator switch (TSS) to 0_C (32_F) position. (See Figure 1-4) Hold time delay override switch (TDS) in depressed position.

c. Checking Suction Modulation Valve

Slowly raise temperature selector setting. As the temperature selector setting is raised, the reading on the volt-ohmmeter will vary, increasing as temperature setting is moved upscale. When the temperature selector is moved below 0_C (32_F), the voltage will remain stable momentarily and then slowly decrease. Also, when the temperature setting is lowered the voltage will decrease.

d. In-Range Relay (IRS) Operation

Continue to raise the temperature selector setting until the selector reaches –2 ¦ 0.5_C (29 ¦ 1_F) where the in-range relay and light emitting diode (LED) will energize.

e. Cooling – Full Modulation

1. Continue to raise temperature selector setting to 0.5 ¦ 0.5_C (33 ¦ 1_F). The suction modulation valve current will be 0.9 to 1.2 vdc.

2. Note that the compressor suction pressure gauge reading drops between 0 psig and 50.8 cm (20 inches) Hg vacuum.

f. Checking Heating ON and Cooling OFF

1. Continue to raise temperature selector setting to 1.0 ¦ 0.5_C (34 ¦ 1_F). The compressor and condenser fan will cycle off and the cool (TC) LED will de-energize.

The heat relay will energize and the TH LED will be illuminated.

2. Continue to raise the temperature selector setting to 2 ¦ 0.5_C (36 ¦ 1_F). The in-range light and the IRS LED will de-energize. The heat relay will remain on and the TH LED will be illuminated.

4.22.2 Temperature Control Board Checkout Procedure with TCSM

a. Equipment Required

1. Multi-Test Meter (volt-ohmmeter)

2. Clamp-on Ammeter

3. Gauge-Manifold

4. Temperature Control Simulator Module (P/N 07-00226).

NOTE

All references to the TCSM board toggle switches (TC, TH, TQ, TU, DR and in-range) positions will be either; left (away from the board) or right (toward the board). TQ switch is not used in units with a quench expansion valve.

b. Procedure

1. Turn unit OFF and disconnect power supply.

2. Open the control box door.

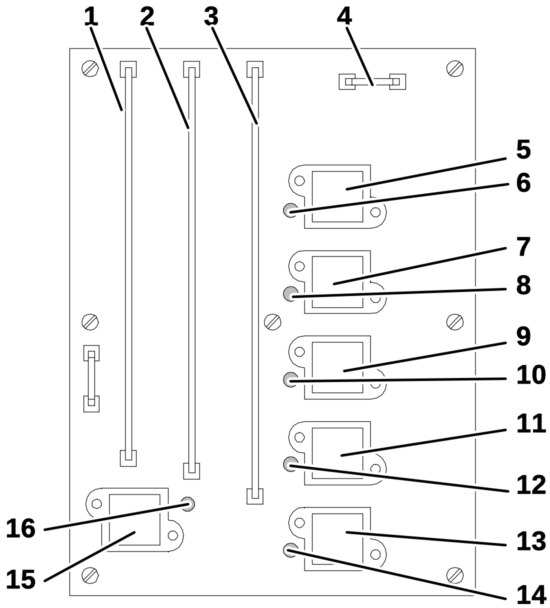
3. Remove the temperature control board and insert temperature control simulator module (TCSM). See Figure 4-19, item 3, for location of temperature control board.

4. Place switches on the simulator in the *air circulation only* position. Simulator (TCSM) switches TC, TH and DR will be to the left. Switches TU and in-range will be to the left also. (Placing the in-range switch to the left takes the humidistat control out of the system). The valve current will be in the OFF position.

5. Connect gauge-manifold to the suction and discharge service valves.

6. Turn unit power ON. The evaporator fan motors are running in high speed at this time. Check to see if the 24 vac warning light is illuminated. This light is located on the test board, near the return air sensor signal (TP6) test point.

(R.A. Sensor Signal). If the 24 vac light is illuminated, stop the unit immediately and remove power supply from unit. Check all wiring to the unit control board.



1. Power Supply and In-Range Board
2. Timing and Current Control Board
3. Temperature Control Board
4. Fuse, 3 Amp
5. Utility Relay (TU)
6. Light Emitting Diode (TU – LED)
7. Quench Relay (TQ)
8. Light Emitting Diode (TQ – LED)
9. Cooling Relay (TC)
10. Light Emitting Diode (TC – LED)
11. Heating Relay (HR)
12. Light Emitting Diode (HR – LED)
13. Defrost Relay (DR)
14. Light Emitting Diode (DR – LED)
15. In-Range Relay
16. Light Emitting Diode (IRS – LED)

Figure 4-19. Unit Control Board

7. Set multi-meter to 30 vdc and plug one test lead in the TP4 jack (DC com) on the simulator board.

8. Plug other test lead in the TP1 jack (12vdc) on the simulator board. Voltage should be 12.8 ¦ 0.8 vdc on the multi-meter. If no voltage appears here, check power supply.

9. Repeat step 8 for the TP2 jack 9vdc. Voltage should be 9 ¦ 1.4 vdc. If 12 vdc appears here, recheck wiring. This can happen after replacing a component on the unit.

10. Place IRS switch to the right. LED and IRS energize.

11. Turn simulator IRS OFF (left). LED and IRS relay de-energize.

12. With the evaporator fan motors running, turn TH switch ON (right). TH LED and relay energize.

13. Using clamp-on ammeter, read the amps of the four (4) heater power leads. (Heater wiring connected to the heat relay terminals 21, 22 and 23.) Amperage reading should be 2.6 to 3.2 on four defrost heater leads marked DH. If amps vary more than two (2A) from leg to leg, turn power OFF and check wiring and/or heaters.

The drain pan heater draws 1.3 to 1.6 amps on lead marked DPH. See applicable wiring schematic.

14. Place simulator switch TH to the left. Heaters and TH LED are de-energized.

15. Place simulator switch TC to the right. Relay TC and TC LED energize. The compressor and condenser fan motor start.

18. Turn simulator board modulation switch to 50% modulation point and notice suction pressure drop. Turn modulation switch to FULL modulation position and note suction pressure drop. As modulation increases, the modulation LED on the simulator board will grow increasingly brighter, do not leave the switch in this position for longer than 30 seconds. If modulating valve malfunctions, refer to section 4.21.

19. Place switch TC to the left. TC LED de-energizes, compressor, and condenser fan motor stop.

20. Place TU switch to the left. TU LED energizes, and the evaporator fan motors switch to low speed operation.

21. Turn power OFF and disconnect power source and then remove simulator board and install regular temperature board.

4.22.3 Replacing the Unit Main Control Board

a. Turn OFF unit power and then open the controller door.

b. Disconnect wiring from defective control board. Then remove screws securing board to unit. Remove complete assembly.

c. Install relays, fuses, three boards, and connect wiring to proper terminals on the replacement control board.

4.22.4 Printed Circuit Board Cleaning Procedure

a. Turn power OFF and remove the printed circuit board from the unit.

b. Clean the surface of the printed circuit board with dry air at low pressure, less than 2.4 Kg/cm@ (20 psig).

c. If grease is encountered, spray the printed circuit board with anhydrous alcohol. If this is not available, use a mixture of distilled water and liquid dishwashing soap, then rinse the printed circuit board with distilled water. Remove grime using clean dry air at low pressure.

d. The printed circuit board can be coated with humiseal P/N 07-50001 to protect the components from corrosion. Be sure not to spray the terminals of the molex connectors as the humiseal is a non-conductor.

e. Spray the connector terminals on the board with contact lubricant P/N 07-50003 before the board is inserted back in the unit.

CAUTION

Do not use aromatic hydro carbons, chlorinated solvents, or freon T.F. degreaser for cleaning. They will react with the plastic materials used in the manufacture of the printed circuit board.

4.22.5 Temperature Set Station Checkout Procedure

NOTE

The temperature set station (CSS) is sometimes referred to as the temperature selector potentiometer.

If a problem with the selector is suspected all three wires must be checked. The selector should be checked for resistance using a reliable ohmmeter at the temperature *selector connection* as shown in Table 4-2.

a. With multi-test meter set on ohms (1K).

b. Place one probe on selector connection pin 1 and other probe on pin 2 (see Figure 4-20). Ohms will be 324 to 334 with the selector set at −25_C (−15_F).

c. Complete checkout procedure by using Table 4-2.

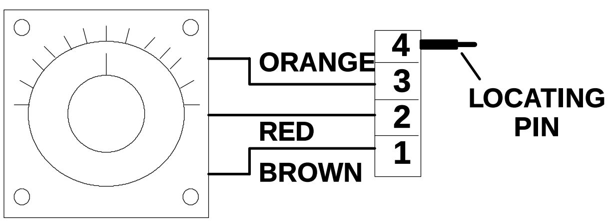


Figure 4-20. Temperature Set Station and Plug

4.22.6 Temperature Controller Sensor Checkout Procedure

Due to variations and inaccuracies in thermometers or other test equipment, a reading close to the chart value would indicate a good sensor. If a sensor is bad, the resistance reading will usually be much higher or lower than the resistance values given in Table 4-6.

a. Turn unit OFF and disconnect power supply.

b. Remove temperature control board, item 3, Figure 4-19 and insert temperature control simulator board (CTD P/N 07-00226).

c. Apply power to unit.

d. Place one probe on TP4 jack (DC Com) and other probe on the sensor test point (either TP5 or TP6). The two sensor test points on the board are marked S.A. sensor signal and R.A. sensor signal. Readings are shown in Table 4-6.

4.22.7 Replacing Temperature Sensor

a. Turn unit power OFF and disconnect power supply.

b. Cut cable 2 inches from shoulder of defective sensor and discard defective probe.

c. Cut one wire of existing cable 41 mm (1-5/8 inch) shorter than the other wire. (See Figure 4-21)

d. Cut one replacement sensor wire (opposite color) back 41 mm (1-5/8 inch).

e. Strip back insulation on all wiring 6.35mm (1/4 inch).

CAUTION

Do not allow moisture to enter wire splice area as this may affect the sensor resistance.

f. Slide a large piece of heat shrink tubing over cable and the two small pieces of heat shrink tubing over the wires before adding crimp fittings as shown in Figure 4-22.

g. Slip crimp fittings over dressed wires (keep wire colors together). Make sure wires are pushed into crimp fittings as far as possible and crimp with crimping tool.

h. Solder spliced wires with a 60% tin and 40% lead Rosincore solder.

i. Slide heat shrink tubing over splice so that both ends of tubing cover both ends of crimp as shown in Figure 4-22.

j. Heat tubing, preferably with a flameless heat gun. If not available, a propane torch will work *(caution should be taken not to burn the heat shrink tubing or wire insulation)*. Make sure all seams are sealed tightly against the wiring to prevent moisture seepage.

k. Slide large heat shrink tubing over both splices and shrink tubing and heat as in step j.

l. Secure sensor to unit and check sensor resistance as detailed in section 4.22.6.

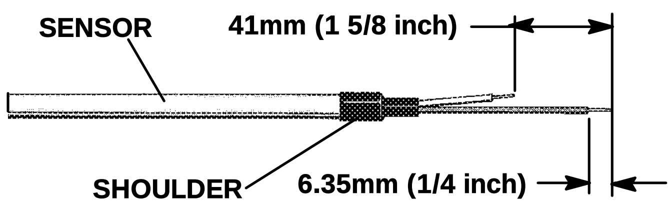


Figure 4-21. Sensor

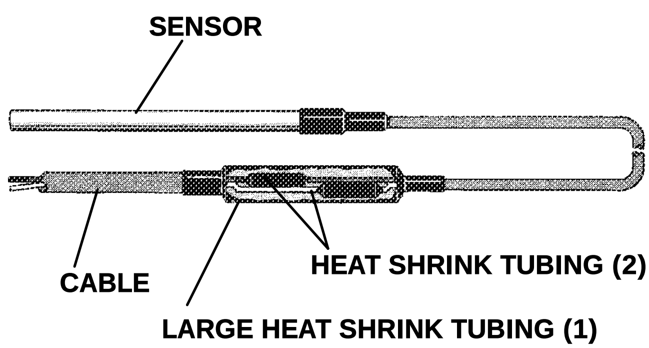


Figure 4-22. Sensor and Cable Assembly

4.23 THERMOSTATIC EXPANSION VALVE

The thermal expansion valve is an automatic device which maintains constant superheat of the refrigerant gas leaving the evaporator regardless of suction pressure. The valve functions are: (a) automatic response of refrigerant flow to match the evaporator load and (b) prevention of liquid refrigerant entering the compressor. Unless the valve is defective, it seldom requires any maintenance other than some minor periodic maintenance as follows:

1. Make sure that the excess capillary tube is secured to the power head assembly and wrapped with "Presstite".

2. Make sure that the thermal bulb is tightly secured to the suction line and wrapped with "Presstite".

a. Removing Expansion Valve

1. Recover the refrigerant charge or pump the unit down per section 4.3.

2. Remove insulation (Presstite) from expansion valve bulb and power assembly and then remove thermal bulb from the suction line.

3. Loosen flare nut and disconnect equalizing line from expansion valve.

4. Remove capscrews and lift off power assembly and remove cage assembly. Check for foreign material in valve body.

5. The thermal bulb is located below the center of the suction line (4 o'clock position). This area must be clean to ensure positive bulb contact.

b. Installing Expansion Valve

1. Replace all gaskets, make sure to lightly coat with refrigerant oil. Insert cage and power assembly and bolts. Tighten bolts equally. Fasten equalizer flare nut to expansion valve.

2. Leak check the unit per section 4.4. Evacuate and dehydrate unit per section 4.5 and add refrigerant charge per section 4.6.

3. Clean suction line with sandpaper before installing bulb to ensure proper heat transfer. Strap thermal bulb to suction line, making sure bulb is firmly against suction line. The bulb is located in the 4 o'clock position on the suction line.

4. Check superheat. (See Table 4-7) Superheat setting is 3.36 to 4.48_C (6 to 8_F) at 0_C (32_F) container temperature.

c. Checking Superheat

NOTE

It is not recommended adjusting internal adjustable valves unless absolutely necessary. This valve has been factory adjusted and set with "Locktite" that's applied to the internal adjusting nut.

If a replacement valve has the wrong superheat setting, the valve may be adjusted if you do not have another replacement valve on hand. Due to the time involved in adjusting the superheat, replace the valve rather than adjusting it.

To Measure Superheat:

1. Open access panel to expose the expansion valve and service port (see Figure 1-1).

2. Attach a temperature tester sensor near the expansion valve bulb and insulate. Make sure the suction line is clean and firm contact is made with tester.

3. Connect an accurate gauge to the service port.

4. Run unit until unit has stabilized. Set controller 5.5_C (10_F) below container temperature.

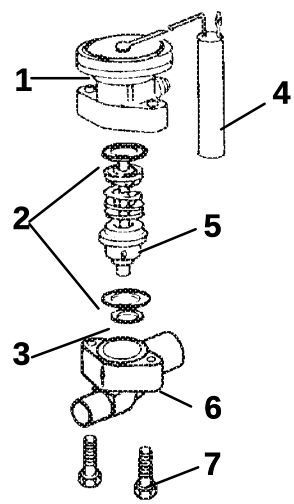
NOTE

Suction pressure must be 0.5 kg/cm@ (6 psig) below valve M.O.P. (maximum operating pressure). Example: if valve rated at 55 MOP, suction pressure must be below this MOP. Recommended pressure is below 3.44 kg/cm@ (49 psig).

5. From the temperature/pressure chart (Table 4-7), determine the saturation temperature corresponding to the evaporator outlet pressure.

6. Note the temperature of the suction gas at the expansion valve bulb.

7. Subtract the saturation temperature determined in Step 6 from the average temperature measured in Step 5. The difference is the superheat of the suction gas.



1. Power Assembly
2. Body Flange Gaskets
3. Seat Gasket
4. Bulb
5. Cage Assembly
6. Body Flange
7. Body Flange Screws

Figure 4-23. Thermostatic Expansion Valve

4.24 EVAPORATOR FAN MOTOR CAPACITORS

The two-speed evaporator fan motors are of the permanent-split capacitor type. The motor is equipped with one capacitor (used in high speed circuit) and another capacitor is used for the low speed circuit.

a. When to check for a defective capacitor

1. Fan motor will not change speed. For example: controller settings above −10_C (14_F) should cause the motor to run in high speed.

Controller settings below −10_C (14_F) should cause the motor to run in low speed.

2. Motor running in wrong direction (after checking for correct wiring application).

b. Removing the capacitor

WARNING

Make sure power to unit is OFF and power plug disconnected before removing capacitor(S).

1. The capacitor located on the motor and above the evaporator fan deck may be removed by two methods:

a. *If container is empty*, open upper, rear, panel of unit and capacitor may be serviced after disconnecting power plug.

b. *If container is full*, turn unit power OFF and disconnect power plug. Remove the evaporator fan motor access panel. (See Figure 1-1) Remove two lower capscrews securing motor assembly to bracket and then remove Ty-Raps from wire harness. Loosen two upper capscrews on fan motor assembly. Remove or set aside motor to reach capacitors.

WARNING

With power OFF discharge the capacitor and disconnect the circuit wiring.

c. Checking the capacitor

Three methods for checking capacitors are:

(1) Direct replacement, (2) volt-ohmmeter, and (3) capacitor analyzer.

1. *Direct replacement:*

Replace capacitor with one of the same value.

2. *Volt-ohmmeter:*

Set meter on RX 10,000 ohms. Connect ohmmeter leads across the capacitor terminals and observe the meter needle. If the capacitor is good, the needle will make a rapid swing toward zero resistance and then gradually swing back toward a very high resistance reading.

If the capacitor has failed open, the ohmmeter needle will not move when the meter probes touch the terminals. If the capacitor is shorted, the needle will swing to zero resistance position and stay there.

3. *Capacitor analyzer:*

The function of the analyzer is to read the microfarad value of a capacitor and to detect insulation breakdown under load conditions. The important advantages of a analyzer is its ability to locate capacitors that have failed to hold their microfarad ratings or ones that are breaking down internally during operation. It is also useful in identifying capacitors when their microfarad rating marks have become unreadable.

4.25 HUMIDISTAT (OPTIONAL)

a. Maintenance

Soiled sensing elements can be cleaned by dipping the stem in soapy fresh water or fresh water with washing powder (maximum 80_C = 176_F).

When drying, the stem must remain tensioned, i.e., the set point knob is set to it's lowest possible R.H. value. Drying time is approximately 24 hours. If necessary, recalibrate the humidistat.

b. Setting

1. The upper switching point of switch **A** is set by the set point knob **E** (see Figure 4-24).

2. In case of deviations of the measured humidity from the set point, a recalibration by means of the nut **S** is recommended:

3. If the actual value is higher than the set point, turn nut **S** clockwise.

4. If the actual value is lower than the set point, turn nut **S** counterclockwise.

Set Point	20%	40%	60%	70%	80%
1/6 turn −	15%	15%	11%	8%	5%

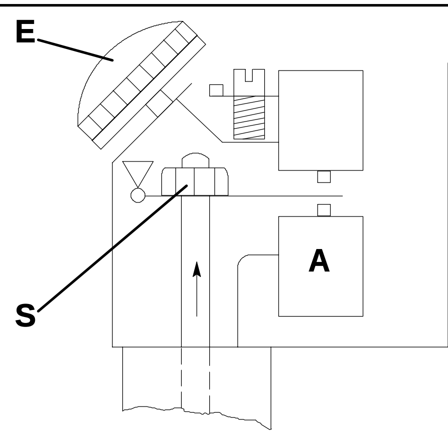


Figure 4-24. Humidistat

4.26 CHECKOUT PROCEDURE FOR OPTIONAL POWER TRANSFORMER

If the unit does not start when connected to a 190/230 vac power supply, check the following:

a. Make sure circuit breaker (CB2) is in the ON position. If CB2 does not hold in, check voltage supply.

b. Check to see if the transformer internal protector (IP-AUTO-TRANS) is closed. Allow a reasonable length of time for transformer to cool down. The transformer includes two (2) internal protectors. Only one is wired into the system as the second protector is a spare.

c. *To Check for Continuity Across the Internal Protector (IP-AUTO-TRANS):*

1. Turn power OFF and disconnect power source.

2. Disconnect white wires **1 and 2** from terminal board.

3. Check for continuity across the internal protector (IP). If (IP) is open and will not reset, connect wires **3 and 4** (18 gauge) to terminal board. Check to see if unit will start.

d. If the internal protector and circuit breakers (CB1 and CB2) are good, check the transformer. Use a voltmeter and with the primary supply circuit ON check the primary (input) voltage (230 vac). Next, check the secondary (output) voltage (460 vac) at the voltage selector switch. The transformer is defective if voltage is not available.

4.27 SERVICING THE OPTIONAL WATER-COOLED CONDENSER

NOTE

When Oakite compound No. 32 is being used for the first time, the local Oakite Technical Service representative should be called in for his suggestions in planning the procedure. He will show you how to do the work with a minimum dismantling of equipment: how to estimate the time and amount of compound required; how to prepare the solution; how to control and conclude the de-scaling operation by rinsing and neutralizing equipment before putting it back into service. His knowledge of metals, types of scale, water conditions and de-scaling techniques will be invaluable to you.

The water-cooled condenser is of the shell and coil type with circulating water through the cupro-nickel coil. The refrigerant vapor is admitted to the shell side and is condensed on the outer surface of the coil.

Rust, scale and slime on the water-cooling surfaces inside of the coil interfere with the transfer of heat, reduce system capacity, cause higher head pressures and increase the load on the system.

By checking the leaving water temperature and the actual condensing temperature, it can be determined if the condenser coil is becoming dirty. A larger than normal difference between leaving condensing water temperature and actual condensing temperature, coupled with a small difference in temperature of entering and leaving condensing water, is an indication of a dirty condensing coil.

To find the approximate condensing temperature, with the unit running in the cooling mode, install a gauge 0 to 36.2 kg/cm@ (0 to 500 psig) on the compressor discharge service valve.

For example: if the discharge pressure is 11.4 kg/cm@ (147 psig), and referring to Table 4-7, R-12 temperature-pressure chart, the 11.4 kg/cm@ (147 psig) converts to 46_C (115_F).

If the water-cooled condenser is dirty, it may be cleaned and de-scaled by the following procedure:

a. Turn unit off and disconnect main power.

b. Disconnect water pressure switch tubing by loosening the two flare nuts. Install 1/4 inch flare cap on water-cooled condenser inlet tube (replaces tubing flare nut). De-scale tubing if necessary.

1. *What You Will Need:*

a. Oakite composition No. 22, available as a powder in 68 kg (150 lb) and 136 kg (300 lb).

b. Oakite composition No. 32, available as a liquid in cases, each containing 3.785 liters (4 U.S. gallon) bottles and also in carboys of 52.6 kg (116 lbs) net.

c. Clean fresh water.

d. Acid proof pump and containers, or bottles with rubber hose.

2. *What You Will Do – (Summary)*:

a. Drain water from condenser tubing circuit. Clean water tubes with Oakite No. 22 to remove mud and slime.

b. Flush.

c. De-scale water tubes with Oakite No. 32 to remove scale.

d. Flush.

e. Neutralize.

f. Flush.

g. Put unit back in service under normal load and check head (discharge) pressure.

3. *Detailed Procedure:*

a. Drain and flush the water circuit of the condenser coil. If scale on the tube inner surfaces is accompanied by slime, a thorough cleaning is necessary before de-scaling process can be accomplished.

b. To remove slime or mud, use Oakite composition No. 22, mixed 170 grams (6 ounces) per liter (one U.S. gallon) of water. Warm this solution and circulate through the tubes until all slime and mud has been removed.

c. After cleaning, flush tubes thoroughly with clean fresh water.

WARNING

Oakite No. 32 is an acid – therefore be sure that the acid is slowly added to the water. DO NOT PUT WATER INTO THE ACID! – this will cause spattering and excessive heat.
Wear rubber gloves and wash the solution from the skin immediately if accidental contact occurs. Do not allow the solution to splash onto concrete.

d. Prepare a 15% by volume solution for de-scaling, by diluting Oakite compound No. 32 with water. This is accomplished by slowly adding 0.47 liter (one U.S. pint) of the acid (Oakite No. 32) to 2.8 liters (3 U.S. quarts) of water.

e. Fill the tubes with this solution by filling from the bottom. See Figure 4-25A. Important: be sure to provide a vent at the top for escaping gas.

f. Allow the Oakite No. 32 solution to soak in the tube coils for several hours, periodically pump-circulating it with an acid-proof pump.

An alternate method may be used, whereby a bottle (see Figure 4-25B) filled with the solution and attached to the coils by a hose can serve the same purpose, by raising and lowering of the bottle. The solution must contact the scale at every point for thorough de-scaling, therefore ensure that no air pockets exist, by regularly opening the vent to release gas. *Keep flames away from the vent gases.*

g. The time required for de-scaling will vary, depending upon the extent of the deposits. One way to determine when de-scaling has been completed is to titrate the solution periodically, using titrating equipment provided free by the Oakite Technical Service representative. As scale is being dissolved, titrate readings will indicate that the Oakite No. 32 solution is losing strength. When the reading remains constant for a reasonable time, this is an indication that scale has been dissolved.

h. When de-scaling is complete, drain the solution and flush thoroughly with fresh water.

i. Next circulate a 56.7 grams (2 ounce) per liter (one U.S. gallon) solution of Oakite No. 22 through the tubes to neutralize. Drain this solution.

j. Flush the tubes thoroughly with fresh water.

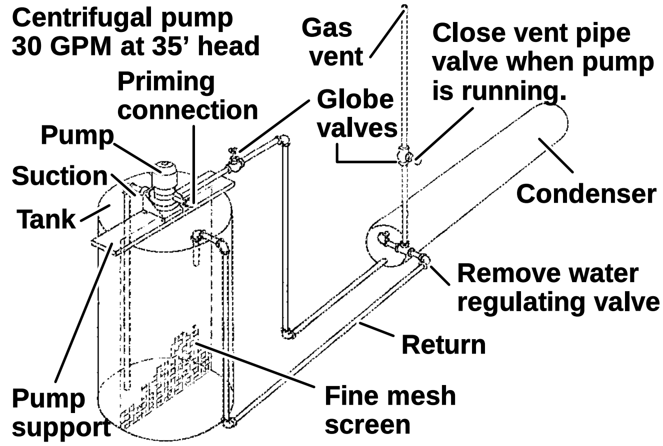
NOTE

If the condenser cooling water is not being used as drinking water or is not re-circulated in a closed or tower system, neutralizing is not necessary.

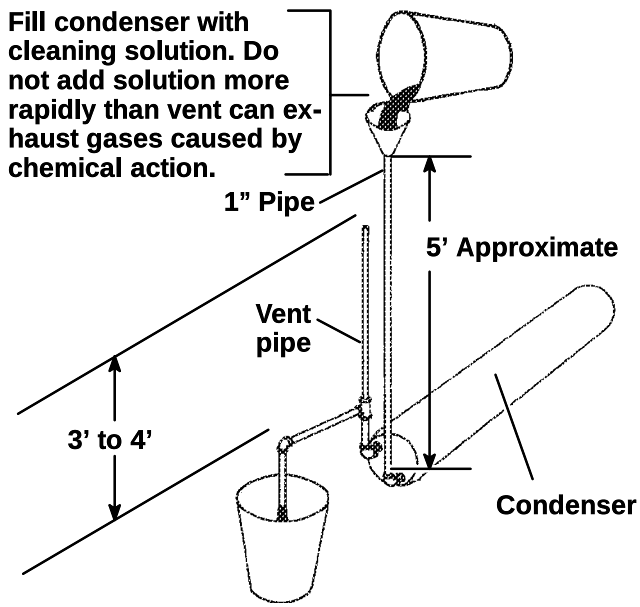
k. Put the unit back in service and operate under normal load. Check the head pressure. If normal, a thorough de-scaling has been achieved.

4. *What You Can Do For Further Help:*

Contact the Engineering and Service Department of the OAKITE PRODUCTS CO., 19 Rector Street, New York, NY 10006 U.S.A. for the name and address of the service representative in your area.



A – Forced Circulation



B – Gravity Circulation

Figure 4-25. Water-Cooled Condenser Cleaning

Table 4-1. Partlow Bulb Temperature – Resistance Chart

TEMPERATURE		RESISTANCE
˚F	˚C	(OHMS)
–10	–23.3	12561.00
–5	–20.6	10579.70
0	–17.8	8944.17
5	–15.0	7588.89
15	–9.4	5520.32
20	–6.7	4731.71
25	–3.9	4068.68
30	–1.1	3509.36
32	0	3310.57
35	1.7	3035.99
40	4.4	2634.10
45	7.2	2291.85
50	10.0	1999.52
55	12.8	1749.11
60	15.6	1534.00
65	18.3	1348.72
75	23.9	1050.14
80	26.7	929.87
85	29.4	825.21
90	32.2	733.93
95	35.0	654.12
100	37.8	584.19
105	40.6	522.79

Table 4-2. Selector Settings and Resistance

SELECTOR SETTINGS		SELECTOR CONNECTIONS (PINS)	RESISTANCE IN OHMS
˚F	˚C		
–15	–25	CSS 1 to CSS 2	324 to 334
–15	–25	CSS 2 to CSS 3	1648 to 1656
–15	–25	CSS 1 to CSS 3	1980 to 1988
32	0	CSS 1 to CSS 2	980 to 988
32	0	CSS 2 to CSS 3	1000 to 1008
32	0	CSS 1 to CSS 3	1980 to 1988
77	25	CSS 1 to CSS 2	1633 to 1641
77	25	CSS 2 to CSS 3	347 to 355
77	25	CSS 1 to CSS 3	1980 to 1988

Table 4-3. Recommended Bolt Torque Values

BOLT DIA.	THREADS	TORQUE	MKG
FREE SPINNING			
#4	40	5.2 in-lbs	0.05
#6	32	9.6 in-lbs	0.11
#8	32	20 in-lbs	0.23
#10	24	23 in-lbs	0.26
1/4	20	75 in-lbs	0.86
5/16	18	11 ft-lbs	1.52
3/8	16	20 ft-lbs	2.76
7/16	14	31 ft-lbs	4.28
1/2	13	43 ft-lbs	5.94
9/16	12	57 ft-lbs	7.88
5/8	11	92 ft-lbs	12.72
3/4	10	124 ft-lbs	17.14
NONFREE SPINNING (LOCKNUTS ETC.)			
1/4	20	82.5 in-lbs	0.95
5/16	18	145.2 in-lbs	1.67
3/8	16	22.0 ft-lbs	3.04
7/16	14	34.1 ft-lbs	4.71
1/2	13	47.3 ft-lbs	6.54
9/16	12	62.7 ft-lbs	8.67
5/8	11	101.2 ft-lbs	13.99
3/4	10	136.4 ft-lbs	18.86

Table 4-4. Wear Limits For Compressors

PART NAME	FACTORY MAXIMUM		FACTORY MINIMUM		MAXIMUM WEAR BEFORE REPAIR	
	INCHES	MM	INCHES	MM	INCHES	MM
MAIN BEARING						
Main Bearing Diameter	1.6268	41.3207			.0020	0.0508
Main Bearing Journal Diameter			1.6233	41.2318	.0020	0.0508
PUMP END						
Main Bearing Diameter	1.3760	34.9504			.0020	0.0508
Main Bearing Journal Diameter			1.3735	34.8869	.0020	0.0508
CONNECTING ROD	1.3768	34.9707			.0020	0.0508
Piston Pin Bearing			0.6878	17.4701	.0010	0.0254
CRANKPIN DIAMETER			1.3735	34.8869	.0025	0.0635
Throw **(28 CFM)**	0.7354	18.6792	0.7334	18.6284		
CRANKPIN DIAMETER			1.3735	34.8869	.0025	0.0635
Throw **(37 CFM)**	0.9698	24.6329	0.9678	24.5821		
CRANKPIN DIAMETER			1.3735	34.8869	.0025	0.0635
Throw **(41 CFM)**	1.072	27.2288	1.070	27.1780		
THRUST WASHER						
(Thickness) **(28 & 37 CFM)**	0.145	3.6830	0.1440	03.6576	.0250	0.6350
THRUST WASHER						
(Thickness) **(41 CFM)**	0.154	3.9116	0.1520	03.8608	.0250	0.6350
CYLINDERS						
Bore	2.0010	50.8254			.0020	0.0508
Piston (Diameter)			1.9860	50.4444	.0020	0.0508
Piston Pin (Diameter)			0.6873	17.4574	.0010	0.0254
Piston Ring Gap	0.013	00.3302	0.0050	00.1270	.0250	0.6350
Piston Ring Side Clearance **(28 & 37 CFM)**	0.001	00.0254	0.0000	00.0000	.0020	0.0508
Piston Ring Side Clearance **(41 CFM)**	0.002	00.0508	0.0010	00.0254	.0020	0.0508

Table 4-5. Compressor Torque Values

SIZE DIAMETER (INCHES)	THREADS PER INCH	TORQUE RANGE		USAGE
		FT-LB	MKG	
1/16	27 (pipe)	8 – 12	1.11 – 1.66	Pipe Plug – Crankshaft
1/8	20 (pipe)	6 – 10	0.83 – 1.38	Oil Return Check Valve – Crankcase
1/4	20 (pipe)	20 – 25	2.77 – 3.46	Pipe Plug – Gauge Connection
1/4	20	10 – 12	1.38 – 1.66	Connecting Rod Capscrew
1/4	28	12 – 15	1.66 – 2.07	Baffle Plate – Crankcase
		12 – 16	1.66 – 2.21	Side Shield
		6 – 10	0.83 – 1.38	Oil Pump Drive Segment
		12 – 16	1.66 – 2.21	Unloader Valve
5/16	18	16 – 20	2.21 – 2.77	Cover Plate – Plate End
				Bearing Head
				Terminal Block Cap Screws
		20 – 30	2.77 – 4.15	Suction Valve
				Discharge Valve
3/8	16	40 – 50	5.53 – 6.92	Pump End Bearing Head
				Bottom Plate – Crankcase Compressor Foot
				Cylinder Head
7/16	14	55 – 60	7.61 – 8.30	Motor End Cover – Crankcase
5/8	11	25 – 30	3.46 – 4.15	Crankshaft
5/8	18	60 – 75	8.30 – 10.37	Oil Bypass Plug – Crankcase
#10	32	4 – 6	0.55 – 0.83	Oil Pump Drive Segment
1-1/2	18 NEF	35 – 45	4.84 – 6.22	Oil Level Sight Glass

NEF – National Extra Fine

Table 4-6. Sensor D.C. Voltages

TEMPERATURE		D.C.	TEMPERATURE		D.C.	TEMPERATURE		D.C.
°F	°C	VOLTS	°F	°C	VOLTS	°F	°C	VOLTS
–20	–28.9	1.57	14	–10.0	3.45	48	8.9	5.32
–18	–27.8	1.68	16	–8.9	3.56	50	10.0	5.45
–16	–26.7	1.78	18	–7.8	3.68	52	11.1	5.55
–14	–25.6	1.90	20	–6.7	3.79	54	12.2	5.67
–12	–24.4	2.00	22	–5.5	3.90	56	13.3	5.78
–10	–23.3	2.10	24	–4.4	4.00	58	14.4	5.88
–8	–22.2	2.22	26	–3.3	4.10	60	15.6	5.98
–6	–21.1	2.32	28	–2.2	4.22	62	16.7	6.10
–4	–20.0	2.44	30	–1.1	4.32	64	17.8	6.20
–2	–18.9	2.55	32	0	4.45	66	18.9	6.32
0	–17.8	2.70	34	1.1	4.55	68	20.0	6.42
2	–16.7	2.80	36	2.2	4.68	70	21.1	6.55
4	–15.6	2.90	38	3.3	4.78	72	22.2	6.65
6	–14.4	3.00	40	4.4	4.88	74	23.3	6.77
8	–13.3	3.10	42	5.5	5.00	76	24.4	6.88
10	–12.2	3.23	44	6.7	5.10	78	25.6	6.98
12	–11.1	3.33	46	7.8	5.22			

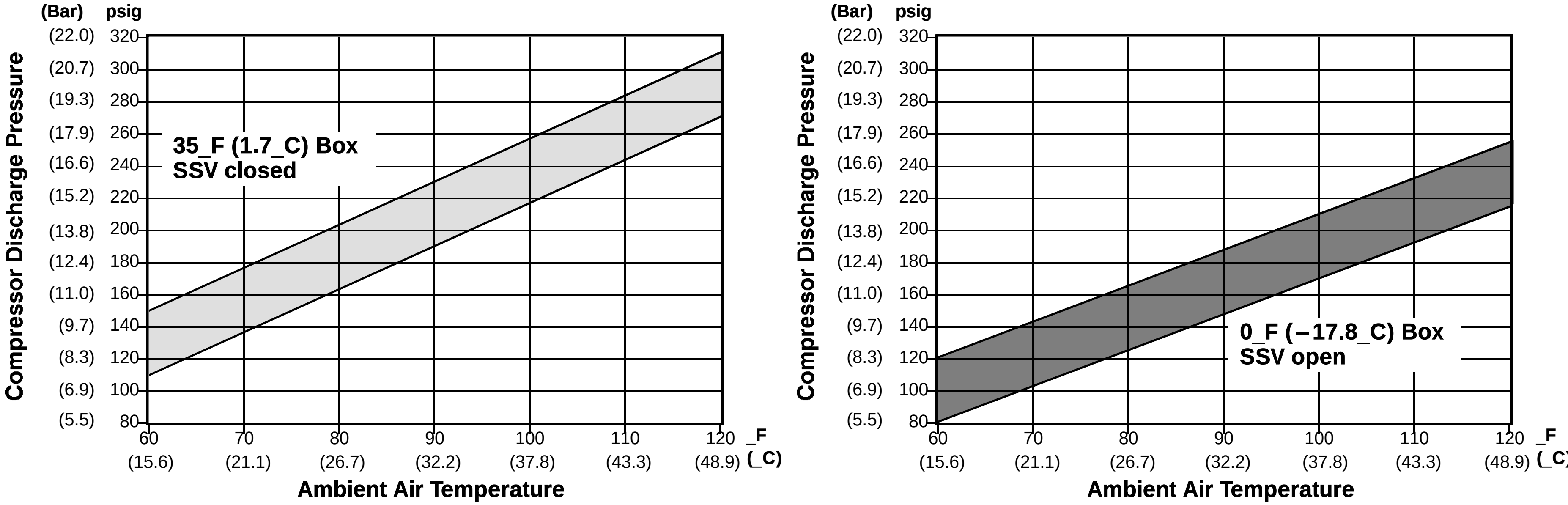
Table 4-7. Temperature-Pressure Chart – R-134a

BOLD FIGURES = Inches Mercury Vacuum (cm Hg Vac)

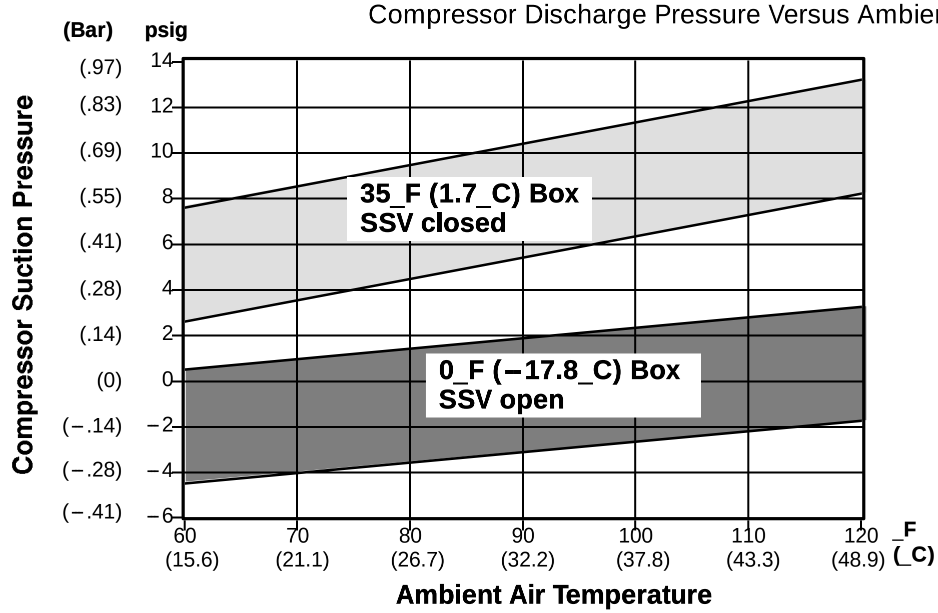
LIGHT FIGURES = psig (kg/cm@)

TEMPERATURE		PRESSURE			TEMPERATURE		PRESSURE		
˚F	˚C	Psig	Kg/cm²	Bar	˚F	˚C	Psig	Kg/cm²	Bar
–40	–40	**14.6**	**37.08**	**–.49**	30	–1	26.1	1.84	1.80
–35	–37	**12.3**	**31.25**	**–.42**	32	0	27.8	1.95	1.92
–30	–34	**9.7**	**24.64**	**–.33**	34	1	29.6	2.08	2.04
–25	–32	**6.7**	**17.00**	**–.23**	36	2	31.3	2.20	2.16
–20	–29	**3.5**	**8.89**	**–.12**	38	3	33.2	2.33	2.29
–18	–28	**2.1**	**5.33**	**–.07**	40	4	35.1	2.47	2.42
–16	–27	**0.6**	**1.52**	**–.02**	45	7	40.1	2.82	2.76
–14	–26	0.4	.03	.03	50	10	45.5	3.30	3.14
–12	–24	1.2	.08	.08	55	13	51.2	3.60	3.53
–10	–23	2.0	.14	.14	60	16	57.4	4.04	3.96
–8	–22	2.9	.20	.20	65	18	64.1	4.51	4.42
–6	–21	3.7	.26	.26	70	21	71.1	5.00	4.90
–4	–20	4.6	.32	.32	75	24	78.7	5.53	5.43
–2	–19	5.6	.39	.39	80	27	86.7	6.10	5.98
–0	–18	6.5	.46	.45	85	29	95.3	6.70	6.57
2	–17	7.6	.53	.52	90	32	104.3	7.33	7.19
4	–16	8.6	.60	.59	95	35	114.0	8.01	7.86
6	–14	9.7	.68	.67	100	38	124.2	8.73	8.56
8	–13	10.8	.76	.74	105	41	135.0	9.49	9.31
10	–12	12.0	.84	.83	110	43	146.4	10.29	10.09
12	–11	13.2	.93	.91	115	46	158.4	11.14	10.92
14	–10	14.5	1.02	1.00	120	49	171.2	12.04	11.80
16	–9	15.8	1.11	1.09	125	52	184.6	12.98	12.73
18	–8	17.1	1.20	1.18	130	54	198.7	13.97	13.70
20	–7	18.5	1.30	1.28	135	57	213.6	15.02	14.73
22	–6	19.9	1.40	1.37	140	60	229.2	16.11	15.80
24	–4	21.4	1.50	1.48	145	63	245.6	17.27	16.93
26	–3	22.9	1.61	1.58	150	66	262.9	18.48	18.13
28	–2	24.5	1.72	1.69	155	68	281.1	19.76	19.37

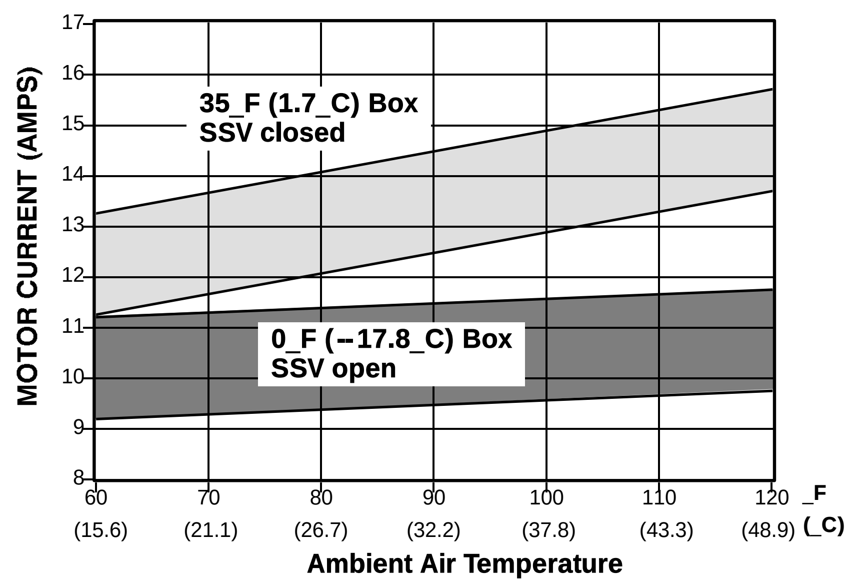
Note: Curves to be used as troubleshooting guide only for model series 69NT40-469 with fresh air makeup vent closed, unit powered on 460vac/60hz and SMV 100% open.



Compressor Discharge Pressure Versus Ambient Air Temperature at Stable Box Temperature



Compressor Suction Pressure Versus Ambient Air Temperature at Stable Box Temperature



Compressor–Motor Current Versus Ambient Air Temperature At Stable Box Temperature

Figure 4-26. R-134a Compressor Pressure and Motor Current Curves Versus Ambient Temperature

SECTION 5

ELECTRICAL WIRING SCHEMATIC AND DIAGRAMS

5.1 INTRODUCTION

This section contains Electrical Wiring Schematics and Diagrams covering the Models listed in Table 1-1. The following general safety notices supplement the specific warnings and cautions appearing elsewhere in this manual. They are recommeded precautions that must be understood and applied during operation and maintenance of the equipment covered herein.

WARNING

Beware of unannounced starting of the evaporator and condenser fans. Do not open condenser fan grille before turning power OFF and disconnecting power plug.

WARNING

Do not attempt to remove power plug(s) before turning OFF start-stop switch (ST), unit circuit breaker(s) and external power source.

Make sure the power plugs are clean and dry before connecting to any power receptacle.

WARNING

Do not use a nitrogen cylinder without a pressure regulator because cylinder pressure is approximately 165 kg/cm@ (2350 psi). Do not use oxygen in or near a refrigeration system as an explosion may occur.

WARNING

Make sure power to unit is OFF and power plug disconnected before removing capacitor(S).

WARNING

Do not open condenser fan grille before turning power OFF and disconnecting power plug.

WARNING

Always turn OFF the unit circuit breaker (CB1) and disconnect main power supply before working on moving parts.

WARNING

Never mix refrigerants with air for leak testing. It has been determined that pressurized, air-rich mixtures of refrigerants and air can undergo combustion when exposed to an ignition source.

CAUTION

Use only Carrier Transicold approved Polyol Ester Oil (POE) -- Castrol-Icematic SW20 compressor oil with R-134a. Buy in small quantities (one quart). When using this hygroscopic oil, immediately reseal. Do not leave container of oil open or contamination will occur.

CAUTION

To prevent trapping liquid refrigerant in the service valve after charging, while the compressor is ON and before disconnecting the manifold gauge set, perform the following steps:

a. Backseat applicable discharge or manual liquid line valve.
b. Midseat manifold gauge set hand valves.
c. Allow the gauge set to pull down to suction pressure.

CAUTION

Make sure that the unit circuit breaker(s) (CB) and the start-stop switch are in the OFF position before connecting to any electrical power source.

LEGEND

ZONE	SYMBOL		DESCRIPTION
K3,M10	C	—	COMPRESSOR CONTACTOR
E2,3	CB1	—	CIRCUIT BREAKER 460V
E4	CB2	—	CIRCUIT BREAKER 230V
K5,M8	CF	—	CONDENSER FAN CONTACTOR
L10	CL	—	COOL LIGHT (WHITE)
M1	CLT	—	CURRENT LIMITING TRANSFORMER
H10,P5	CM	—	CONDENSER FAN MOTOR
J10,P2-4	CP	—	COMPRESSOR MOTOR
K16	CSS	—	TEMPERATURE SET STATION
F-I18	DD	—	DIGITAL DISPLAY
M5	DHBL	—	DEFROST HEATER - BOTTOM LEFT
L5	DHBR	—	DEFROST HEATER - BOTTOM RIGHT
M5	DHTL	—	DEFROST HEATER - TOP LEFT
L5	DHTR	—	DEFROST HEATER - TOP RIGHT
L16,17	DIS	—	DEFROST INTERVAL SELECTOR
J13	DL	—	DEFROST LIGHT (AMBER)
K5	DPH	—	DRAIN PAN HEATER
F12,H15	DR	—	DEFROST RELAY
I15	DTT	—	DEFROST TERMINATION THERMOSTAT
M6-7,M12	EF	—	EVAPORATOR FAN CONTACTOR
E-F9,P7,8	EM	—	EVAPORATOR FAN MOTOR
G7,D15	F	—	FUSE
	FLA	—	FULL LOAD AMPS
M11	HL	—	HEAT LIGHT (AMBER)
K10	HPS	—	HIGH PRESSURE SWITCH
K4,M11	HR	—	HEATER CONTACTOR
I11	HTT	—	HEAT TERMINATION THERMOSTAT
F-G9,H-J10	IP	—	INTERNAL PROTECTOR
M13	IRL	—	IN-RANGE LIGHT (GREEN)
F13,G15	IRS	—	CONTROLLER RELAY (IN-RANGE)
H14	MDS	—	MANUAL DEFROST SWITCH
J-M13,L-M10	RM	—	REMOTE MONITORING RECEPTACLE
N16,17	RTS	—	RETURN TEMPERATURE SENSOR
J18	SDS	—	SET TEMP. DISPLAY SWITCH
G14	SMV	—	SUCTION MODULATION VALVE
H,I16,17	SSS	—	SCALE SELECTOR SWITCH
L9	SST	—	SUCTION SOLENOID THERMOSTAT
M9	SSV	—	SUCTION SOLENOID VALVE
G8	ST	—	START-STOP SWITCH
M16,17	STS	—	SUPPLY TEMPERATURE SENSOR
	T	—	CONTROLLER TERMINAL
I-L10	TB	—	TERMINAL BLOCK CONNECTION
F10,11,K15	TC	—	CONTROLLER RELAY (COOLING)
P17	TDS	—	TIME DELAY OVERRIDE SWITCH
H11,I15	TH	—	CONTROLLER RELAY (HEATING)
H-J4-6	TR	—	TRANSFORMER
	TU	—	CONTROLLER RELAY (UTILITY - NOT USED)
C-E16,17	TSS	—	TEMPERATURE SIMULATOR SWITCH
	VS	—	VOLTAGE SWITCH
L8	WP	—	WATER PRESSURE SWITCH (OPTIONAL)

Figure 5-1. Electrical Wiring Schematic — Model 69NT40-469-7
(Sheet 1 of 2)

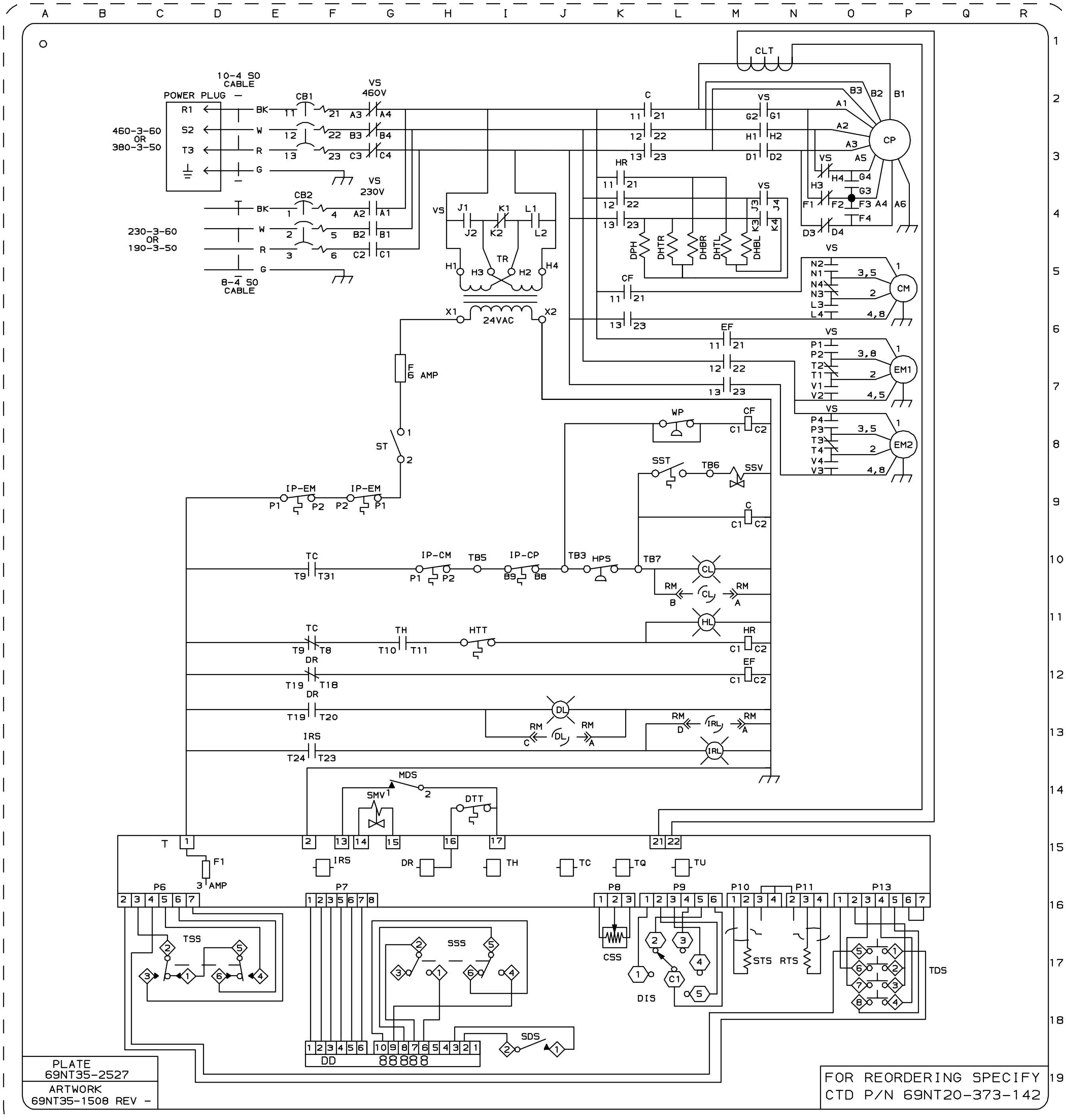


Figure 5-1. Electrical Wiring Schematic – Model 69NT40-469-7
(Sheet 2 of 2)

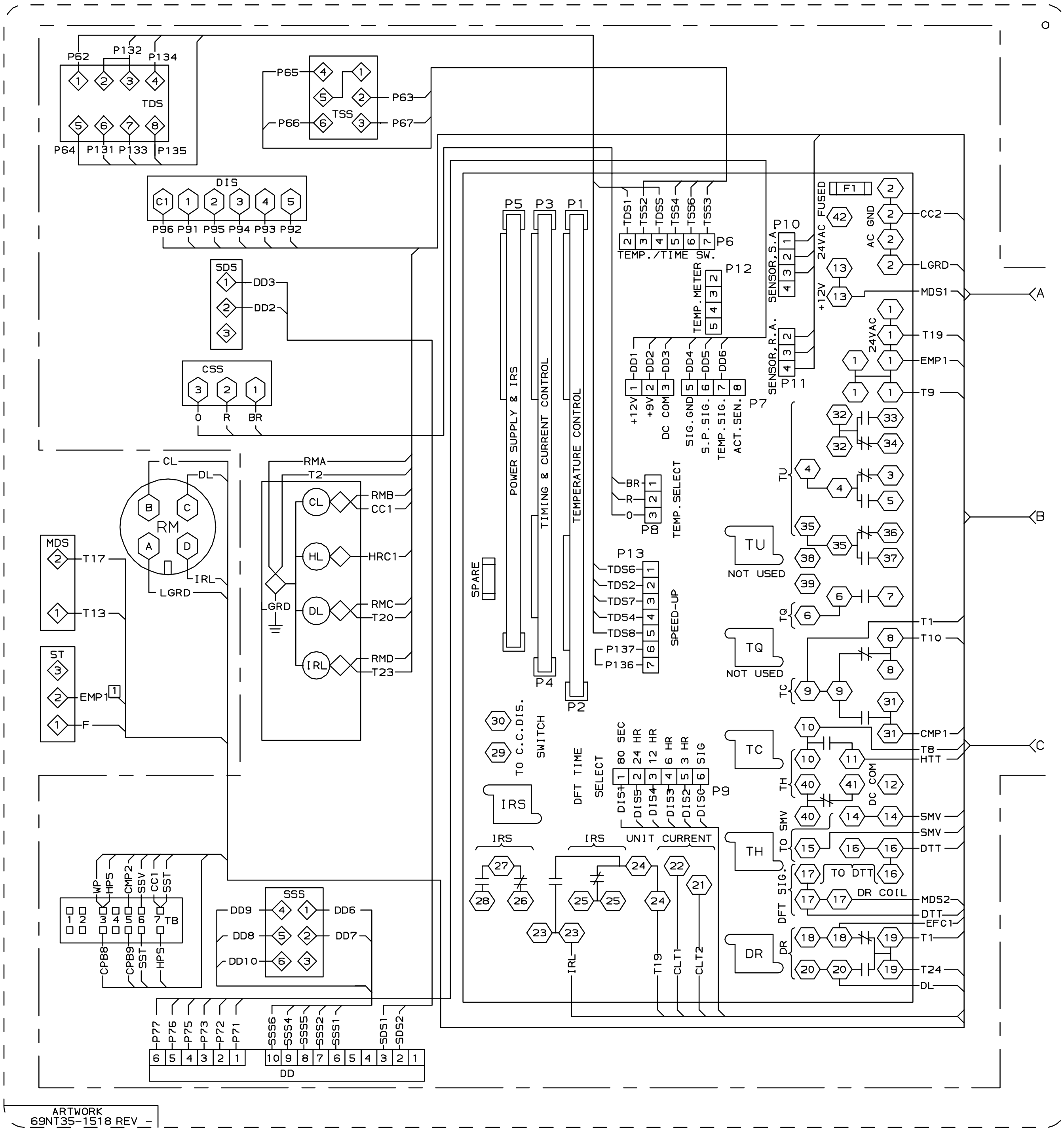


Figure 5-2. Electrical Wiring Diagram – Model 69NT40-469-7
(Sheet 1 of 2)

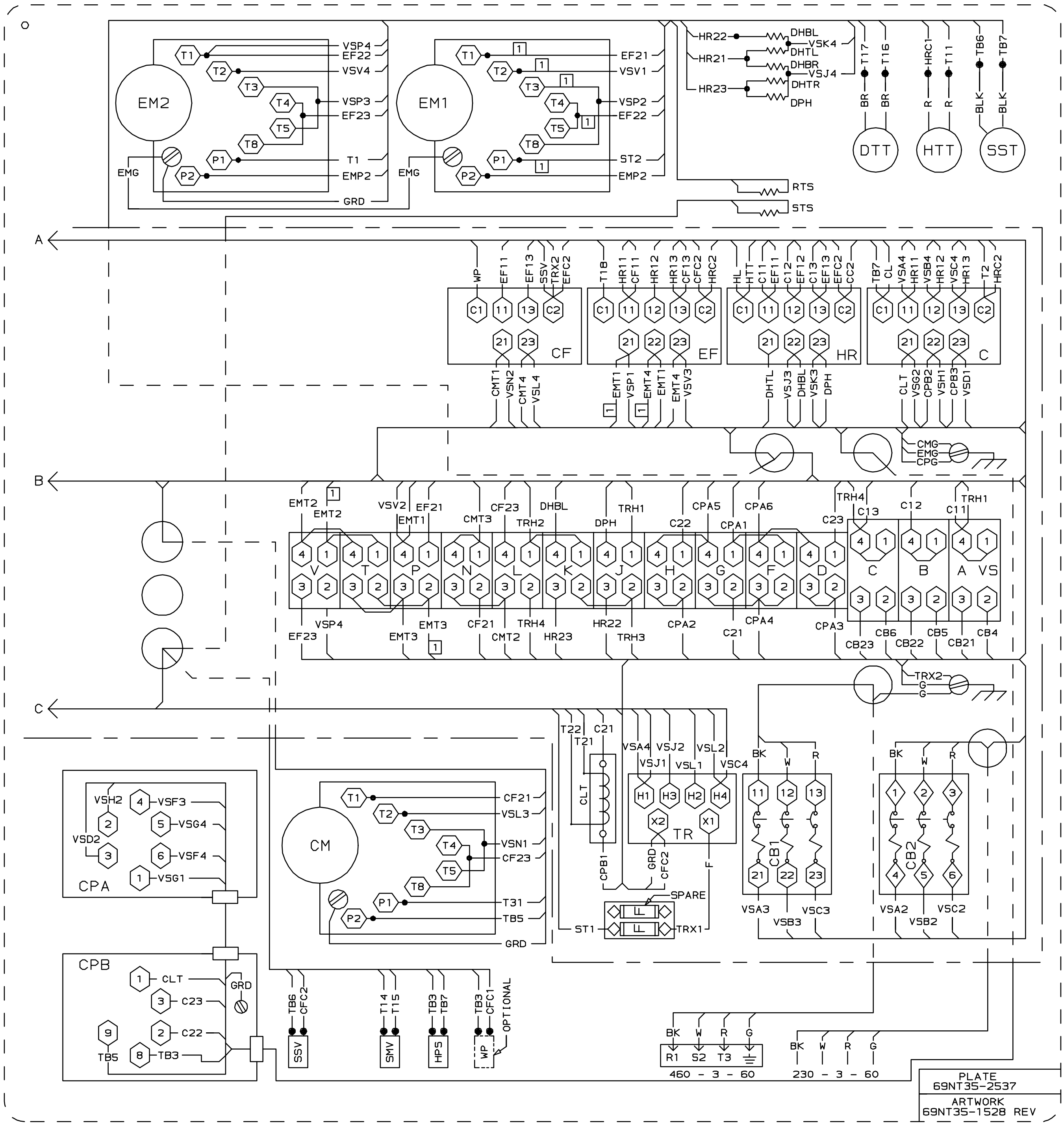


Figure 5-2. Electrical Wiring Diagram – Model 69NT40-469-7
(Sheet 2 of 2)