



**TRANSICOLD**

# **Container Refrigeration Unit**

**Model**

**69NT40-449**

**69NT40-459**

**OPERATION  
AND SERVICE**

T-257-03

\$6.00



**TRANSICOLD**

# OPERATION AND SERVICE MANUAL

**CONTAINER REFRIGERATION UNIT**

**MODEL**  
**69NT40-449**  
**69NT40-459**



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# SECTION 1

## DESCRIPTION

### 1.1 INTRODUCTION

#### 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.**

This manual contains Operating Data, Electrical Data and Service Instructions for the refrigeration units listed in Table 1-1. Also Table 1-1 charts some 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 R-134a, compressor lubricating oil (approved POE SW20 compressor oil for R-134a only), mode indicating lights, temperature controller and is ready for operation upon installation.

Some units are dual voltage units designed to operate on 190/230 or 380/460 volts ac, 3 phase, 50-60 hertz power. (Refer to section 1.5.) Other units are designed to operate on 380/460 volts ac, 3 phase 50/60 hertz power only.

Operating control power is provided by a single phase transformer which steps down the ac supply power source to 24 volts ac, 1 phase control power.

The temperature controller is a microprocessor solid state controller. Refer to section 1.11. Once the temperature controller is set at a 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.

#### WARNING

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

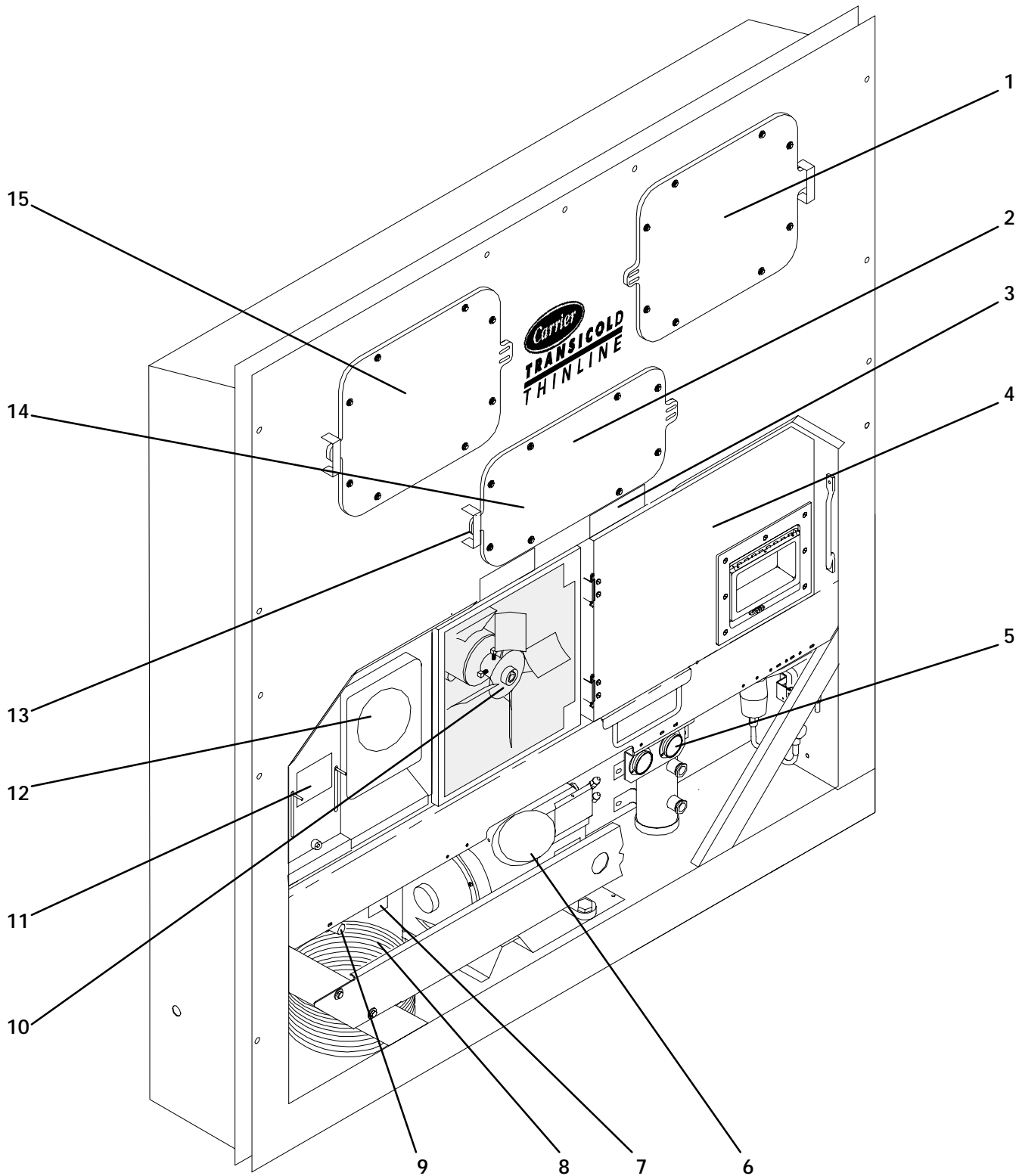
Some units are equipped with a Carrier Transicold DataCORDER (Microprocessor based recorder). Detailed information on the DataCORDER will be found in section 1.11.7. Some units are equipped with a Partlow mechanical temperature recorder.

Some units may have a TransFRESH controlled atmosphere system added. Contact TransFRESH Corporation, P.O. Box 1788, Salinas, CA 93902 for information on their system.

**Table 1-1. Model Chart**

MODELS	UNIT WEIGHT		REFRIGERANT 134A		Two Speed Evaporator Fan Motors	Water-Cooled Condenser	Receiver	Power (Auto) Transformer	Dual Voltage Compressor	Humidistat	USDA Cold Treatment	Partlow Temperature Recorder
	LB	KG	LB	KG								
69NT40-449-7	1390	630	11.5	5.2	X	-	X	X	-	B	-	X
69NT40-449-15	1285	583	11.5	5.2	-	-	X	-	X	B	C	X
69NT40-449-17	1265	574	11.5	5.2	-	-	X	-	X	B	-	X
69NT40-449-18	1230	558	11.5	5.2	X	-	X	-	-	X	X	X
69NT40-449-21	1265	562	11.5	5.2	-	-	X	-	X	B	C	X
69NT40-449-22	1265	562	11.5	5.2	-	-	X	-	X	B	C	X
69NT40-449-23	1265	574	11.5	5.2	-	-	X	-	X	B	C	X
69NT40-449-27	1235	560	11.5	5.2	X	-	X	-	-	X	X	X
69NT40-449-28	1385	628	11.5	5.2	X	-	X	X	-	B	C	X
69NT40-449-29	1275	578	11.5	5.2	X	X	-	-	-	X	X	-
69NT40-459-4	1245	565	11.5	5.2	X	X	-	-	-	B	-	-

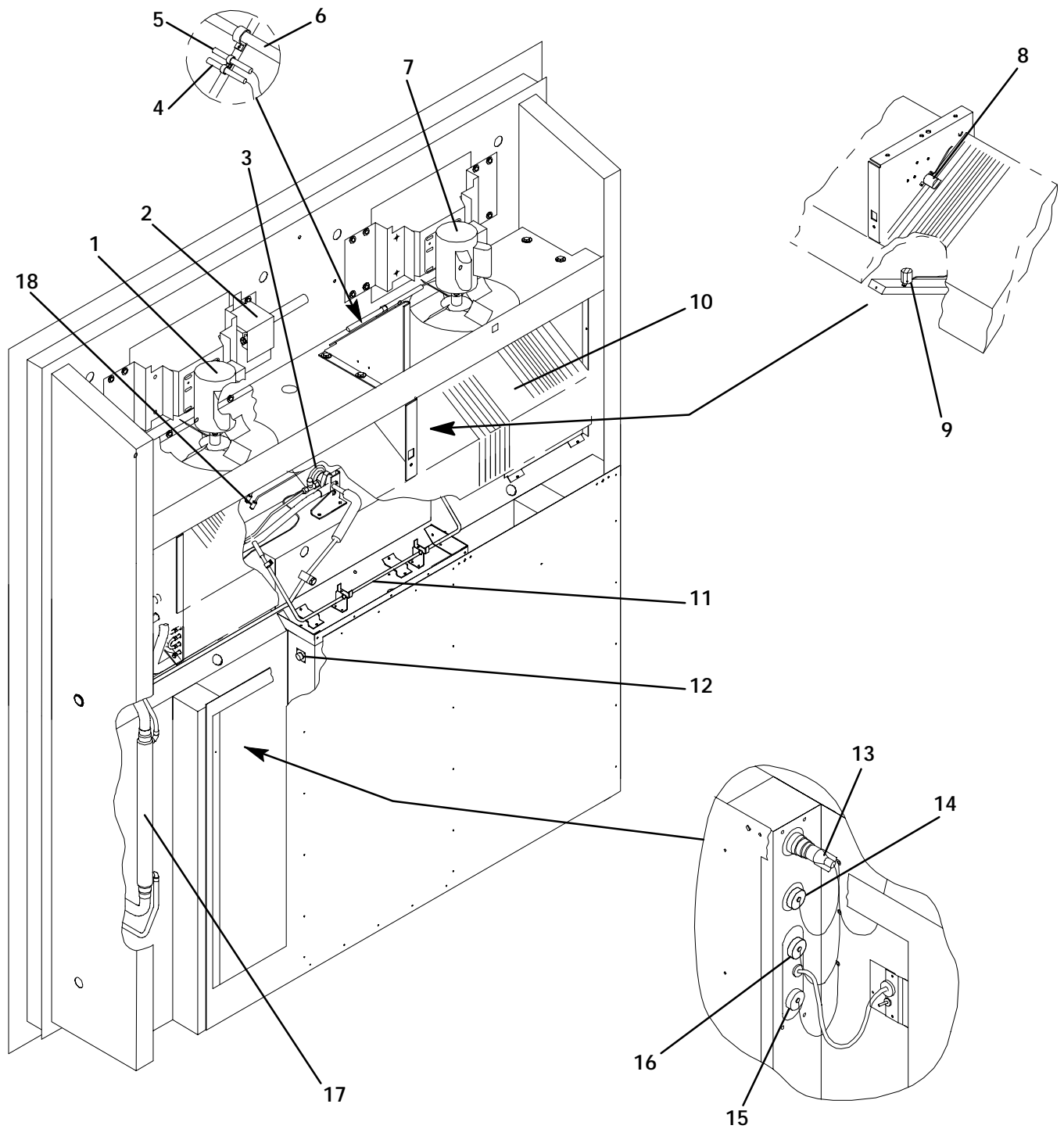
- A – Provision for water-cooled condenser. If the water-cooled condenser is added, the refrigerant charge will change.
- B – The microprocessor (Rev 601) includes code 32 for dehumidification, even though the units do not have a humidistat.
- C – Provision for USDA Cold Treatment.
- X – Features that apply to model.



- |   |                                       |
|---|---------------------------------------|
| 1. Access Panel (Evap. Fan Motor #1)                          | 8. Power Cables and Plug              |
| 2. Expansion Valve – Access Location<br>(Also see Figure 1-2) | 9. Interrogator Connector             |
| 3. Fork Lift Pockets  | 10. Condenser Fan Motor (CM)          |
| 4. Control Box  | 11. Make-Up Air Cover                 |
| 5. Pressure Gauges (Optional)                                 | 12. Recording Thermometer (Optional)  |
| 6. Compressor Motor (CP)                                      | 13. TIR Locking Devices               |
| 7. Serial/Model Number Plate                                  | 14. Access Panel (Heater Location)    |
|   | 15. Access Panel (Evap. Fan Motor #2) |

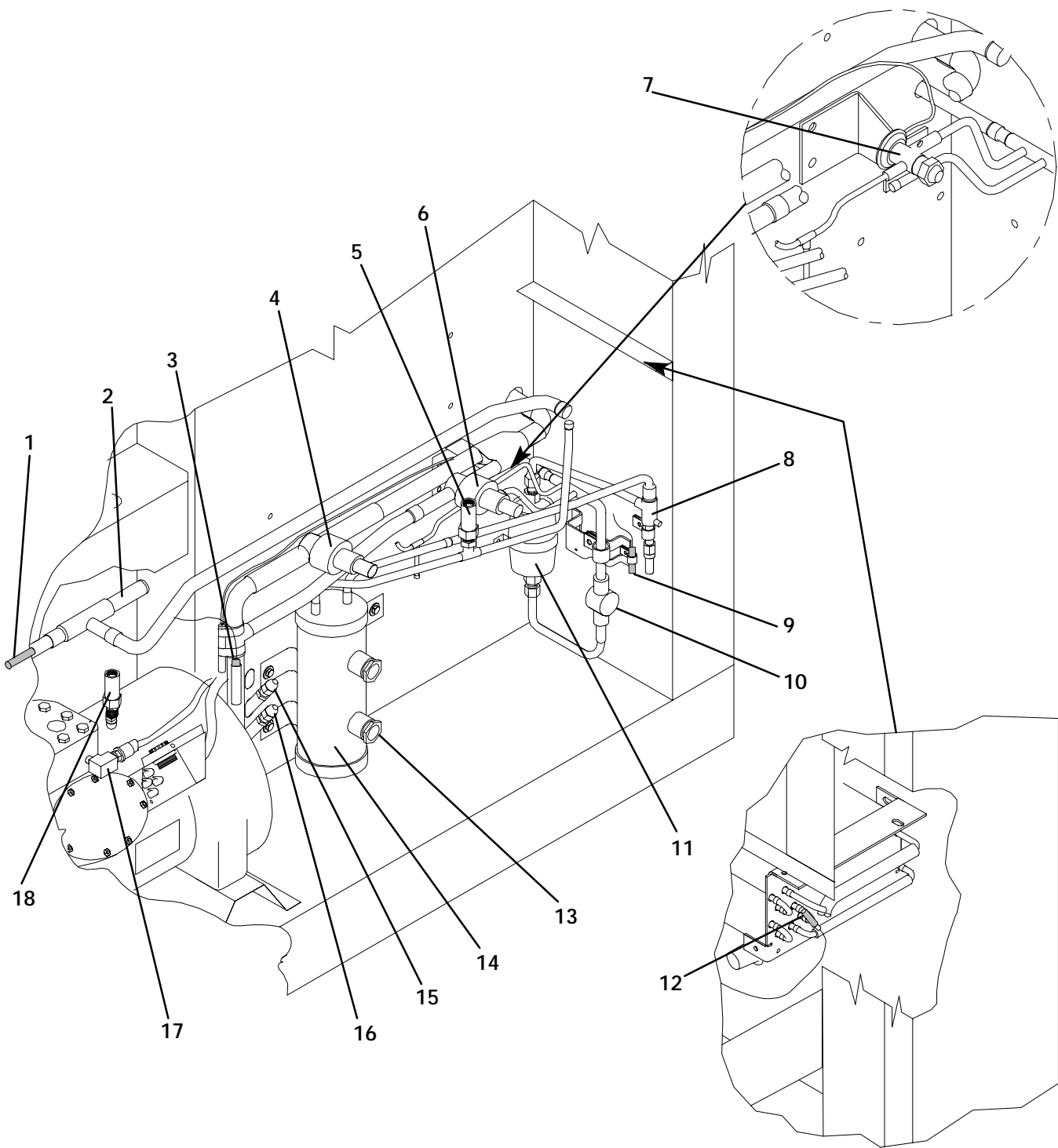
**Figure 1-1. Refrigeration Unit – Front**





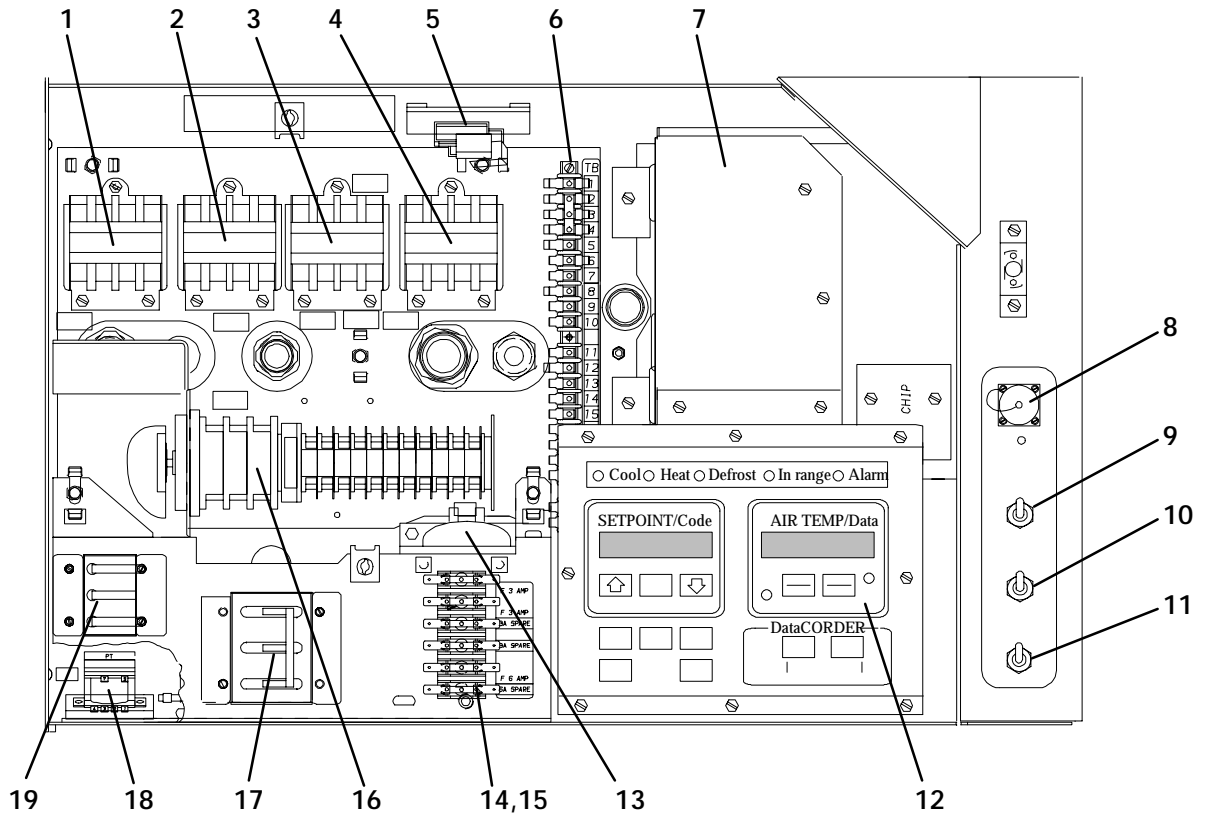
- |  |                                 |
|--|---------------------------------|
| 1. Evaporator Fan Motor #1 (EM1)               | 10. Evaporator Coil             |
| 2. Humidity Control Switch (HCS) (Optional)    | 11. Drain Pan Heater (DPH)      |
| 3. Thermostatic Expansion Valve                | 12. Dummy Receptacle            |
| 4. Return Recorder Sensor (RRS)                | 13. USDA Probe Receptacle (PR3) |
| 5. Return Air Temperature Sensor (RTS)         | 14. USDA Probe Receptacle (PR1) |
| 6. Chart Recording Thermometer Bulb (Optional) | 15. Interrogator Receptacle     |
| 7. Evaporator Fan Motor #2 (EM2)               | 16. USDA Probe Receptacle (PR2) |
| 8. Defrost Termination Thermostat (DTT)        | 17. Heat Exchanger              |
| 9. Heater Termination Thermostat (HTT)         | 18. Evaporator Coil Heaters     |

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

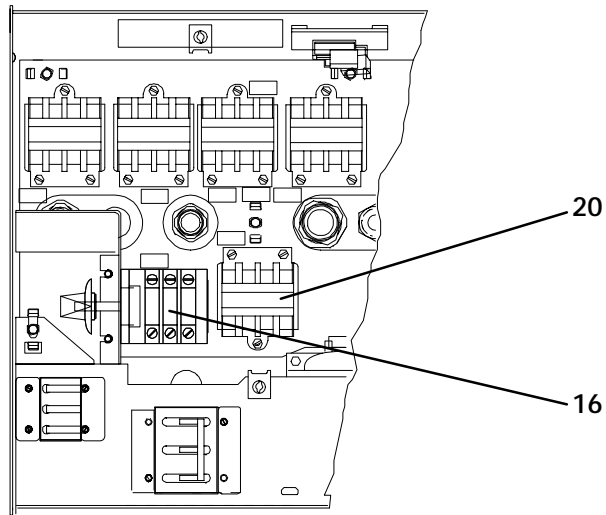


- |   |  |
|---|--|
| 1. Compressor Discharge Sensor (CPDS If Used) | 10. Moisture-Liquid Indicator                  |
| 2. Discharge Pressure Regulator Valve         | 11. Filter-Drier                               |
| 3. Compressor Suction Sensor (CPSS)           | 12. Condenser Saturation Sensor (CSAS If Used) |
| 4. Suction Modulation Valve (SMV)             | 13. Receiver Sight Glass                       |
| 5. Pressure Relief Valve – High Side          | 14. Receiver or Water-Cooled Condenser         |
| 6. Suction Solenoid Valve (SSV)               | 15. Supply Air Temperature Sensor (STS)        |
| 7. Quench Expansion Valve                     | 16. Supply Recorder Sensor (SRS) (Optional)    |
| 8. Manual Liquid Line Valve                   | 17. High Pressure Switch (HPS)                 |
| 9. Ambient Sensor (AMBS)                      | 18. Pressure Relief Valve – Low Side           |

**Figure 1-3. Receiver and Tubing Section**



**UNITS WITH ONE-SPEED EVAPORATOR MOTOR**



**UNITS WITH TWO-SPEED EVAPORATOR MOTOR**

- |   |   |
|---|---|
| 1. Compressor Contactor (C)                     | 11. Start-Stop Switch (ST)                    |
| 2. Condenser Fan Contactor (CF)                 | 12. Microprocessor Control Panel (Display)    |
| 3. Heater Contactor (HR)                        | 13. Control Transformer (TR)                  |
| 4. Evaporator Fan Contactor – High Speed (EF)   | 14. Control Fuse (F) (6 amp)                  |
| 5. Current Transformer (CT)                     | 15. Fuse (F3A & F3B) (5 amp) Slow Blow        |
| 6. Terminal Block (TB)                          | 16. Voltage Switch (VS) (Optional)            |
| 7. Microprocessor Control Box                   | 17. Circuit Breaker (CB-1) – 460V             |
| 8. Remote Monitoring Receptacle (RM) (Optional) | 18. Potential Transformer (PT)                |
| 9. Battery Module Switch (BMS) (Optional)       | 19. Circuit Breaker (CB-2) – 230V (Optional)  |
| 10. Manual Defrost Switch (MDS)                 | 20. Evaporator Fan Contactor – Low Speed (ES) |

**Figure 1-4. Control Box**

## 1.2 GENERAL DESCRIPTION

### a. Compressor Section

#### NOTE

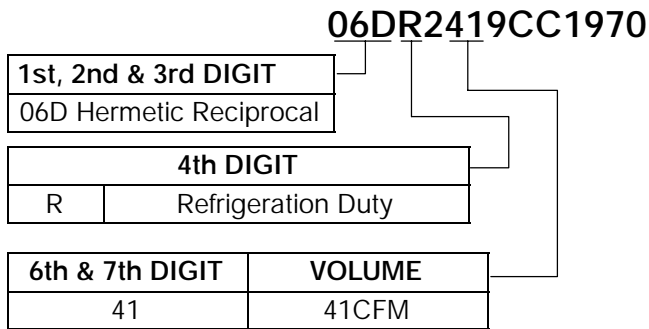
Check the compressor Serial/Model Number plate for CFM displacement, refer to Table 1-2.

The compressor section includes the compressor (with high pressure switch), power cable storage compartment, and an optional power (auto) transformer which is 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, discharge pressure regulator valve, compressor suction sensor (CPSS) and compressor discharge sensor (CPDS).

The supply air temperature sensor (STS), supply recorder sensor (SRS) and ambient sensor (AMBS) are located to the right of the compressor.

**Table 1-2. Compressor Model Number Significance Chart**



### b. Condenser Section

The condensing section consists of a condenser fan motor, condenser fan, condenser saturation sensor (CSAS), and an air-cooled condenser coil. When the unit is operating, air is pulled in the bottom of the coil and discharges horizontally out through the front of the condenser fan grille.

### c. Evaporator Section

The evaporator section contains the optional mechanical temperature recorder bulb, return recorder sensor (RRS), return temperature sensors (RTS), thermostatic expansion valve, evaporator fan motors and fans (2), evaporator coil and heaters, drain pan and heaters, defrost and heat termination switches, and a heat exchanger. See Figure 1-2 and Figure 1-3 for sensor location.

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.

Some units are equipped with two-speed evaporator fan motors. Refer to Table 1-1. When transporting perishable commodities, the fan motors will be in high speed (above  $-10_C = +14_F$ ).

The evaporator coil heaters are accessible by removing the front, lower access panel. The defrost

termination switch (DTT) is located on the coil center tube-sheet and may be serviced by removing the upper rear, panel or by removing the left front, upper access panel and reaching through the evaporator fan venturi AFTER POWER IS TURNED OFF AND POWER PLUG DISCONNECTED.

### d. Control Box

The control box and door include the manual switches, circuit breaker(s), contactors, transformers (potential and control) and fuses. (See Figure 1-4)

## 1.3 REFRIGERATION SYSTEM DATA

### a. Compressor – Motor Assembly

*No. of Cylinders:* 6

*Model:* 06DR

*Weight (Dry):* 260 lb (118 kg)

### b. Approved Compressor Oil

Castrol Icematic – SW20

### c. Compressor Oil Charge

3.6 liters (7.6 U.S. Pints)

### d. Compressor Oil Sight Glass

The oil level range should be between the bottom to 1/4 of the sight glass, with the compressor off.

### e. Defrost Timer

*Initiates Defrost:* Refer to section 1.11.4 (Code 25)

### f. Defrost Termination Thermostat

*Opens:* 23.9 (  $\pm$  3 )\_C = 75 (  $\pm$  5 )\_F

*Closes:* 15.6 (  $\pm$  3 )\_C = 60 (  $\pm$  5 )\_F

### g. Expansion Valve Superheat

*Verify at  $-18_C$  (0\_F) container box temperature:*

3.3 to 4.4\_C (6 to 8\_F)

### h. Heater Termination Thermostat

*Opens:* 54 (  $\pm$  3 )\_C = 130 (  $\pm$  5 )\_F

*Closes:* 38 (  $\pm$  3 )\_C = 100 (  $\pm$  5 )\_F

### i. High Pressure Switch

*Cutout:* 25 (  $\pm$  0.7 ) kg/cm<sup>2</sup> = 350 (  $\pm$  10 ) psig

*Cut-In:* 18 (  $\pm$  0.7 ) kg/cm<sup>2</sup> = 250 (  $\pm$  10 ) psig

### j. Refrigeration Charge

Refer to Table 1-1.

### k. Pressure Relief Valves

*Low Side:*

Opens: 18.63 kg/cm<sup>2</sup> (265 psig)

*High Side:*

Opens: 35 kg/cm<sup>2</sup> (500 psig)

### l. Unit Weight

Refer to Table 1-1.

### m. Water Pressure Switch (Optional)

*Cut-In:* 0.5  $\pm$  0.2 kg/cm<sup>2</sup> ( 7  $\pm$  3 psig)

*Cutout:* 1.6  $\pm$  0.4 kg/cm<sup>2</sup> ( 22  $\pm$  5 psig)

## 1.4 ELECTRICAL DATA

### a. Circuit Breaker

*CB-1 Trips at:* 29 Amps

*CB-2 (250vac, 40 amp) Trips at:* 50 Amps

*CB-2 (250vac, 50 amp) Trips at:* 62.5 Amps

### b. Compressor Motor

*Full Load Amps (FLA):* 17.6 Amps @ 460 vac  
(with current limiting set at 21 amps)  
(Model 69NT40)

### c. Condenser Fan Motor

*Bearing Lubrication:* Factory lubricated, additional grease not required.

*Full Load Amps:* 2.6/1.3 @ 190/380 vac/50 hz  
3.2/1.6 @ 230/460 vac/60 hz

*Horsepower:* 0.43/50 hz (0.75/60 hz)

*Rotation:* CCW when viewed from shaft end.

*Speed:* 1425/50 hz (1725/60 hz) RPM

*Voltage and Frequency:*

180 – 230/360 – 460 vac @ 50 hz | 1.25 hz

200 – 250/400 – 500 vac @ 60 hz | 1.5 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 + 5/– 10% each at 230 volts

*Resistance (cold):* 66.8 to 77.2 ohms

*Ambient:* @ 20\_C (68\_F)

*Type:* Sheath

### f. Evaporator Fan Motor(s)

*Bearing Lubrication:* Factory lubricated, additional grease not required

*Full Load Amps*

High Speed: 1.6 @ 380 vac/50 hz  
(2.1 @ 460 vac/60 hz)

Low Speed: 0.6 @ 380 vac/50 hz  
(0.6 @ 460 vac/60 hz)

Single Speed Motor: 3.2/1.6 @ 190/380 vac/50 hz  
(0.58/1.0 @ 230/460 vac/60 hz)

*Nominal Horsepower*

High Speed: 0.58 @ 380 vac/50 hz  
(1.0 @ 460 vac/60 hz)

Low Speed: 0.07 @ 380 vac/50 hz  
(0.12 @ 460 vac/60 hz)

Single Speed Motor: 0.58 @ 50 hz  
(1.0 @ 60 hz)

*Rotation*

Evap. Fan Motor #1 (See Figure 1-2):

CW when viewed from shaft end

CCW when viewed from end opposite shaft end

Evap. Fan Motor #2 (See Figure 1-2):

CCW when viewed from shaft end

CW when viewed from end opposite shaft end

*Speed*

High Speed: 2850 rpm @ 50 hz  
(3450 rpm @ 60 hz)

Low Speed: 1425 rpm @ 50 hz  
(1750 rpm @ 60 hz)

Single Speed Motor: 2850 rpm @ 50 hz  
(3450 rpm @ 60 hz)

*Voltage and Frequency:*

180 – 230/360 – 460 vac @ 50 hz | 1.25 hz

200 – 250/400 – 500 vac @ 60 hz | 1.5 hz

### g. Fuses

*Control Circuit:* 6 Amps (F)

*Microprocessor:* 5 Amps (Slow Blow) (F3A)

*Battery Charger:* 5 Amps (Slow Blow) (F3B)

## 1.5 VOLTAGE SWITCH AND POWER (AUTO) 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 (Auto) 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 “0” (OFF). (See Figure 1-4.)

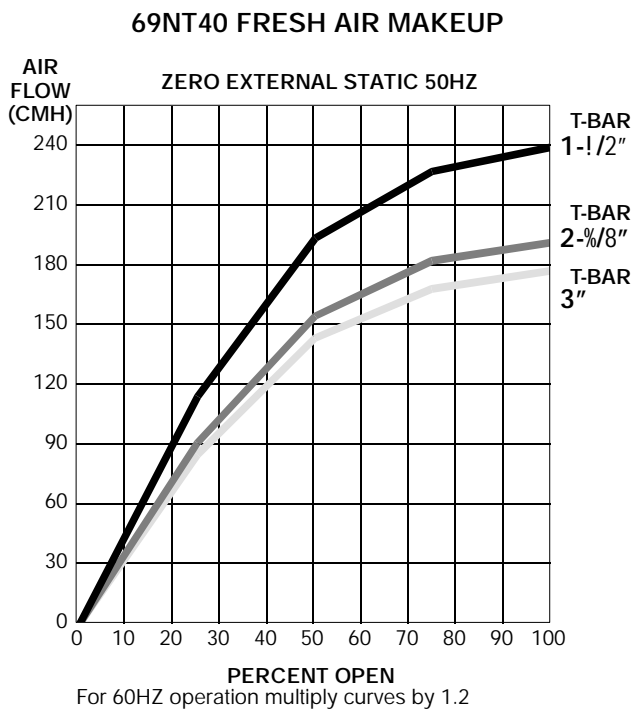
2. Connect 190/230 vac power cable plug (black cable). Place voltage switch (VS) in the 230 v position. Place circuit breaker (CB-2) in position “1”. Close and secure control box door and then place the start-stop switch (ST) in position “1”.

### 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 “0”. (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”.

## 1.6 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.

Air exchange depends on static pressure differential which will vary depending on the container and how the container is loaded. The chart above gives air exchange values for an empty container. Higher values can be expected for a fully loaded container.

### 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.

### b. Air Sampling for Carbon Dioxide (CO<sub>2</sub>) 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 a 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.

### c. Reduced Flow for Fresh Air Makeup (Optional)

On some models the air slide is supplied with two adjustable air control disks. The fresh air makeup can be adjusted for (15, 35, 50 or 75) cubic meters per hour (CMH). The air flow has been established at 60HZ power and 2 1/2 inch T bar and with 15mm (.6 inch) H<sub>2</sub>O external static above free blow.

Loosen the hex nut and adjust each disk to the required air flow and tighten hex nut. Both disks must be set to the same open position.

#### NOTE

The main air slide is in the fully closed position during reduced air flow operation.

**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. Circuit Breaker (CB-2) – Manual Reset	1. Trips at 29 amps (460 vac) 1. Refer to paragraph 1.4.a
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 <sup>@</sup> (265 psig)
7. Abnormal pressures in the high refrigerant side	7. Pressure Relief Valve – High Side	7. Opens at 35 kg/cm <sup>@</sup> (500 psig)
8. Abnormally high discharge pressure	8. High Pressure Switch (HPS)	8. Opens at 25 kg/cm <sup>@</sup> (350 psig)
9. Excessive current draw by the microprocessor	9. Fuse (F3A)	9. Opens at 5 amps
10. Excessive power (auto) 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)

## 1.7 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 and condenser fan motor.

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).

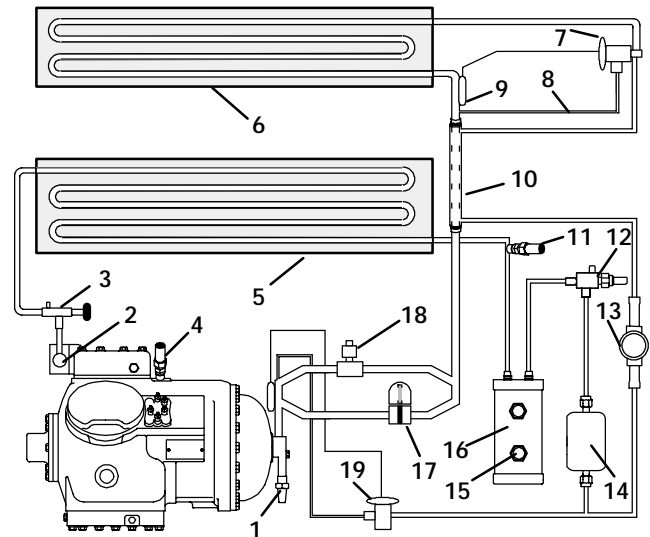
## 1.8 REFRIGERATION CIRCUIT

Starting at the compressor, 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 discharge 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<sup>2</sup> (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 manual liquid line 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 thermostatic expansion 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
17. Suction Solenoid Valve
18. Suction Modulation Valve
19. Quench Expansion Valve

**Figure 1-5. Refrigeration Circuit**

## 1.9 REMOTE MONITORING (OPTIONAL)

### NOTE

Models with an in-range light, the light will be illuminated if the container return air temperature is within the tolerance selected. Refer to section 1.11.4 (Code 29).

### 1.9.1 Remote Monitoring Receptacle (Optional)

When the remote monitor is connected to the remote monitoring receptacle, 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

**1.10 SUCTION SOLENOID VALVE**

The suction solenoid valve, shown in Figure 1-3 is controlled by the controller relay (TS).

**a. Operation**

If set point is below -10\_C (+ 14\_F), and the suction solenoid valve override is not activated, controller relay (TS) closes to energize the suction solenoid valve (SSV). Once opened, the refrigerant flow rate and unit cooling capacity is increased.

If set point is above -10\_C (+ 14\_F), and the suction solenoid valve (SSV) is not activated, suction solenoid valve opens during temperature pulldown period unless current limiting restricts its use.

**b. Suction Solenoid Override**

This function restricts the opening of the suction solenoid valve (SSV) under certain ambient and box temperature conditions. If the primary return sensor (RTS) fails (AL56), the suction solenoid valve will not open unless the ambient temperature is less than 10\_C (50\_F). If the ambient sensor fails (AL58), the suction solenoid valve will not be allowed to open until the return air temperature is less than 1.67\_C (35\_F). If both the

ambient and return air (RTS) sensors fail, the suction solenoid valve will not be allowed to open until at least one of the sensors is repaired.

**1.11 COMPUTER CONTROL – ELECTRONICS CENTER**

**1.11.1 Brief Description**

**NOTE**

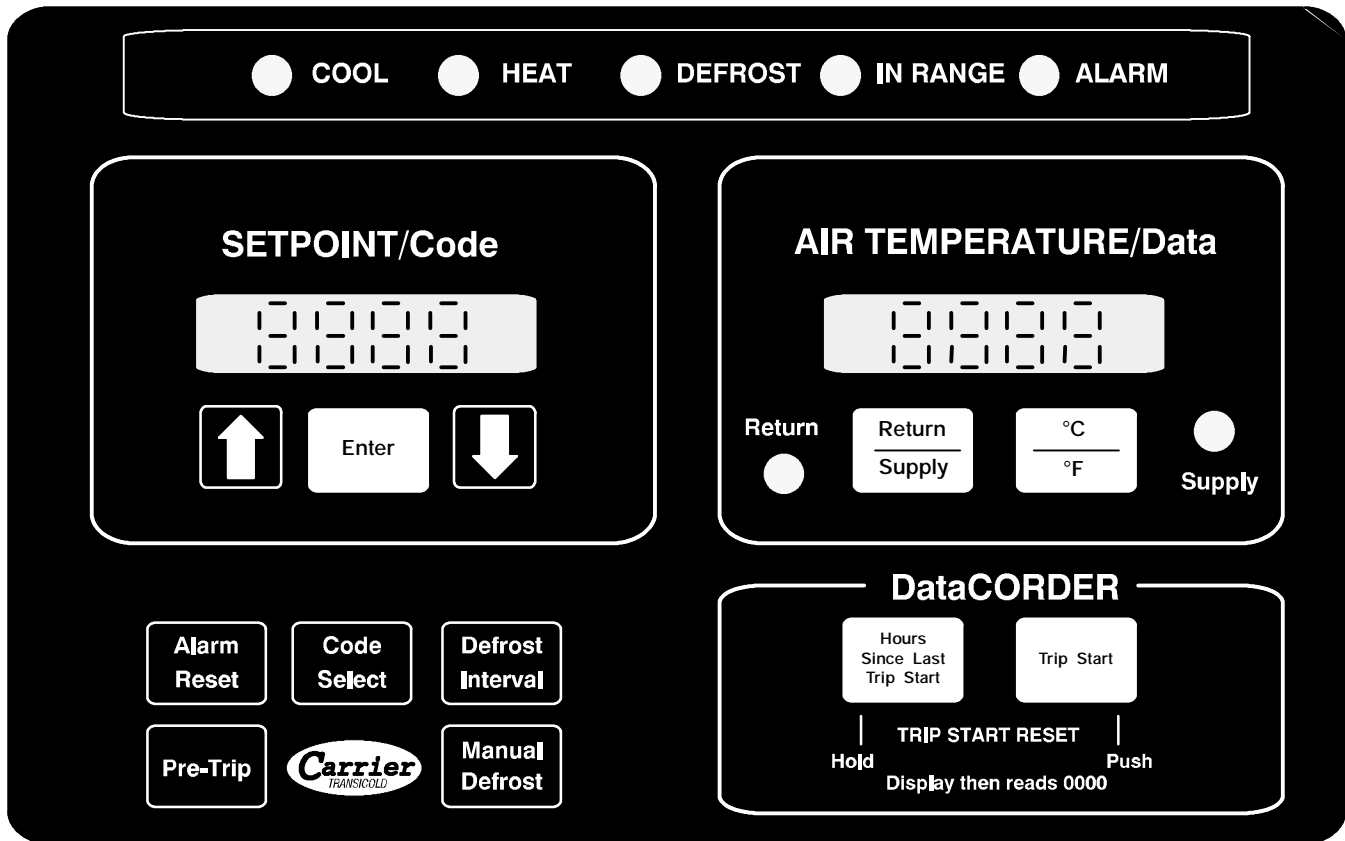
For manual override operation of the microprocessor, refer to Table 4-7.

**CAUTION**

**When doing any arc welding on the unit or container, disconnect all connectors from controller and remove ground lead going to I/O board to prevent any damage due to electrostatic discharge.**

The Carrier Transicold Computer Control – Electronics Center (CC-EC) is a custom-designed computer which incorporates electronic intelligence to:

- a. Control temperature of supply or return air to extremely tight limits by providing modulation refrigeration control and electric heat control and defrost to ensure continuous conditioned air delivery to the load.



**Figure 1-6. Microprocessor Control Panel**



b. Provide dual independent readouts of set point and supply or return air temperatures and, in addition, the following data:

- Ambient Air Temperature
- DataCORDER Probe Temperatures (Optional)
- Refrigeration Valve Positions (open, close or % open)
- Power Supply Voltage, Frequency and Line Currents
- Refrigerant Suction, Discharge, Condenser Temperatures
- Refrigerant Discharge Pressure
- Compressor Running Hours
- Time Remaining Until Defrost

c. Provide digital readout and ability to select the following data:

- Defrost Interval
- \_C or \_F
- In-Range Tolerance
- Time Delay Start Interval – Start of Unit
- Current Limiting

d. Signal malfunction alarm light and/or digital display identification of the following:

- Internal or Fuse Protection of Control Circuit, Transformer, Compressor, Evaporator and Condenser Motor
- High Pressure Cut-Out
- Individual Sensor Failure
- High Temperature Thermostat
- Failure of Heaters, Defrost Termination Thermostat, and Compressor
- Self-Diagnostic Conditions of Computer Functions

e. Provide a detailed automatic pre-trip step-by-step checkout of refrigeration unit performance, proper component operation, proper electronic and refrigeration control operation, proper heater operation, checking probe calibration and current limiting.

f. Provide storage of detailed temperature information on set point and return and supply air, record of power outage, defrost initiation, set point changes, alarm occurrences and date of trip start.

This data is recorded for a minimum of 1500 hours of unit operation (the equivalent of 62 days continuous running operation or approximately 120 calendar days of average container utilization) and can be printed out for each hour interval. A backup battery saves data in the DataCORDER during periods of unpowered service.

For USDA recording requirements a (optional) backup battery for data recording during periods of unpowered service (for up to 8 days), and receptacle for three remote mounted PT100 resistance temperature detector (RTD) probes are available.

g. Provide a convenient environmentally protected portable computer which can be easily carried from unit

to unit to interrogate each unit during or at the end of each trip and then is capable of either directly printing this data out in short or long form reports or transfer the data into a PC computer for long-term storage on floppy or hard disk storage. The data can be displayed in tabular form.

The interrogator will not erase the data from the unit DataCORDER memory. After 1500 hours of data recording, the older data will be overwritten by the latest reading. (Refer to section 1.11.5 TP00 & TP01)

h. Provide a two-way communication link to transmit operational and stored unit data to a remote computer communication center and the ability to allow remote control of refrigeration unit operation, pre-trip initiation, defrost initiation, set point change, defrost interval \_C or \_F, in-range tolerance, time delay start interval and current limiting.

i. The controller provides the ability to select or change Codes 26 to 32 without AC power being hooked up. (Refer to section 1.11.9)

### 1.11.2 General Layout of Control Center

The entire Computer Control – Electronic Center is housed in one control box consisting of a control panel which has the annunciator board and display board attached behind it. The relay board and logic board are secured above the control panel. Locking push-on connectors are used to attach the wiring of the unit to the logic and relay boards. Gold-plated terminals are used to ensure reliable electrical connections and eliminate corrosion. The microprocessor control box is designed to permit ease of installation and removal and allows rapid replacement of the microprocessor on-board the ship. This permits analysis and repair of the control center at more convenient repair areas aboard ship or elsewhere.

All control functions are accessed or viewed through a display panel designed for optimum user friendliness and convenience.

The display panel is mounted at a 15-degree downward tilt to aid in visibility when stacked in close quarters and consists of:

a. Twelve (12) push energized membrane switches (keypad) are dedicated to the following functions:

b. Two (2) large LCD's (19mm/0.748 inch – high) which are easily viewed in direct sunlight and backlit for superior nighttime visibility.

c. Five (5) Mode Indicator Lights

- Cool
- Heat
- Defrost
- In-Range
- Alarm

d. Two (2) (Yellow) – high intensity light emitting diodes (LED) for return or supply air probe display indication.

Key	Function
Arrow Up	Change set point upward. Change codes upward. Scan alarm list upward. Change user selectable features upward. Pre-trip advance forward.
Arrow Down	Change set point downward. Change codes downward. Scan alarm list downward. Change user selectable features downward. Pre-trip repeat backward.
Return/Supply	Displays non-controlling probe temperature (momentary display).
_C/_F	Displays alternate units temperature scale (momentary display).
Alarm Reset	Clears alarm light and alarm memory (when followed by <i>Enter</i> key).
Code Select	Access function codes (see arrow up and arrow down).
Defrost Interval	Displays selected defrost interval.
Pre-Trip	Initiate pre-trip inspection (when followed by <i>Enter</i> key). Discontinues pre-trip in progress.
Manual Defrost	Initiates a defrost cycle when pressed. (In addition, a separate toggle switch on the electric control box door is provided.)
Enter	Entering a set point change. Extending to 30 seconds the time a chosen function code is displayed. Entering a code select mode to interrogate the alarm list. Entering the value of a user selectable mode. Clearing the alarm list and initiating pre-trip.

DataCORDER Key	Display (Optional)
Hours Since Last Trip Start	Hours since last trip start.
Trip Start	Initiates Trip Start (when pressed simultaneously with hours since last trip start).

### 1.11.3 Microprocessor Temperature Control

There are two control ranges Frozen and Perishable. The Frozen range is active with set points at or *below*  $-10_C (+14_F)$  and the Perishable range is active at set

points *above*  $-10_C (+14_F)$ . See Figure 1-8 and Figure 1-9.

#### a. Perishable range above $-10_C (+14_F)$ .

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, Dehumidification Control (Code 32 OFF) – cooling by refrigeration with suction modulation and the compressor cycling at light loads. Electric resistance heating.
2. Conventional plus Dehumidification, Humidity Control (Code 32 ON) – 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 (Code 32 OFF)

The supply probe is used for control and is so indicated by the LED on the display board. The Perishable temperature range demands high accuracy. The system is capable of maintaining supply air temperature to within  $+0.25_C (+0.5_F)$  of the set point temperature setting. The compressor is energized continuously to ensure a steady and stable supply air temperature to the container. In Perishable range *above*  $-10_C (+14_F)$  control is maintained by controlling the positions of the solenoid modulation valve (SMV) and suction solenoid valve (SSV, on 69NT40 only).

When pulling down to set point, both valves will be open to reduce the pulldown time unless suction solenoid override is activated. See section 1.10 for explanation of suction solenoid override. The current limit function will override if the current is above the selected value, and restrict the valves. When the temperature reaches set point, the suction solenoid valve will close.

As the temperature enters the in-range temperature tolerance, the in-range light will energize.

The controller logic is designed so the solenoid modulating valve will begin to close as set point is reached. The modulation valve will close to restrict refrigerant flow until the capacity of the unit and the load are balanced.

If the temperature drops below set point, the compressor will remain running for a few minutes. This is to accommodate any initial overshoot which might occur. After this time and at  $0.2_C (0.4_F)$  or greater below set point, the compressor will be turned OFF.

The heaters will be energized if the temperature drops to  $0.5_C (0.9_F)$  below set point. The heaters will de-energize when the temperature rise to  $0.2_C (0.4_F)$  below set point. The compressor will not restart until the temperature rise to  $0.2_C (0.4_F)$  above set point, and the 6 minute time delay has been satisfied.

#### 2. Operation in the Dehumidification Mode (Code 32 ON) – Optional

The dehumidification mode is activated by selecting Code 32 and pressing the *Enter* key to display "ON." The control probe LED (supply 1) will flash ON and OFF every second to indicate the dehumidification mode is

active. Once the Mode is active and the following conditions are satisfied, the controller will activate the heat relay to begin dehumidification.

1. The humidistat is calling for dehumidification. (ie., HCS is closed and 24 vac is at plug Pd23.)
2. The pulldown mode is NOT active. (ie., The bypass valve is closed.)
3. The control probe (ie., Supply 1) temperature is less than or equal to setpoint + .25\_C.
4. The system is in the control mode and the compressor is running.

This applies power to the defrost and drain pan heaters. This added heat 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 de-energizes the heat relay.

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

Two timers are provided in the Dehumidification mode to prevent rapid mode switching and consequent contactor wear. They are:

1. Heater debounce timer (3 minutes).
2. Out-of-range timer (5 minutes).

The heater debounce timer is activated whenever the contactor status is changed. The contactor remains energized (or de-energized) for at least 3 minutes even if the humidistat switch (HCS) opens (or closes). This is to prevent rapid cycling of the heat contactor when the humidistat approaches setpoint. If the mode is terminated by a condition other than the humidistat switch (HCS). For example, an out-of-range condition or compressor shutdown, the heat relay is de-energized immediately.

The out-of-range timer is provided to allow the heaters to remain energized during a temporary out-of-range condition. If the control probe remains out-of-range for more than 5 minutes, the heaters will be de-energized to allow the system to recover. The out-of-range timer starts as soon as the temperature exceeds the in-range tolerance value set by code Cd29.

Cooling capacity reduction by modulation is the same as described for the conventional operating mode when any of the above 4 conditions are invalid.

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

#### **b. Frozen range below $-10_C (+14_F)$**

The return air probe is used for control and is so indicated by the LED on the display board.

The Frozen temperature range is not sensitive to minor temperature changes. The method of temperature

control employed in this range takes advantage of this fact, to greatly improve the energy efficiency of the system. Temperature control in the Frozen range below  $-10_C (+14_F)$  is accomplished by cycling the compressor on and off as the load demand requires.

If the return air temperature in the container drops  $0.2_C (0.4_F)$  below the set point temperature, the compressor is cycled off. When the temperature is greater than  $0.2_C (0.4_F)$  above set point and 6 minute time delay has been met, the compressor will restart. The system will always operate at full capacity which means both the solenoid modulating (SMV) and suction solenoid (SSV) valves are fully open unless suction solenoid override is activated. See section 1.10 for explanation of suction solenoid override.

The temperature control is still within the tight limits. Conditions could exist, however, which may cause the return air temperature to rise rapidly. Such a case would be the initial reaching of set point temperature. When the set point temperature is initially reached, the load may still be warmer than the set point temperature. This could cause a rapid rise in return air temperature when the compressor is off, causing a rapid restart or on/off cycling of the compressor which is undesirable. To prevent this from occurring, a 6 minute compressor off time must be satisfied before the compressor will restart. Under a condition of a rapidly changing return air temperature, the time delay may allow the return air temperature to rise slightly more than  $0.2_C (0.4_F)$  above the set point temperature before the compressor can restart.

#### **1.11.4 Function and Data Codes**

There are 30 functions which the operator may access to examine the operating status of the unit. To access these functions, perform the following: Press the *code select* key, press an arrow key until the left window displays the desired code number (see Table 1-4). The right window will display the value of this item for 5 seconds before returning to the normal display mode. If a longer time is desired, pressing the *Enter* key will extend the time to 30 seconds after the last pressing of the *Enter* key. Below is an explanation of all Function codes.

##### **Code 00 – Alarm List Display Selection** (See Table 1-3 and Table 1-4)

This process will allow the user to examine all alarms that are written in the list. To notify the user of the top of the list, “Strt” is displayed. By using the arrow keys, the entire list may be displayed. Each alarm number will be preceded by a status indication, “IA” for inactive alarm and “AA” for active alarm. See Alarm section.

##### **Code 01 – Suction Modulation Valve Opening (%)**

The suction modulation valve (SMV) is a normally open valve which restricts flow of refrigerant to the compressor when energized by a pulse width modulated (PWM) output. The amount of closing of the valve is proportional to the applied current over the range of 0.2 to 1.3 Amps. The valve remains 100% open below 0.2 A and is 0% open at 1.3 A.

## Code 02 – Quench Valve (Open or Closed)

### NOTE

All R-134a models have a thermostatic expansion quench valve, so Code 02 is NOT APPLICABLE.

## Code 03 – Suction Solenoid Valve (Open or Closed)

Model (69NT40) will have a suction solenoid valve (SSV) to provide maximum refrigerant flow to the refrigeration system. This valve will always be open for set points below  $-10_C$  ( $+14_F$ ) and during temperature pulldown periods unless current limiting restricts its use.

## Codes 04, 05 & 06 – Line Current, Phase A, B & C

The container is supplied by a three-phase electrical system, so there are three current sensors in the system. The current draw is used for control and diagnostic purposes.

For control processing, the largest of the three current values is used for current limiting purposes.

For diagnostic processing, the current draws are used to determine control unit operations. Whenever a heater or a motor is turned ON or OFF, the current draw increase/reduction for that activity is measured for all three legs of the system. Each current draw is then tested to determine if it falls within the expected range of values for the respective unit. Failure of this test will result in a pre-trip failure or a control alarm indication.

## Code 07 – Supply Voltage

The supply voltage will be a nominal 230 vac or 460 vac level, and will determine which set of current draw values to use for testing. The voltage is constantly monitored and a voltage level – lower than 20% of its proper voltage will result in “LO” being alternately displayed with the set point.

## Code 08 – Supply Frequency

The value of the main power frequency is displayed in Hertz.

## Code 09 – Ambient Air Temperature

The ambient sensor (AMBS) measures the temperature outside the container. It is a factor in determining which speed the condenser fans will use (optional), and it is also used as a diagnostic factor for determining the system load. For locations of sensor, see Figure 1-3.

## Code 10 – Compressor Suction Temperature

Measured just prior to the compressor suction service valve, the compressor suction temperature is used for pre-trip diagnostics as an indicator of proper quench operation. For location of compressor suction sensor (CPSS), see Figure 1-3.

## Code 11 – Compressor Discharge Temperature (not applicable for some units)

The compressor discharge temperature is measured near the compressor discharge valve. For location of compressor discharge sensor (CPDS), see Figure 1-3.

## Code 12 – Saturated Condenser Temperature (not applicable for some units)

The saturated condenser temperature is measured on a condenser return bend. It is also used to calculate discharge pressure. For location of condenser saturation sensor (CSAS), see Figure 1-3.

Table 1-4. Function Code Assignments

FUNCTION CODE	DATA
<b>Display Only Functions</b>	
Cd00	Alarm List
Cd01	Suction Modulation Valve Opening (%)
DCd02	Quench Valve (Open – Closed)
Cd03	Suction Solenoid Valve (Open – Closed)
Cd04	Line Current, Phase A
Cd05	Line Current, Phase B
Cd06	Line Current, Phase C
Cd07	Supply Voltage
Cd08	Supply Frequency
Cd09	Ambient Air Temperature
Cd10	Compressor Suction Temperature
DCd11	Compressor Discharge Temperature
DCd12	Saturated Condenser Temperature
DCd13	Compressor Discharge Pressure
Cd14	Future Expansion
Cd15	Future Expansion
Cd16	Compressor Motor Hour Meter
DCd17	Hours Since Last Trip Start
Cd18	Software Revision Number
DCd19	Serial # (First 4 of 8)
DCd20	Serial # (Second 4 of 8)
DCd21	USDA #1 Probe Temperature
DCd22	USDA #2 Probe Temperature
DCd23	Secondary Return Air Temperature (USDA)
Cd24	Secondary Supply Air Temperature
Cd25	Time Remaining Until Defrost
<b>Display/Select Functions</b>	
Cd26	Defrost Interval
Cd27	Temperature Units ( $_C$ or $_F$ )
Cd28	Failure Action
Cd29	In-Range Tolerance
Cd30	Stagger Start Offset Time
Cd31	Current Limit
Cd32	Dehumidification Control (Optional)

D = Codes that are NOT APPLICABLE for some units

## Code 13 – Compressor Discharge Pressure (not applicable for some units)

Calculated from the saturated condenser temperature.

Pressure is displayed in units of psig when code 27 is set to  $_F$  and units of bars when code 27 is set to  $_C$ . “P” appears after the value to indicate psig and “b” appears after the value to indicate bars.

### **Code 14 & 15 – Future Expansion**

These codes are for future expansion.

### **Code 16 – Compressor Motor Hour Meter**

Records total hours of compressor run time in increments of (10) ten hours (ie. 3000 hours displayed as 300).

### **Code 17 – Hours Since Last Trip Start** (not applicable for some units)

This is the total number of hours since the last trip start. Up to 62 days can be recorded. A back-up battery keeps the clock running when power is disconnected.

### **Code 18 – Software Revision Number**

The software revision number is displayed.

### **Code 19 – Serial # (First 4 of 8)** (not applicable for some units)

The first 4 digits of the Serial number for the Microprocessor are displayed.

### **Code 20 – Serial # (Second 4 of 8)** (not applicable for some units)

The last 4 digits of the Serial number for the Microprocessor are displayed.

### **Code 21 – USDA #1 Probe Temperature** (not applicable for some units)

Displays the temperature of the #1 remote cold treatment probe.

### **Code 22 – USDA #2 Probe Temperature** (not applicable for some units)

Displays the temperature of the #2 remote cold treatment probe.

### **Code 23 – Secondary Return Air Temperature** (not applicable for some units)

The secondary return air temperature (for four-probe systems) is measured at the same place as the primary return air temperature.

### **Code 24 – Secondary Supply Air Temperature**

The secondary supply air temperature (for four-probe systems) is measured at the same place as the primary supply air temperature.

### **Code 25 – Time Remaining Until Defrost**

This code displays the time remaining until the unit goes into defrost (in hours).

#### **NOTE**

The following are user-selectable functions. The operator can change the value of these functions to meet the operational needs of the container.

### **Code 26 – Defrost Interval**

The defrost interval is the time interval between defrost cycles of which there are four possible selectable values: 3, 6, 12 or 24 hours. The factory default value is 3 hours. During pulldown, the interval is automatically set at 2.5 hours.

The time interval of the first defrost will not begin counting down until DTT is closed. At the time DTT closes, or at power-up if DTT is already closed, the time

interval to the first defrost cycle is entered into the microprocessor.

When the interval timer has counted down 2.5 hr, the in-range status of the unit is checked. If out-of-range and the control temperature is greater than 5\_C above set point, the unit immediately goes into the defrost mode. Upon termination of defrost, the user selected interval (ie., 3, 6, 12 & 24 hr) is reset. During pulldown from high ambient, this cycle will repeat until the control temperature is less than or equal to the (set point temperature + 5\_C). At such time, the selected defrost interval time will be completed.

If the unit drifts out-of-range and the control temperature is greater than 5\_C above set point, after the 2.5 hours of countdown but prior to completion of the selected interval, the unit will immediately go into defrost. Upon termination of defrost, the selected interval will be reset.

If DTT opens at any time during the timer count down, the interval is reset and the countdown begins over.

If DTT has failed open (ie., AL61 is active) and the primary return sensor temperature is less than 10\_C, the interval timer countdown begins. The interval timer is reset if the return air temperature rises above 24\_C. (See section 2.4.3.)

### **Code 27 – Temperature Units (\_C or \_F)**

This code determines the temperature unit's \_C or \_F which will be used for all temperature displays. The user selects \_C or \_F by selecting code 27 and pushing the *Enter* key. The factory default value is \_C.

### **Code 28 – Failure Action**

If after 15 minutes of running, all four of the control sensors are out of range, the system will enter the shutdown state defined by the failure action. The user selects one of four possible actions as designated by a selection code:

- A – Full Cooling (SMV 100%)
- B – Partial Cooling (SMV 50% open)
- C – Evaporator Fan Only
- D – Full System Shutdown – Factory Default

### **Code 29 – In-Range Tolerance**

The in-range tolerance will determine the bandwidth of temperatures around the set point which will be designated as in-range. If the control temperature is in-range, the in-range light will be illuminated. There are four possible values.

- 1. | 0.5\_C ( | 0.9\_F)
- 2. | 1.0\_C ( | 1.8\_F)
- 3. | 1.5\_C ( | 2.7\_F)
- 4. | 2.0\_C ( | 3.6\_F)

### **Code 30 – Stagger Start Offset Time**

The stagger start offset time is the amount of time that the system will delay at start-up, thus allowing multiple units to stagger their control initiation when all units are powered up together. The eight possible offset values are in (seconds):

- 0 = Factory Default (3, 6, 9, 12, 15, 18, 21)

### Code 31 – Current Limit

The current limit is the maximum current demand allowed on any phase at any time. Limiting the unit's current (amperage) reduces the load on the mains power and lowers the compressor discharge pressure. Whenever this is desirable, the limit can be lowered. Note, however, that capacity is also reduced. The five values are:

21 = Factory Default (15, 17, 19, 23)

### Code 32 – Dehumidification Control

This code activates the dehumidification control mode of the system. Press the *Enter* key to toggle the mode between "ON" and "OFF." When the code is set to ON, the control probe LED will flash ON and OFF every second to indicate the mode is active. Code 32 is only applicable to units with a humidistat.

#### 1.11.5 Alarms

The alarm philosophy balances the protection of the refrigeration unit and that of the refrigerated cargo. The action taken when an error is detected always considers the survival of the cargo. Rechecks are made to confirm an error actually exists. Some alarms requiring compressor shutdown have time delays before and after to try to keep the compressor on line. An example is a low main voltage. When the voltage drops over 20%, an indication is given on the display, but the unit will continue to run.

If a detectable problem is found to exist, the alarm code will be alternately displayed with the set point on the left display. Alarm codes in the "20 series" will also illuminate the red alarm light.

To determine if other alarms exist or have existed, the alarm list must be accessed. The alarm list will store up to eleven alarms in the sequence in which they occurred. When accessing the alarm list, an "IA" or an "AA" will appear to the left of the alarm code number. The "IA" indicates an inactive alarm; one that has occurred, but no longer exists. The "AA" indicates an active alarm; one that is still indicating an improper condition.

The codes in memory are displayed by pressing the *code select* key and then an arrow key until Code 00 is displayed in the left window. "Strt" will be displayed in the right window. Press the *Enter* key to enter this code. Now press the *up arrow* key and the alarm codes will be displayed on the right window in the sequence they occurred.

To extinguish the alarm light, and in so doing remove all alarms from the alarm list memory, first ensure all alarm codes on the alarm list have "IA" to the left of the number, "AA" codes will prevent any reset of the list. Press the *alarm reset* key and within five seconds the *Enter* key. If the alarm light does not extinguish, check the alarm list (Code 00). It is possible that more alarms exist than can be displayed on the alarm list, a maximum of 11 alarms can be displayed. If an active alarm has been corrected, the microprocessor may not detect this until the unit has been turned OFF and ON. The OFF and ON action will cause a retest of all components.

Alarms TP00 and TP01 can only be cleared by first trip starting the unit (simultaneously pressing the *trip*

*start* key and hours since *trip start* key) and then pressing the *alarm reset* and *Enter* keys.

The controller must be in the "Normal Display Mode." (ie., Set point and control Probe Display) and all alarms must be inactive to clear the alarm light and queue.

### Alarm 20 – Control Circuit Fuse

Alarm 20 is triggered by the control circuit fuse opening and will cause the software shutdown of all control units. This alarm will remain active until the 6-amp fuse is replaced.

### Alarm 21 – Evaporator Fan Motor

Alarm 21 is triggered by the opening of the evaporator motor internal protector. This alarm will disable all control units until the motor protector resets.

### Alarm 22 – Auto Transformer

Alarm 22 is triggered by the auto transformer internal protector opening, and will result in the disabling of all control units except the evaporator fans. The alarm will stay active until the transformer protector resets.

### Alarm 23 – Compressor Motor

Alarm 23 is triggered by the opening of the compressor motor internal protector. This alarm will disable all control units except for the evaporator fans and will remain active until the motor protector resets.

**Table 1-5. Alarm Indications**

ALARM NO.	ALARM DESCRIPTION
AL20	Control Circuit Fuse Open
AL21	Evaporator Fan Motor Internal Protector
AL22	Auto Transformer Internal Protector
AL23	Compressor Motor Internal Protector
AL24	Condenser Fan Motor Internal Protector
AL25	Compressor High Pressure Limit Safety
AL26	All Supply and Return Air Sensor Failure
AL27	Probe Circuit Calibration Failure
AL51	Alarm List Failure
AL52	Alarm List Full
AL53	Main Voltage Sensor Failure
AL54	Primary Supply Air Sensor Failure
AL55	Secondary Supply Air Sensor Failure
AL56	Primary Return Air Sensor Failure
DAL57	Secondary Return Air Sensor Failure
AL58	Ambient Temperature Sensor Failure
AL59	Heat Termination Thermostat Failure
AL60	Defrost Termination Thermostat Failure (Closed)
AL61	Defrost Termination Thermostat Failure (Open)
AL62	Heaters Failure
AL63	Compressor Motor Failure
DAL64	DataCORDER Low Battery
AL65	Current Over Limit
DTP00	Approaching DataCORDER Memory Overwrite
DTP01	DataCORDER Overwriting Data
ERR #	Internal Microprocessor Failure
LO	Low Main Voltage (More than 20%)
D	Alarms that are NOT APPLICABLE for some units

### **Alarm 24 – Condenser Fan Motor**

Alarm 24 is triggered by the opening of the condenser motor internal protector and will disable all control units except for the evaporator fans. This alarm will remain active until the motor protector resets. This alarm is deactivated if the unit is operating on water cooled condensers.

### **Alarm 25 – Compressor High Pressure**

Alarm 25 is triggered when the compressor high discharge pressure safety switch remains open for at least one minute. This alarm will remain active until the pressure switch resets, at which time the compressor will restart.

### **Alarm 26 – All Sensors Failure**

Alarm 26 is triggered by a reading that all of the control sensors are out-of-range. This can occur for box temperatures outside the range of  $-40_{\text{C}}$  ( $-40_{\text{F}}$ ) to  $+55_{\text{C}}$  ( $+131_{\text{F}}$ ) or in the unlikely event that two (four in DataCORDER unit) probes are bad. This alarm is masked for 15 minutes to give the unit time to bring the box within range. If the problem is that the unit is out-of-range, the DTT is used to determine if the high or low limit is being exceeded. If still out-of-range after 15 minutes, the probes are considered in error and the alarm is triggered.

This alarm triggers the failure action code set by Code Cd28.

### **Alarm 27 – Probe Circuit Calibration Failure**

Every second, the probe circuit current source is checked for proper calibration. If after three consecutive seconds, the current source cannot be brought into calibration, Alarm 27 is triggered.

The controller continues to try to calibrate. The alarm will remain active until successful calibration is achieved.

### **Alarm 51 – List Failures**

During start-up diagnostics, the alarm list is examined to determine validity of its contents. This is done by testing the set point and the alarm list. If the contents are invalid, Alarm 51 is set.

During control processing, any operation involving alarm list activity that results in an error will cause Alarm 51 to be set.

Alarm 51 is a “display only” alarm and is not written into the alarm list. Pressing the *alarm reset* key will result in an attempt to clear the alarm list. If that action is successful (all alarms are inactive), Alarm 51 will be reset.

### **Alarm 52 – List Full**

Alarm 52 is set whenever the alarm list is determined to be full; at start-up or after recording an alarm in the list. Alarm 52 is displayed, but is not recorded in the alarm list.

This alarm can be reset by clearing the alarm list. This can be done only if all alarms written in the list are inactive.

### **Alarm 53 – Main Voltage Sensor Failure (PT transformer)**

Alarm 53 is caused by a line voltage reading of less than 30V, PT transformer secondary output less than 1vac (TB13 – Ground). It is a display alarm with no associated failure action. While Alarm 53 is active, no range testing will be done of the line voltage and, for current test purposes, the voltage will be assumed to be 460 vac. Alarm 53 will be reset by any voltage reading greater than 30V.

### **Alarm 54 – Primary Supply Air Sensor**

Alarm 54 is set by an invalid primary supply sensor reading outside the range of  $-38$  to  $+54_{\text{C}}$ . This alarm is ignored during the first 15 minutes of operation. See Alarm 26.

If Alarm 54 is set and the primary supply is the control sensor, the secondary supply sensor will be used for control.

### **Alarm 55 – Secondary Supply Air Sensor**

Alarm 55 is set by an invalid secondary supply sensor reading outside the range of  $-38$  to  $+54_{\text{C}}$ . This alarm is ignored during the first 15 minutes of operation. See Alarm 26.

If Alarm 55 is set and the secondary supply is the control sensor, the the primary return sensor will be used for control.

### **Alarm 56 – Primary Return Air Sensor**

Alarm 56 is set by an invalid primary return sensor reading outside the range of  $-38$  to  $+54_{\text{C}}$ . This alarm is ignored during the first few minutes of operation. See Alarm 26.

If Alarm 56 is set and the primary return is the control sensor, the primary supply sensor will be used for control.

### **Alarm 57 – Secondary Return Air Sensor (not applicable for some units)**

Alarm 57 is set by an invalid secondary return sensor reading outside the range of  $-38$  to  $+54_{\text{C}}$ . This alarm is ignored during the first 15 minutes of operation. See Alarm 26.

This sensor is only used for data logging and has no backup.

### **Alarm 58 – Ambient Temperature Sensor**

Alarm 58 is triggered by an ambient temperature outside the valid range from  $-50_{\text{C}}$  ( $-58_{\text{F}}$ ) to  $+70_{\text{C}}$  ( $+158_{\text{F}}$ ). This is a display alarm and has no associated failure action.

### **Alarm 59 – Heat Termination Thermostat (HTT)**

Alarm 59 is triggered by the opening of the heat termination thermostat and will result in the disabling of the heater. This alarm will remain active until the thermostat resets.

### **Alarm 60 – Defrost Termination Thermostat (DTT) Closed Failure**

Alarm 60 is an indication of a probable failure (closed) of the defrost termination thermostat (DTT). It is triggered by the opening of the heat termination thermostat (HTT) or the failure of the DTT to open (within 1.0 to 1.5 hours depending on voltage) during defrost.

### **Alarm 61 – Defrost Termination Thermostat Open Failure**

Alarm 61 is an indication of a DTT stuck open failure. It is activated if DTT is not sensed closed 30 minutes after power up or 30 minutes of compressor run time with primary return temperature below  $7_{\text{C}}$  ( $45_{\text{F}}$ ).

## Alarm 62 – Heater

Alarm 62 is the heater alarm caused by improper amperage resulting from heater activation (deactivation). Each phase of the power source is checked for proper amperage.

This alarm is a display alarm with no resulting failure action, and will be reset by a proper amp draw of the heater.

## Alarm 63 – Compressor Motor

Alarm 63 is triggered by improper current draw increase (decrease) resulting from compressor turn on (off). The compressor is expected to draw a minimum of 2 amps; failure to do so will cause the alarm.

This is a display alarm with no associated failure action and will be reset by a proper amp draw of the compressor.

## Alarm 64 – DataCORDER Low Battery (not applicable for some units)

Alarm 64 is an indication that the DataCORDER battery is low. It is a display alarm and will only be reset by replacement of the battery.

## Alarm 65 – Current Limit

Alarm 65 is triggered within the current limiting system. If the compressor is ON and current limiting procedures cannot maintain a current level below the user selected limit, the current limit alarm is activated.

This alarm is an inactive display alarm and is inactivated by power cycling the unit or changing the current limit via the code select Cd31.

## TP00 (not applicable for some units)

This alarm indicates that the memory is almost full and the recorder will soon start to overwrite the oldest data.

## TP01 (not applicable for some units)

This alarm indicates that the recorder is overwriting the oldest data. This will happen approximately every 55-62 days depending on the number of events that have been stored with the temperature data. It is recommended that data be downloaded from the recorder to safe storage at the end of each trip and no later than when a TP00 alarm occurs. Otherwise data will be lost.

### NOTE

TP00 and TP01 alarms are reset by trip starting the unit and then pressing the alarm reset and *Enter* key.

## ERR #

The microprocessor performs self-check routines. If an internal failure occurs, an ERR #0-4 will appear on the display. This is an indication the microprocessor needs to be replaced.

## LO

This message will be alternately displayed with the set point whenever the main voltage drops more than 20% of its proper voltage. The unit may operate at even lower voltages, but damage to motors may occur.

## 1.11.6 Pre-Trip Inspection

### CAUTION

**Pre-Trip inspection should not be performed with critically controlled cargoes loaded into the container.**

On units equipped with a DataCorder, before commencing any testing of the unit, manual or automatic, the DataCorder should be Trip Started by pressing and holding the “Hours Since Last Trip Start” key and simultaneously pressing the “Trip Start” key until “0000” is displayed in the right hand window.

The following is the sequence the microprocessor performs when pre-trip inspection is initiated. To initiate pre-trip, push the *pre-trip* key and within 5 seconds, the *Enter* key. As each test is successfully completed, the word “pass” will appear in the right-hand side display window. The individual test code is displayed in the left-hand side window.

If a failure should occur, the microprocessor will indicate this by displaying the word “fail” in the right window. The return and supply indicators will also alternately flash. This will continue until the user provides further instructions. Pressing the *down arrow* will cause the last test series to be repeated. This is recommended to avoid being misled by an erroneous reading. Pressing the *up arrow* will start the next test in the sequence.

When no problems are encountered, pre-trip will finish and the unit will return to normal control mode operation. To exit pre-trip at any time, press the *pre-trip* key and hold it for 1 second. A delay of up to 5 seconds may be encountered.

### NOTE

The compressor time guard may be in effect upon completion of pre-trip. Consequently the compressor may not start for up to 6 minutes.

Tests are performed by measuring temperatures or amperage of the individually tested components. These values are compared to proper values and the “Pass/Fail” indication given.

### Test Codes:

#### P Pre-Trip Initiated

All lights LED's and LCD segments are turned on for visual inspection.

#### P1-0 Heaters Turned On

Amperage measurements are made.

Failure is an indication of faulty heater(s) or improper wiring.

#### P1-1 Heaters Turned Off

Amperage should be zero.

Failure indicates contactor has remained (arced) closed, or current sensor is reading improperly.

#### P2-0 Preheaters Checked (If so Equipped)

See P1.

#### P3-0 Low Speed Condenser Fan On

(If so Equipped) See P3-2.



### **P3-1 Low Speed Condenser Fan Off**

(If so Equipped) See P1-1.

### **P3-2 High Speed Condenser Fan On**

Amperage measurements are made after 15 seconds.

Failure is an indication that the motor is defective, or didn't start due to bad contactor or defective wiring. Motor could also be heavily loaded (i.e. bad bearing).

### **P3-3 Condenser Fan Off**

See P1-1.

### **P4-0 Low Speed Evaporator Motor Turned On**

See P3-2 (1 Minute Test).

### **P4-1 Evaporator Motor Off**

See P1-1.

### **P4-2 High Speed Evaporator Motor Turned On**

See P3-2 (1 Minute Test).

### **P4-3 Evaporator Motor Off**

See P1-1.

### **P5 Probe Tests**

See P5-0 and P5-1, also, you should make note that during the pre-trip test, codes P5-0 and P5-1 will be seen only when a failure occurs.

### **P5-0 Return/Supply Probe Test**

A temperature comparison is made between the return and supply probes. High speed evaporator fans are run for 8 minutes to eliminate air temperature differences.

### **P5-1 Primary/Secondary Probe Test**

(For unit with DataCORDER only) After 8 minutes, the temperature difference between the primary and secondary probe (supply and return) is compared to a standard.

A failure may be due to some temperature extreme which existed before the test started and the test should be rerun. If still bad, check probes and connections and possibility of airflow restriction.

### **P6-0 Compressor Started And Runs for 45 Seconds**

Check for a minimum current increase is made.

A failure indicates a compressor motor problem, or power source fault.

### **P6-1 Suction Modulation Valve Opening**

The Modulation Valve is fully opened, for two minutes unless restricted by the current limiting function. A predetermined temperature difference, dependent upon the valve position and box temperature is compared to the supply and return probe readings.

A failure indicates low capacity. This could be due to the modulation valve not opening as required, or some other restriction in the line, such as the filter drier. If the suction solenoid valve open test below fails, this would indicate that another part of the system is bad (i.e. compressor). There is the possibility that a probe is in error, even if P5-0 passed.

### **P6-2 Quench Valve Test**

NOT APPLICABLE

### **P6-3 Suction Modulation Valve (Closed)**

The modulation and suction solenoid valve are closed and the unit is run for 5 minutes. The return and supply probe readings are to be within a range indicating a minimal capacity.

A failure indicates improper closing of the valve. The possibility of a faulty probe could also be examined.

### **P6-4 Suction Solenoid Valve**

The suction solenoid valve is opened (Modulation Valve closed). The supply and return probe temperature difference is compared to a predetermined value.

A failure indicates low capacity. This could be caused by the valve being defective or improperly wired. Also see P6-2 above.

### **1.11.7 DataCORDER (Optional)**

Carrier Transicold has developed a microprocessor recorder for container refrigeration units which eliminates the mechanical recorder and paper chart, and replaces it with a solid state memory device capable of recording at one hour intervals, for a period of 62 days of continuous unit operation or, more practically, 120 calendar days average use.

This microprocessor temperature recorder, which we have termed the "DataCORDER," has many additional capabilities which the old, mechanical chart recorder did not have.

The following data is stored and can be displayed in report form.

- Trip Start Date
- Initial Set Point Temperature
- Supply Air Temperature
- Return Air Temperature
- Remote Probe Temperatures in the Container (Cold treatment recording)
- Set Point Temperature Changes
- Power Outages
- Alarm Occurrences
- Defrost Occurrences
- Pre-Trip Occurrences
- Dehumidification mode

Trip start date is activated by simultaneously holding both *Trip Start* and *Hours Since Last Trip Start* keys.

The operator can display Hours Since Last Trip Start by just depressing and holding this keypad switch.

Each one hour interval of the DataCORDER is called a TIC. All events that occur are recorded at the TIC following the event. Multiple occurrences of the same event between TIC's are not recorded; only the last event.

A special type of recording is provided for USDA cold treatment purposes. Cold treatment recording requires either two or three remote probes that are placed in the cargo at various locations. Provision is made to connect these probes to the DataCORDER via receptacles located at the rear left-hand side of the unit. Four receptacles are provided. Three (four pin) are for the probes and one (five pin) is provided for the interrogator. All receptacles are

sized to accept a MIL-C-5015-14S size plug with a bayonet locking ring. The DataCORDER inputs are designed to accept a four wire PT100 RTD (resistance temperature detector) probe.

A label on the back panel of the unit shows which receptacle is used for each probe. The USDA #1 and #2 probes are installed in their receptacles. The other receptacle is used for the third cold treatment probe as well as the standard DataCORDER return probe. Therefore, when cold treatment is begun, the unit return probe must be removed from this receptacle and installed in a dummy receptacle next to it. The third cold treatment probe (referred to as the "RTN" probe) can then be installed. (See Figure 1-2.)

The five pin receptacle is used to latch in the USDA back-up battery and for probe calibration at the beginning of the cold treatment. These functions are performed by the interrogator with a special interconnecting cable and software. Contact the Carrier service representative for details.

The DataCORDER records four probe temperature (supply, return, USDA #1 and USDA #2) every minute over the hour interval to calculate an average temperature for recording at the clock TIC. If the setpoint at the time of the TIC is within the cold treatment range of 27-38\_F, it is assumed that a treatment is in progress and the temperatures recorded are snapshot or instantaneous values. If the setpoint is outside the cold treatment range, the average temperature is recorded.

The standard DataCORDER report displays the supply and return air temperatures. The cold treatment report displays USDA #1, USDA #2 and the return air temperature. Cold treatment recording is backed up by a battery so recording can continue if AC power is lost. The battery capacity is sufficient to allow recording for eight days at 0\_F ambient. After eight consecutive days of battery backed up recording, the controller automatically disconnects the battery from the DataCORDER to prevent its damage. The battery is housed in a module that also contains a charger to maintain or restore battery capacity when AC power is on. This module is located on a stud plate in the lower left corner of the unit.

When the dehumidification mode is activated or de-activated (ie., Code 32 is turned ON or OFF), this status is stored in the DataCorder memory and reported at the next TIC. Note: All microprocessors have dehumidification capability but some units are NOT equipped with a humidistat. Refer to Table 1-1 model chart to see which units have a humidistat.

Two diagnostic alarms are provided for the DataCORDER.

TP00 – This alarm indicates that the memory is almost full and the recorder will soon start to overwrite the oldest data.

TP01 – This alarm indicates that the recorder is overwriting the oldest data. This will happen approximately every 55-62 days depending on the number of events that have been stored with the temperature data. It is recommended that data be downloaded from the recorder

to safe storage at the end of each trip and no later than when a TP00 alarm occurs. Otherwise data will be lost.

#### NOTE

TP00 and TP01 alarms are reset by trip starting the unit and then pressing the alarm reset and *Enter* key.

#### 1.11.8 Communications

##### a. DataCORDER Retrieval – Interrogation

Data retrieval from the DataCORDER can be accomplished with two devices: (1) a stand-alone DOS base portable computer with appropriate cable and software or (2) the Husky "Hunter" computer with appropriate cable and software. Both are battery operated portable computers. The main difference between them is that the Husky computer has smaller memory storage and consequently is designed to be used with a desktop PC for downloading, data storage and output processing. These functions can be performed on the portable computer using floppy disks. The main advantage of the Husky is its smaller size, weight and superior durability in harsh environments.

The interrogation software for the portable computer is supplied on a 3.5 inch floppy disk. This software allows interrogation, screen view of the data, hard copy report generation, cold treatment probe calibration, cold treatment initialization and file management. With a double sided double density disk, the portable computer can store approximately 2995 trip days of data. This is equivalent to interrogation of 100 units with an average trip length of 29.9 days.

With a few menu driven keystrokes, either computer can read the DataCORDER.

A short report on that interrogation can be displayed on the computer to identify key information such as Trip Start, Power Outages, and Temperature Out-of-Range conditions.

The Husky computer comes with an IBM PC compatible program loaded on a 5-1/4" floppy disk which allows the customer to custom install a report format to the user's requirements.

This installation program is easily loaded into the PC and is menu driven so that the portable computer can be programmed to provide the desired customer report format headings and revised easily by the customer.

The Husky computer can then be attached to the serial port interface on the 69NT unit to interrogate the DataCORDER. The computer has an LCD multi-line dot matrix display which is menu driven for ease of use by the operator.

The Husky computer can store interrogation of up to 100 units for a maximum total of 750 trip days at an average of 7.5 days per unit or 50 units at an average of 15 days per unit.

After interrogation of many units is completed, the portable computer will display that it is full.

It can then be downloaded to directly print to a serial or parallel port printer (with a serial-to-parallel connection).

It also can be downloaded to a PC for storage on hard or floppy disks.

Once in disk storage it can be retrieved or downloaded to an analysis program for further analysis if desired and can be printed in tabular or graphical form.

### b. Remote Monitoring

All data that was previously described as either stored or displayed can be transmitted to a remote monitoring unit (RMU) shipboard computer center.

This data includes the present operating temperatures, pressure, voltages, amperages and alarms defined by the code select functions.

This data also includes the temperature, set point changes, power outages, defrost initiation, and alarm occurrences that are stored in the DataCORDER for the last 1500 operating hours.

By way of 2-way communication, the shipboard computer center can initiate all functions and selectable features that are accessible at the unit such as set point change, pre-trip initiation, defrost initiation, etc.

The remote monitoring unit (RMU) may be field installed to the unit. Mounting brackets for the RMU are provided behind the microprocessor control panel (Display).

Three wire harnesses are provided in the unit to interconnect the RMU (labeled "CI" for communications interface on the schematics) and the controller. One harness connects the RMU and controller current loop communication ports. Another provides 24 volt AC power to the RMU. The third connects the output port of the RMU to the 460 volt power line just ahead of CB-1. Please refer to the unit schematic and wiring diagrams.

#### NOTE

None of the harnesses are connected. They must be field connected when the RMU is installed.

### 1.11.9 Setting Function Codes Without AC Power (Optional)

For units equipped with a Battery Module Switch (BMS) and Battery Module or Disposable Batteries.

If the user wishes to enter a new set point or change the user selectable codes (Refer to section 1.11.1) without AC power hooked up to the unit, the following procedure should be used:

- a. Make sure that the PN connector is hooked up to the battery module.
- b. Set switch (BMS) to position "1".
- c. Enter new set point by pressing the Up or Down Arrow keys until the desired temperature is then reached. Then press the Enter key.
- d. To change the user selectable codes, (Codes 26 through 32) must be accessed. Once the desired code is reached, the user may change the value of these functions to meet the operational needs of the container. (Refer to Section 1.11.4 for an explanation of the Function Codes.)

- e. Once all desired entries have been made, switch the BMS switch to the "0" position.

#### NOTE

The controller will give the user two minutes to make a keystroke. If a key is not pressed within the two minute period, the micro will enter an inactive mode and "Data Log" will appear on the display. To exit the inactive mode, simply switch the BMS switch to the "0" position.

To reactivate the controller after switching BMS to the "0" position, wait 10 seconds after the "Data Log" disappears, then switch the BMS to position "1".

Once the controller is activated, if a key is depressed within the initial two minute period, the controller will remain active for 30 seconds, thereafter. (i.e., If a key is pressed 10 seconds after the controller is activated, "Data Log" will appear 30 seconds later if no other keys are pressed.

#### CAUTION

**Anytime (BMS) is in position "1" and the refrigeration unit is not operating, the battery will be discharging. Therefore, the switch must be set to position "0" when battery power is not required.**

### 1.12 USDA BATTERY MODULE (OPTIONAL)

Units configured for USDA cold treatment contain either a battery/charger module or a "C" size battery box. This allows for temperature and unit status recording while main system power (460/230) is not available or connected. The three pin power cable is used to latch in the USDA back-up battery box and for probe calibration at the beginning of the cold treatment.

#### a. Operating Instructions

1. Unplug dummy plug (Item 4, Figure 1-7).
2. Connect power cable (2) to USDA battery box module (3). (Install with flat side on plug body up)

#### CAUTION

**Anytime power cable is connected to module and the refrigeration unit is not operating, the battery will be discharging. Therefore, the power cable must be unplugged from module except when performing cold treatment recording, calibration, or charging battery.**

#### NOTE

Stow power cable in dummy receptacle and insert dummy plug in module receptacle to prevent corrosion of terminals when not in use.

#### b. Battery Check and Charging

Plug power cable into module and start unit or apply 24 vac to module. If low battery charge light illuminates, charge battery by operating unit or applying 24 vac to module until charge light extinguishes. Alternatively, install a module with a pre-charged battery. (When charging from an external source, apply 24 vac to pin PL2. Ground pin PL1.)

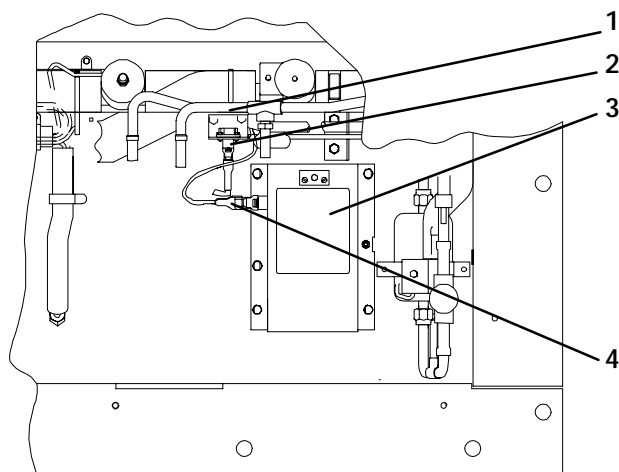
## NOTE

Normally, charging the battery until the light is extinguished will provide adequate power to perform cold treatment calibration without AC power available to unit. Depending on the ambient temperature and degree of discharge, charging for as little as one hour or as much as 24 hours could be required to extinguish the light. Charging for 4 to 6 hours after light is extinguished is required to fully charge battery.

### 1.13 USDA COLD TREATMENT PROCEDURE

Sustained cold temperature has been employed as an effective postharvest method for the control of the Mediterranean and certain other tropical fruit flies. Exposing infested fruit to temperatures of 2.2 degrees Celsius (36\_F) or below for specific periods results in the mortality of the various stages of this group of notoriously injurious insects.

In response to the demand to replace fumigation with this environmentally sound process, Carrier has integrated this Cold Treatment capability into its microprocessor controller. These units have the ability to maintain the container temperature within 1/4 degree Celsius of setpoint and record minute changes in product temperature within the DataCORDER memory and thus meet USDA criteria (refer to section 1.11.7).



1. Dummy Receptacle
2. Power Cable
3. 12v DC Battery and Charger Module or 9 "C" Size Battery Box
4. Dummy Plug

**Figure 1-7. USDA Battery Module**

The following is a summary of the steps required to initiate a USDA Cold Treatment.

- a. Pre-cool the container to the treatment temperature or below.
- b. The product should be pre-cooled to treatment temperature.
- c. Latch in the USDA back-up battery box.
- d. Probe calibration is achieved by ice bathing the three USDA probes and performing the

"Calibrate/Monitor Probes" function on a DOS based portable computer or "Husky" interrogator. This calibration determines the three probe offsets.

e. The product is then loaded directly from the pre-cooling storage area to the container so that the product temperature does not rise.

f. Placement of probes – there are three probes required for a USDA cold treatment procedure.

Sensor 1 Place in pulp of the product located next to the return air intake.

Sensor 2 Place in pulp of the product five feet from the end of the load for 40 ft. containers and three feet from the end of the load for 20 ft. containers. This probe should be placed in a center carton at 1/2 the height of the load.

Sensor 3 Place in pulp of product five feet from the end of the load for 40 ft. containers and three feet from the end of the load for 20 ft. containers. This probe should be placed in a carton at a side wall at 1/2 the height of the load.

g. To initiate USDA Recording begin the cold treatment recording, connect the interrogator and select the "Cold Treatment Initialization/Update" option.

h. Interrogation software is available for DOS based personal computers which allow retrieval of trip data from the DataCORDER memory. Contact a Carrier service representative for details.

### 1.14 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.

#### a. The humidistat will be in operation if:

1. Supply air is in-range (in-range light illuminated).
2. Dehumidification control Code 32 is ON.
3. Controller is set above -10\_C (+14\_F).
4. Container relative humidity reaches set point of the users desired R.H. setting on the humidistat.

The above energizes the humidistat circuit 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. Set the controller set pointer within 2\_C (3.6\_F) of container supply air temperature.
3. Set the dehumidification control Code 32 to ON.

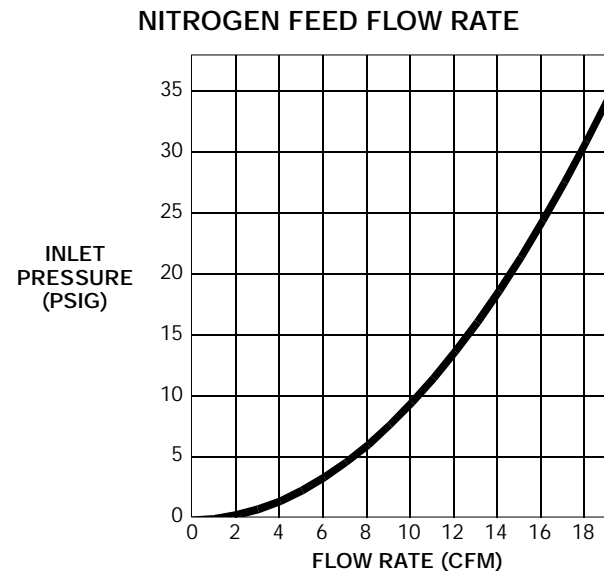
4. Turn the humidistat control knob until heaters are energized (heat light ON) and then reset control to the users desired R.H. value. Replace access panel and lockwire.

### 1.15 NITROGEN FEED (Optional)

The purpose of the option is to provide a way to inject nitrogen into the air stream of the unit. This is done by connecting a nitrogen line to the quick-connect on the front of the unit, with a 1/4" nipple conforming to the MIL-C-4109. The nitrogen can then be feed into the unit with a maximum pressure of 35 PSI which gives a flow rate of 19.2 CFM.

#### WARNING

**Do not use a nitrogen feed inlet pressure higher than 35 PSI.**



### 1.16 WATER-COOLED CONDENSER (OPTIONAL)

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

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.

#### 1.16.1 Water-Cooled Condenser with Water Pressure Switch

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 per minute = 3 to 7 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 section 1.3.)

#### 1.16.2 Water-Cooled Condenser with Condenser Fan Switch (CFS)

For operation of the refrigeration unit with the water-cooled condenser with (CFS), 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 lpm (3 to 7 gpm).
- c. Set CFS switch to position "O" when water is supplied to water-cooled condenser. This will de-energize the condenser fan relay. The condenser fan motor will stop and will remain stopped until the CFS switch is set to position "1".

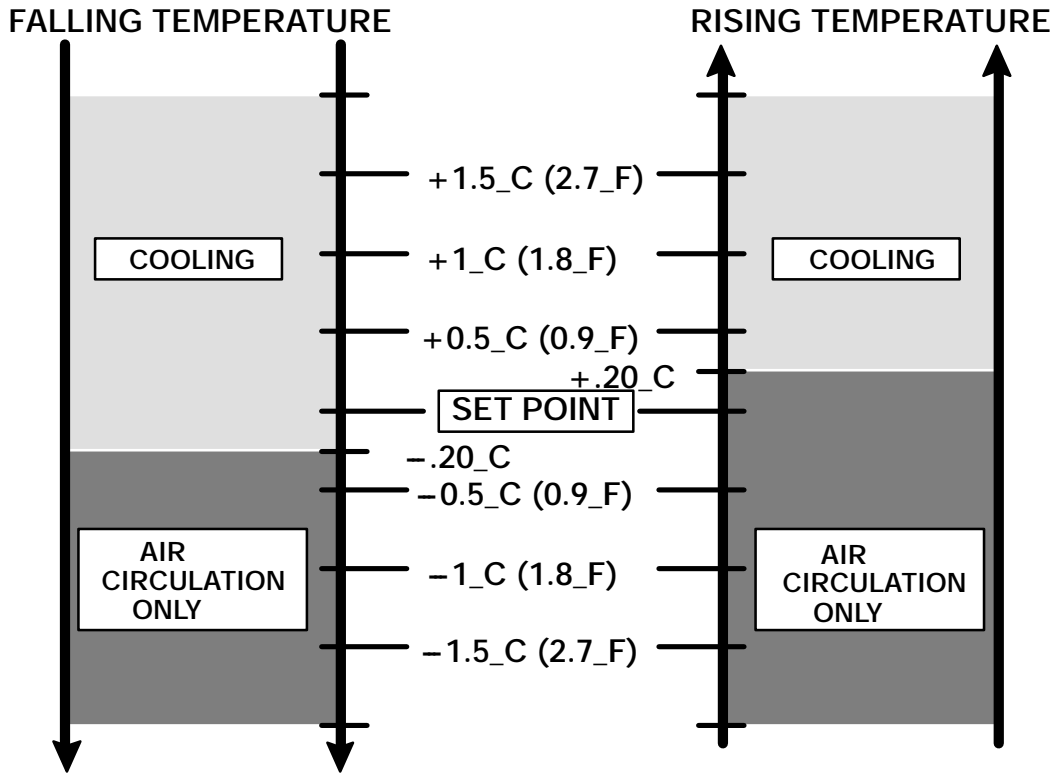
The refrigeration unit operating with the water-cooled condenser and CFS switch in position "O", will perform as outlined in section 2-4 except that the condenser fan motor is stopped in all modes.

#### WARNING

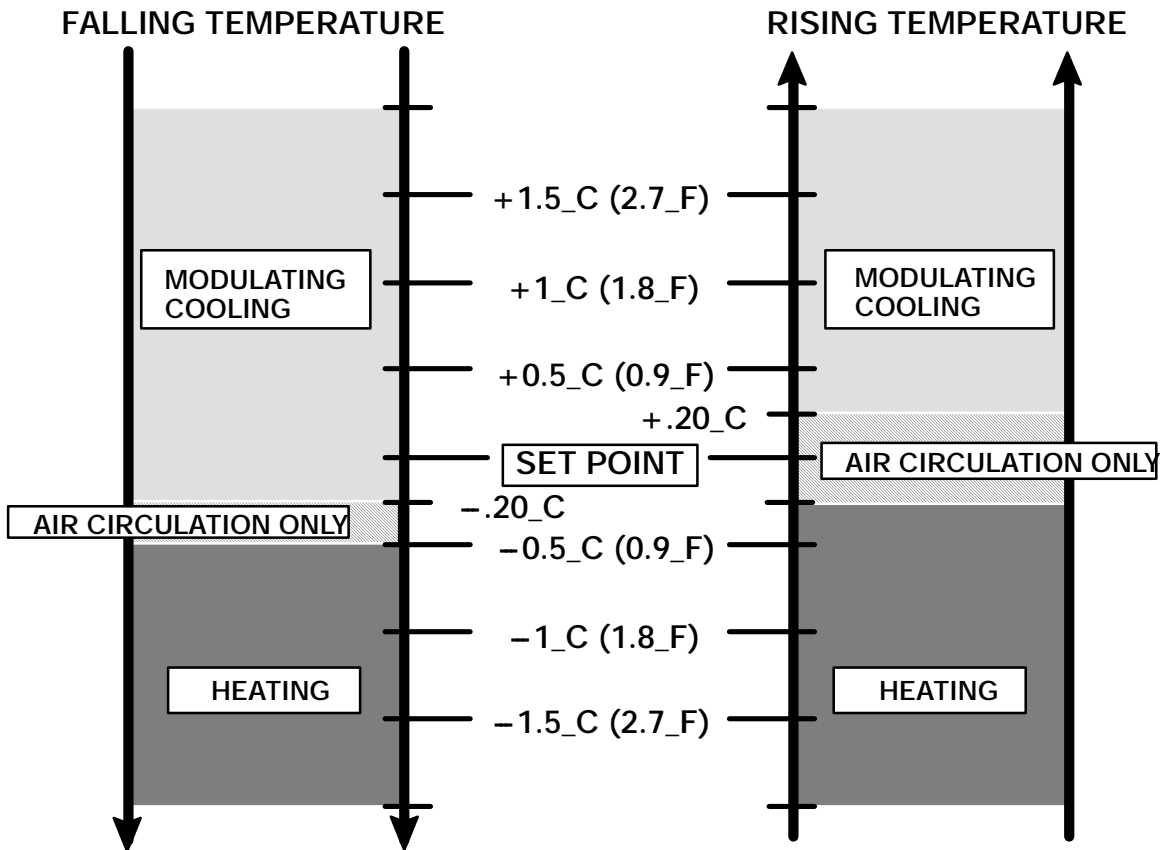
**When water flow is below 11 lpm (3 gpm) or when water-cooled operation is not in use, the CFS switch must be set to position "1" or the unit will not operate properly.**

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

Turn the unit off and set the CFS switch to position "1". Disconnect the water supply and the discharge line to the water-cooled condenser. The unit should now perform as outlined in section 2.4.



**Figure 1-8. Controller Set Point BELOW -10\_C (+14\_F)**



**Figure 1-9. Controller Set Point ABOVE -10\_C (+14\_F)**

## SECTION 2

### OPERATION

#### 2.1 PRE-TRIP INSPECTION (Before Starting)

##### WARNING

**Beware of unannounced starting of the evaporator and condenser fans.**

- 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 the chart. Then close and secure door.
- e. Open 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. Start refrigeration unit. (Refer to section 2.3.)

#### 2.2 STARTING AND STOPPING INSTRUCTIONS

##### CAUTION

**Make sure that the unit circuit breaker(s) (CB-1 & CB-2) and the start-stop switch (ST) are in the OFF position before connecting to any electrical power source.**

##### a. Starting the Unit

1. Refer to Pre-Trip Inspection, section 2.1.
2. Check power source for proper voltage. Connect unit power plug and turn main power ON.
3. Turn refrigeration unit circuit breaker(s), and the start-stop switch ON (position “1”).
4. *Units equipped with a DataCORDER:*

Trip start date is activated by simultaneously holding both Trip *Start* and *Hours Since Last Trip Start* keys.
5. Refer to section 2.3 after unit is running.

##### b. Stopping the Unit

Turn the start-stop switch to position “0” (OFF position).

#### 2.3 AFTER STARTING INSPECTION

- a. Check rotation of condenser and evaporator fans.
- b. Check compressor oil level. (Refer to section 4.10)
- c. Run unit at least 5 minutes to stabilize. Start microprocessor Pre-Trip Inspection. (Refer to section 1.11.6)

#### 2.4 UNIT OPERATION

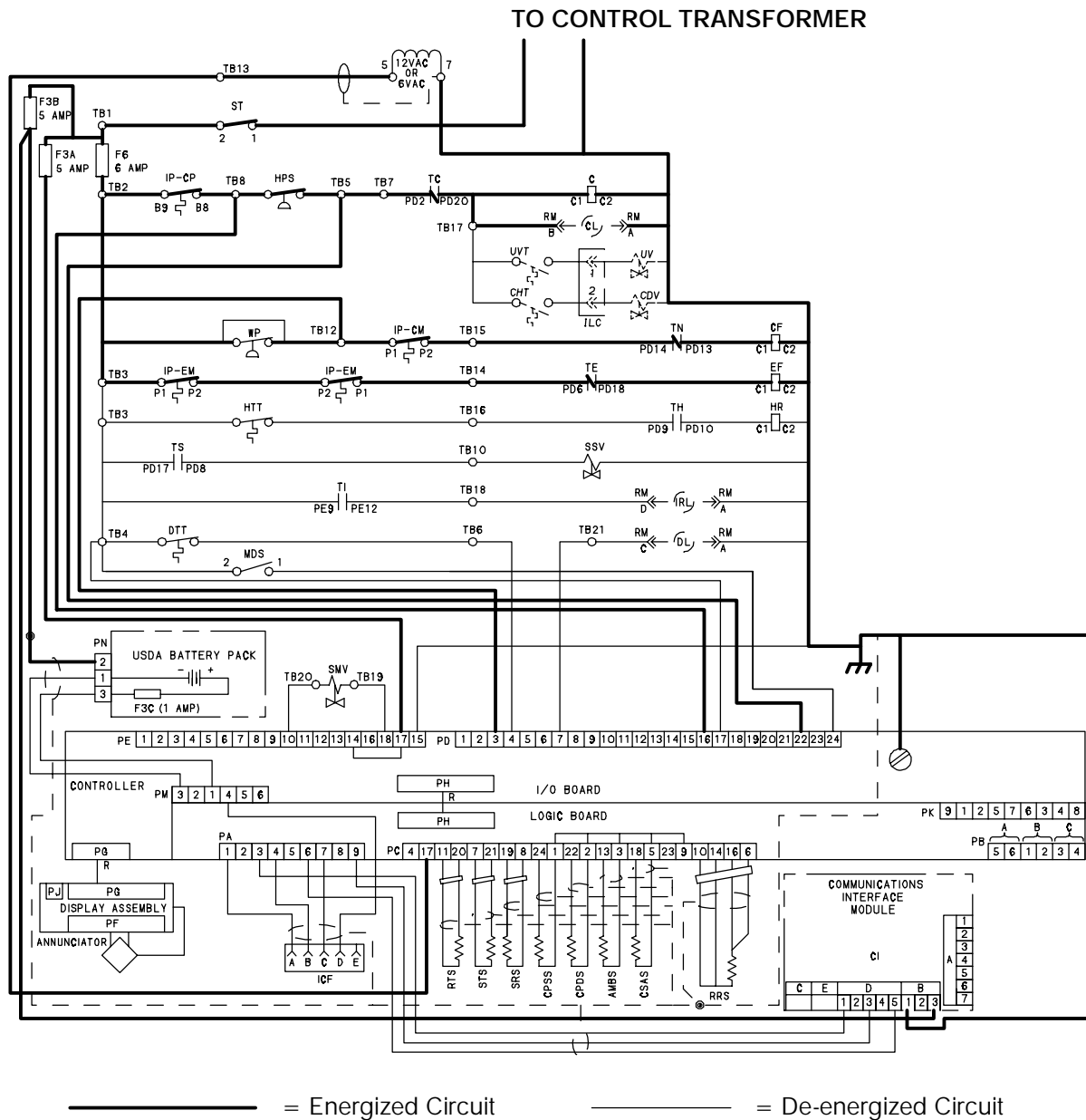
##### 2.4.1 Cooling – Controller Set BELOW –10\_C (+ 14\_F)

##### NOTES

1. The suction solenoid valve (SSV) opens to increase the refrigerant flow rate and cooling capacity at –10\_C (+ 14\_F) unless SSV override is activated.
2. In the frozen range the suction modulation valve is 100% open.
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).

When the return air temperature decreases to 0.2\_C (0.4\_F) below set point, relays TC and TN de-energizes. This results 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 0.2\_C (0.4\_F) above set point, and providing a sufficient off time period has elapsed, relays TC and TN energizes to restart the compressor and condenser fan motor. Also, at this time, the cool light is illuminated.



**Figure 2-1. Cooling**

**2.4.2 Controller Set ABOVE -10\_C (+14\_F)**  
**NOTE**

Setting the controller above -10\_C (+14\_F) on units with two-speed motors will place the motors in high speed (relay EF energizes). (Contactor ES de-energizes)

**a. Cooling (See Figure 2-1.)**

With decreasing supply air temperature and if the supply air is above set point, the unit will be cooling with the condenser fan motor, compressor motor and evaporator fan motors energized. Also, at this time, the cool light is illuminated.

When the air temperature decreases to a tolerance above set point, relay TI energizes and the in-range light is illuminated. (Refer to section 1.11.4. Code 29).

If the air temperature continues to fall, modulating cooling starts at approximately 0.2\_C (0.4\_F) above set

point. The modulating valve will have a variable current up to 1.30 amps at full modulation.

During this cooling mode, a running sum of the temperature differential (supply air temperature - set point) is kept. When the supply air falls below set point, the differential is negative. The longer supply air remains below set point, the more negative the running sum becomes.

When the supply air temperature decreases to 0.2\_C below set point and the running sum is less than -250 degrees C seconds, relays TN and TC de-energize shutting off the condenser fan and compressor motors. 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 supply air is within a tolerance of set point.



If the unit is in the holding mode (neither heating or cooling) and the supply air temperature increases to 0.2\_C (0.4\_F) above set point, and providing a 6 minute 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.

**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).

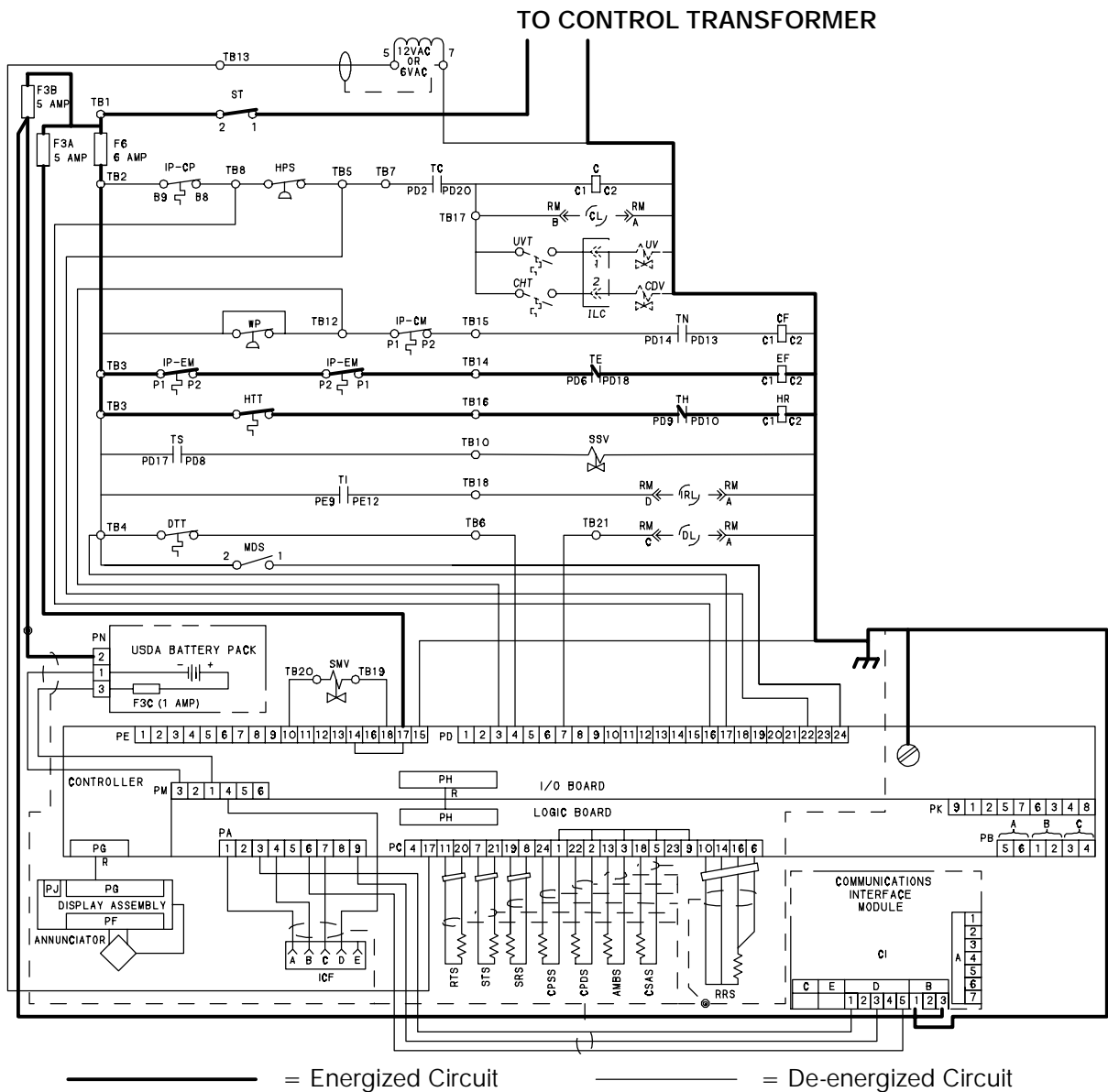
If the air temperature decreases 0.5\_C (0.9\_F) below controller set point, TH closes and the system enters the heating mode which is designed to raise the container air temperature. When TH closes, power flows through TH contacts and the heat termination thermostat to energize the heat relay (HR). This in turn energizes the heaters

and heat light. The evaporator fans continue to run to circulate air throughout the container.

As the supply air decreases to the in-range tolerance below set point, relay TI and the in-range light de-energize (after 15 minutes time delay) and will remain de-energized until the supply air increases to a tolerance below set point. (Refer to section 1.11.4 Code 29)

When the temperature rises to 0.2\_C (0.4\_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 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.



**Figure 2-2. Heating Mode**

### 2.4.3 Defrost (See Figure 2-3.)

Refer to section 1.11.4 (Code 26) for description of the defrost interval selector and automatic defrost initiation.

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

TC opens to de-energize the compressor contactor and cool light. Also (TN) relay opens to de-energize the condenser fan motor contactor (CF).

Also (TE & TV) relays open to stop the evaporator fan motors.

The in-range light remains illuminated during defrost.

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

The 54.5\_C (130\_F) heat termination thermostat (HTT) will open the circuit if the defrost mode does not terminate at 24\_C (75\_F). The controller will terminate defrost if termination does not occur within 1.0 to 1.5 hours depending on voltage. An alarm will be given of a possible DTT failure.

When the return air falls to 7\_C (45\_F), the controller checks to ensure defrost termination thermostat (DTT) closed properly. If not, a DTT failure alarm is given and the defrost mode is operated off of return temperature sensor (RTS). The defrost mode will be terminated after one hour by the controller.

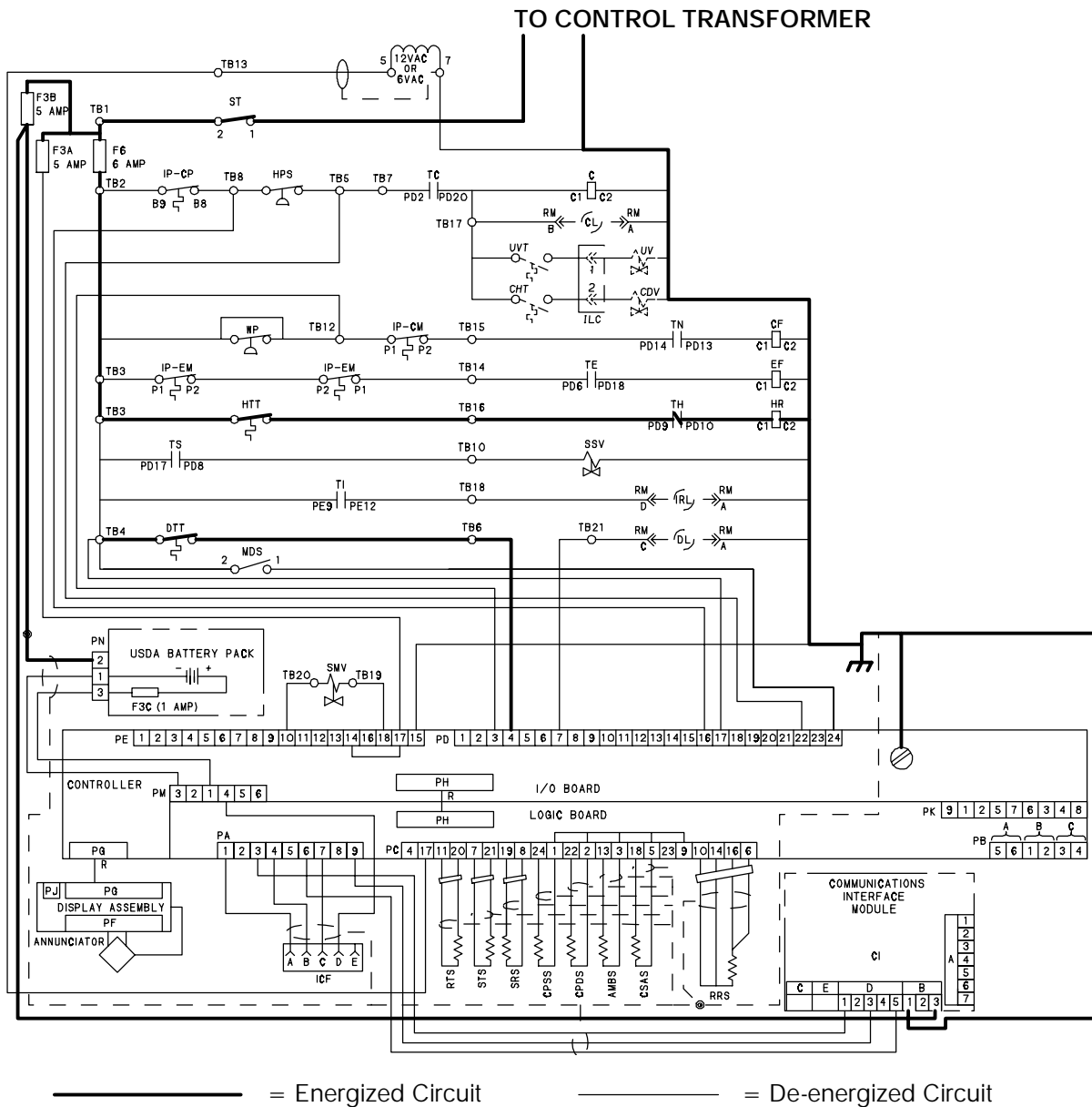


Figure 2-3. Defrost

**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
<b>Single</b> Speed Evaporator Motor Relay (EF)	Energized	Energized	Energized	Energized	De-energized
<b>High</b> Speed Evaporator Motor Relay (EF)	Energized at set points above -10_C (14_F) →				De-energized
<b>Low</b> 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
<b>INDICATING LIGHTS</b>					
Cool	ON	OFF	ON	OFF	OFF
Defrost	OFF	OFF	OFF	OFF	ON
In-Range	On - If In-Range (Refer to paragraph 1.11.4, Code 29) →				
Heat	OFF	OFF	ON	ON	ON
<b>POWER CIRCUIT</b>					
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 1.14)

**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
<b>Single</b> Speed Evaporator Motor Relay (EF)	Energized	Energized	**	**	De-energized
<b>High</b> Speed Evaporator Motor Relay (EF)	De-energized at set points below -10_C (14_F) →				
<b>Low</b> 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
<b>INDICATING LIGHTS</b>					
Cool	ON	OFF	**	**	OFF
Defrost	OFF	OFF	**	**	ON
In-Range	On - If In-Range (Refer to paragraph 1.11.4, Code 29) →				
Heat	OFF	OFF	**	**	ON
<b>POWER CIRCUIT</b>					
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)

## SECTION 3

### TROUBLESHOOTING

INDICATION/ TROUBLE	POSSIBLE CAUSES	REFERENCE SECTION
<b>3.1 UNIT WILL NOT START OR STARTS THEN STOPS</b>		
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
Loss of control power in respective branch of control circuit only	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	3.7
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
<b>3.2 UNIT RUNS BUT HAS INSUFFICIENT COOLING</b>		
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	4.24
	Suction solenoid valve malfunction	1.10/4.23
<b>3.3 UNIT OPERATES LONG OR CONTINUOUSLY IN COOLING</b>		
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	4.15/4.26
	Defective evaporator fan motor/capacitor	4.15/4.26
	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
	Compressor worn	4.7
Current limit (Code 31) set to wrong value	1.11.4	

<b>INDICATION/ TROUBLE</b>	<b>POSSIBLE CAUSES</b>	<b>REFERENCE SECTION</b>
<b>3.4 UNIT WILL NOT HEAT OR HAS INSUFFICIENT HEATING</b>		
No power to unit	Start-Stop switch OFF or defective Circuit breaker OFF or defective External power source OFF	Check Check Turn on
No control power	Circuit breaker or fuse defective Transformer defective (TR) Condenser fan internal motor protector open Evaporator fan internal motor protector open Heat relay defective  Heater termination switch open	Replace Replace 4.18 4.15 Check  4.14
Unit will not heat or has insufficient heat	Heater(s) defective Heater contactor or coil defective Evaporator fan motor(s) defective or rotating backwards Evaporator fan motor contactor defective Temperature controller malfunction Defective wiring Loose terminal connections Low line voltage	4.16 Replace 4.15/4.26 Replace 3.9 Replace Tighten 1.5
<b>3.5 UNIT WILL NOT TERMINATE HEATING</b>		
Unit fails to stop heating	Temperature controller improperly set Temperature controller malfunction Heater termination switch remains closed along with the heat relay	Reset 3.9 4.14
<b>3.6 UNIT WILL NOT DEFROST PROPERLY</b>		
Will not initiate defrost automatically	Defrost timer malfunction Loose terminal connections Defective wiring Defrost termination or heat termination switch open Heater contactor or coil defective	1.11.4 Tighten Replace 4.13 Replace
Will not initiate defrost manually	Manual defrost switch defective Defrost termination switch open	Replace 2.4.3
Initiates but relay (DR) drops out	Low line voltage	1.5
Initiates but does not defrost	Heater contactor or coil defective Heater(s) burned out	Replace 4.16
Frequent defrost	Wet load	Normal

<b>INDICATION/ TROUBLE</b>	<b>POSSIBLE CAUSES</b>	<b>REFERENCE SECTION</b>
<b>3.7 ABNORMAL PRESSURES (COOLING)</b>		
High discharge pressure	Condenser coil dirty	4.17
	Condenser fan rotating backwards	4.18
	Condenser fan inoperative	4.18
	Refrigerant overcharge or noncondensibles	4.6
	Discharge 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	4.25
	No evaporator air flow or restricted air flow	3.10
	Excessive frost on evaporator coil	3.6
	Evaporator fan(s) rotating backwards	4.14/4.26
Suction and discharge pressures tend to equalize when unit is operating	Discharge pressure regulator valve	Replace
	Heat exchanger defective	Replace
	Compressor valves defective	4.6
	Compressor cycling/stopped	Check
<b>3.8 ABNORMAL NOISE OR VIBRATIONS</b>		
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
<b>3.9 TEMPERATURE CONTROLLER MALFUNCTION</b>		
Will not control	Defective Sensor	4.22
	Defective wiring	Check
	Fuse (F3A, F3B) blown	Replace
<b>3.10 NO EVAPORATOR AIR FLOW OR RESTRICTED AIR FLOW</b>		
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	4.15/4.26
	Evaporator fan(s) loose or defective	4.15

<b>INDICATION/ TROUBLE</b>	<b>POSSIBLE CAUSES</b>	<b>REFERENCE SECTION</b>
<b>3.11 THERMOSTATIC EXPANSION VALVE MALFUNCTION</b>		
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	4.25
	Ice formation at valve seat	4.4/4.5
	Superheat too high	4.25.c
	Power assembly failure	4.25
	Loss of element/bulb charge	4.25
High suction pressure with low superheat	Broken capillary	4.25
	Foreign material in valve	
	Superheat setting too low	4.25.c
	External equalizer line plugged	Open
Liquid slugging in compressor	Ice holding valve open	4.4/4.5
	Foreign material in valve	4.25
	Pin and seat of expansion valve eroded or held open by foreign material	4.25
Fluctuating suction pressure	Improper bulb location or installation	4.25
	Low superheat setting	4.25.c
<b>3.12 POWER (AUTO) TRANSFORMER MALFUNCTION</b>		
Unit will not start	Circuit breaker (CB-2) tripped	Check
	Power transformer internal protector open	4.21
	Power transformer defective	4.21
	Power source not turned ON	Check
<b>3.13 WATER-COOLED CONDENSER OR WATER PRESSURE SWITCH MALFUNCTION</b>		
High discharge pressure	Dirty coil	4.29
	Noncondensibles	
Condenser fan starts and stops	Water pressure switch malfunction	Check
	Water supply interruption	



## SECTION 4

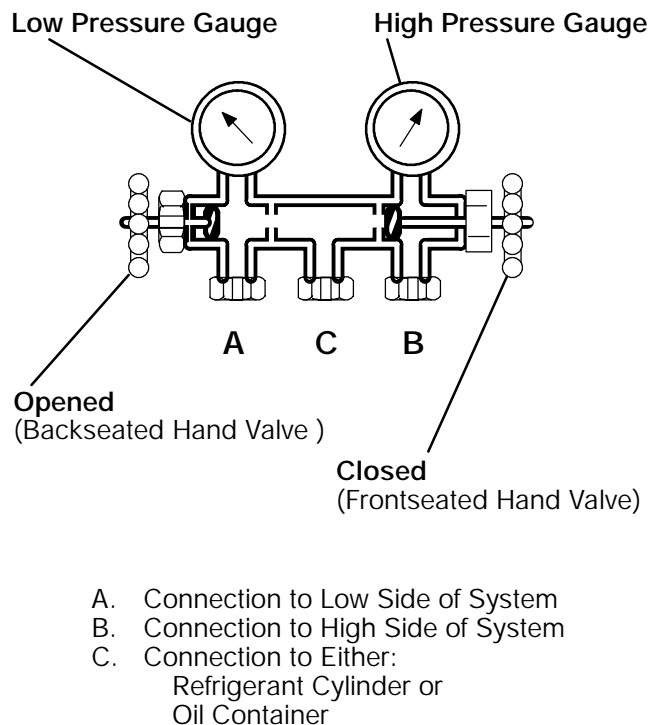
### SERVICE

#### 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.



**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 their 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:

- Midseat both hand valves.
- Connect the utility hose (yellow) to a vacuum pump.
- Evacuate to 10 inches of vacuum.
- Charge with R-134a to a slightly positive pressure of 0.1 kg/cm<sup>2</sup> (1.0 psig).
- 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:**

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

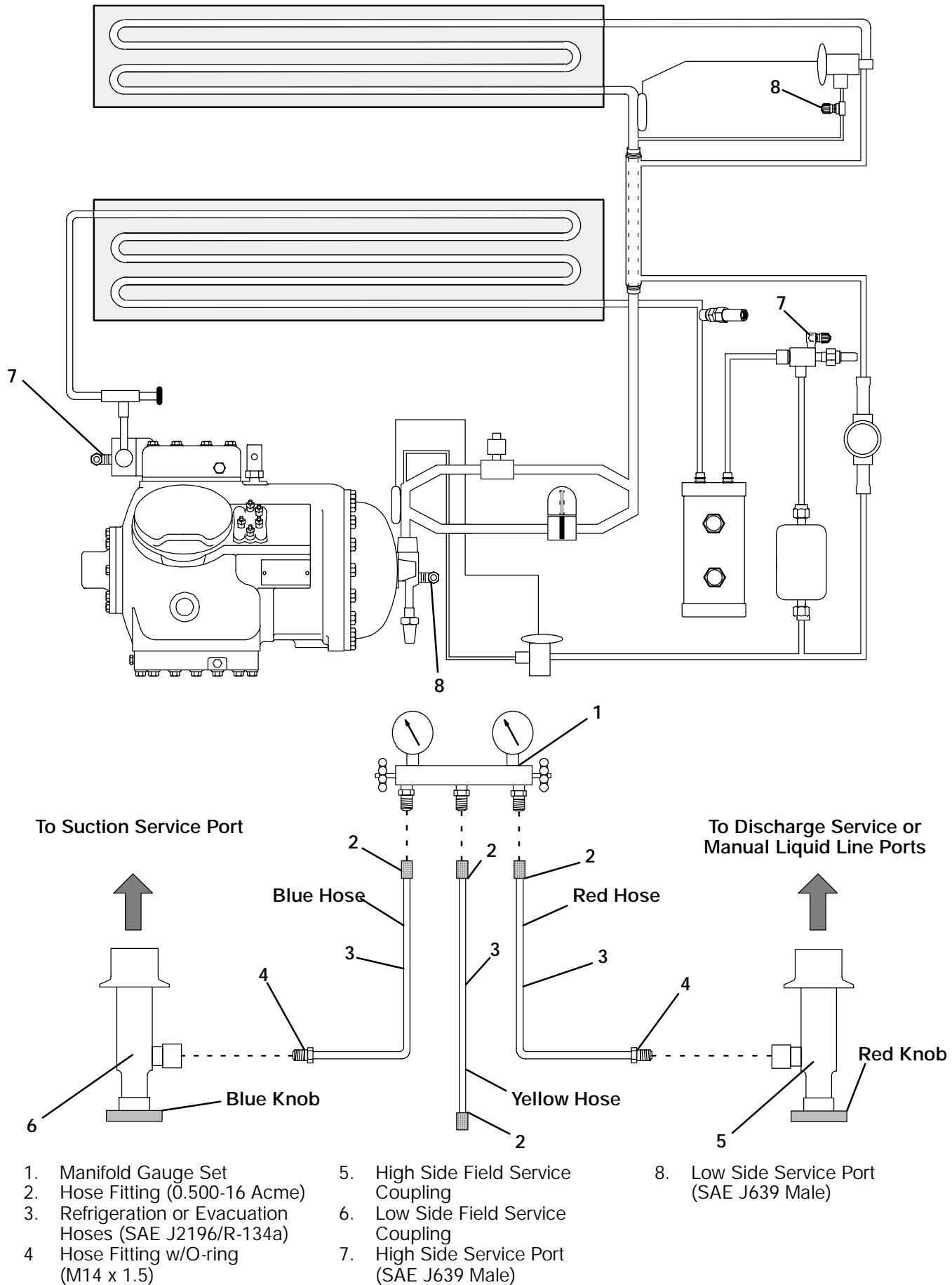
#### b. Removing the Manifold Gauge Set

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).



**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.

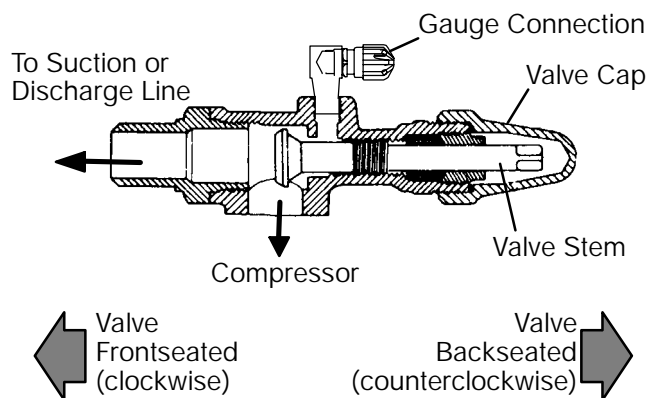


Figure 4-3. Suction or Discharge Service Valve

## 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. When working with refrigerants you must comply with all local government environmental laws, U.S.A. EPA section 608.

### 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<sup>2</sup> (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 to 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<sup>2</sup> (30 to 50 psig). Remove refrigerant cylinder and leak check all connections.

### NOTE

It must be emphasized that only the correct refrigerant cylinder be connected to pressurize the system. Any other gas or vapor will contaminate the system which will require additional purging and evacuation of the high side (discharge) 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<sup>3</sup>H = 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 REFRIGERANT CHARGE

### 4.6.1 Checking the Refrigerant Charge

#### NOTE

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).

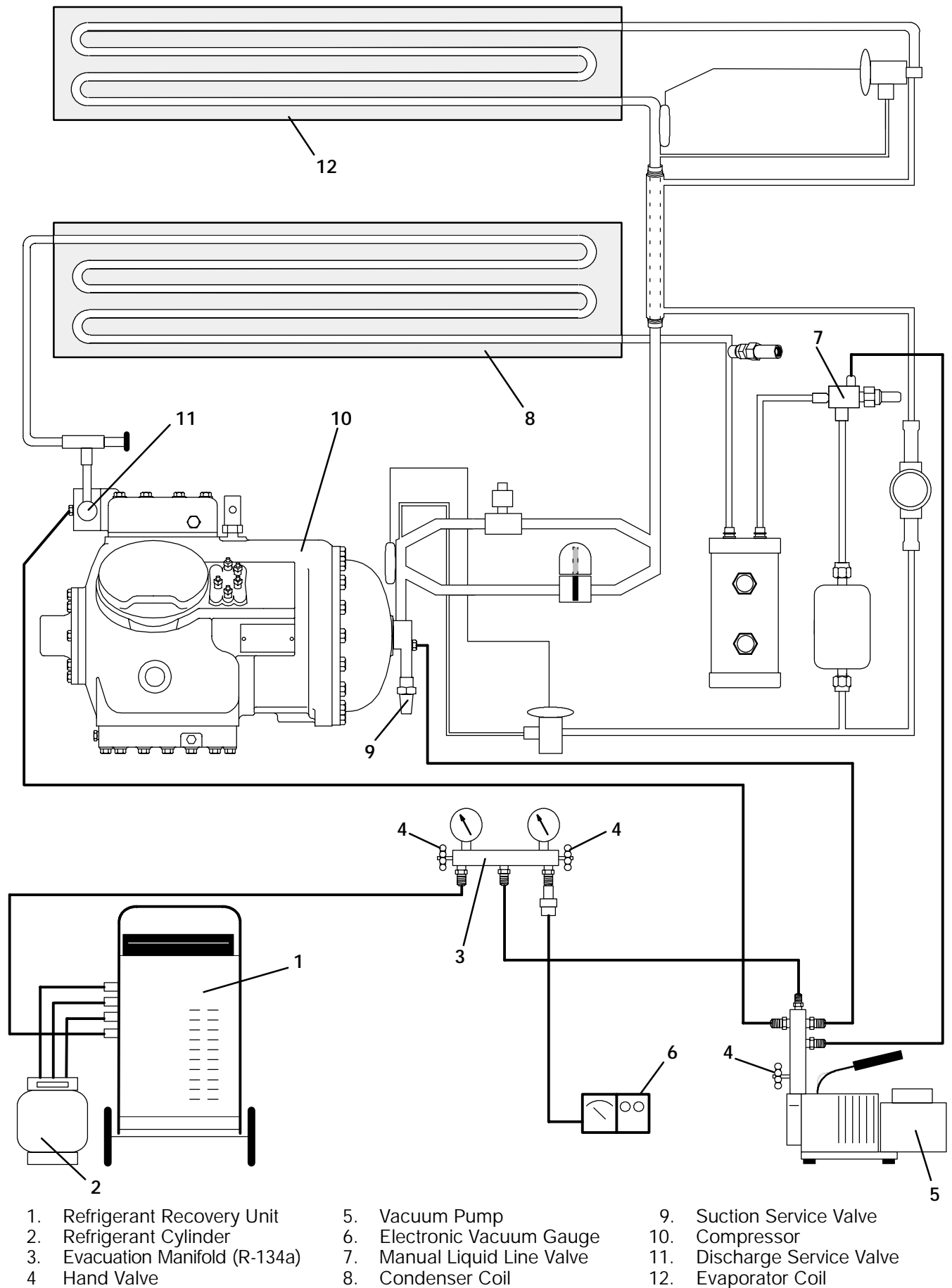
- a. Connect the gauge manifold to the compressor discharge and suction service valves.
- b. *Units equipped with the receiver;* partially block the condenser coil inlet air starting from the front of the condenser coil. Increase the area blocked until the compressor discharge pressure is raised to approximately 12 kg/cm<sup>2</sup> (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<sup>2</sup> (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 cylinder of R-134a on scale and connect charging line from cylinder to liquid line valve. Purge charging line at liquid line valve and then note weight of cylinder and refrigerant.
- c. Open liquid valve on cylinder. 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 manual liquid line valve (to close off gauge port). Close liquid valve on cylinder.
  - e. Start unit in cooling mode. Run approximately ten minutes and check the refrigerant charge. (Refer to section 4.6.1.)



**Figure 4-4. Vacuum Pump Connections**

### 4.6.3 Adding Refrigerant to System (Partial Charge)

- Examine the unit refrigerant system for any evidence of leaks. Repair as necessary. (Refer to section 4.4)
- Maintain the conditions outlined in section 4.6.1.
- Fully backseat (to close off gauge port) the suction service valve (see Figure 1-3) and remove the service port cap.
- Connect charging line between suction service valve port and cylinder of refrigerant-134a. Open VAPOR valve.
- 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 COMPRESSOR – MODEL O6DR (See Figure 4-5.)

#### WARNING

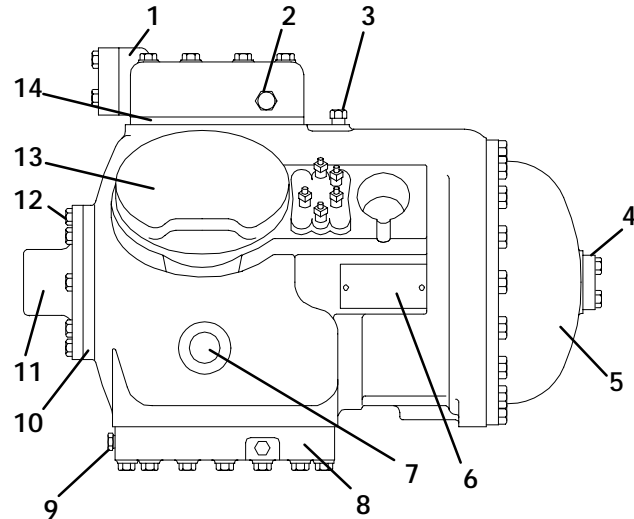
**Make sure power to the unit is OFF and power plug disconnected before replacing the compressor.**

#### NOTES

- Check the compressor Serial/Model Number plate for CFM displacement, refer to Table 1-2.
- The compressor should not operate in a vacuum greater than 50.80 cm Hg vacuum (20 inches Hg vacuum).
- 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.
- Check oil level in service replacement compressor. (Refer to sections 1.3.b. and 4.10)
- A compressor terminal wiring kit must be ordered as a separate item when ordering replacement compressor. Appropriate installation instructions are included with kit.
- Refer to Table 4-1 and Table 4-2, for applicable compressor wear limits and torque values.
- Refer to Figure 4-28 for charts on compressor pressure-temperature and motor current curves.

- Remove the protective guard from lower section of the unit.
- Remove refrigerant. (Refer to section 4.3)
- Disconnect wiring in the compressor junction box after identifying same. Disconnect wiring from compressor terminals and remove compressor junction box.
- Remove bolts from service valve flanges.
- Remove compressor plate mounting bolts.
- Remove compressor and mounting plate. The compressor weighs approximately 118 kg (260 pounds).

- Remove high pressure switch (HPS) from compressor and check operation of switch (refer to section 4.13.2).
- Remove compressor mounting bolts from mounting plate and install mounting plate on replacement compressor.
- Install replacement compressor terminal wiring kit (following instructions included with kit).
- Install high pressure switch on compressor.
- Install compressor and mounting plate in unit.



- Discharge Valve Flange
- High Pressure Switch Connection
- Low Side Pressure Connection
- Suction Valve Flange
- Motor End Cover
- Serial/Model No. Plate
- Sight Glass
- Bottom Plate
- Oil Drain Plug
- Bearing Head
- Oil Pump
- Oil Fill Plug (Refer to paragraph 4.10.c)
- Cylinder Head
- Valve Plate

**Figure 4-5. Compressor – Model O6DR**

- Install junction box to compressor and connect all wiring per wiring diagram and then install junction box cover.
- Install new gaskets on service valves.
- Install mounting bolts in service valves and torque to a value of 2.77 to 4.15 mkg (20-30 ft/lb).
- Install a new filter-drier. (Refer to section 4.12)
- 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.*
- Fully backseat (open) both suction and discharge service valves.
- Remove vacuum pump lines.

- s. Start unit and check refrigerant charge. (Refer to section 4.6.1.)
- 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.a. Add oil if necessary. (Refer to section 4.10.b)

#### 4.8 COMPRESSOR DISASSEMBLY

##### WARNING

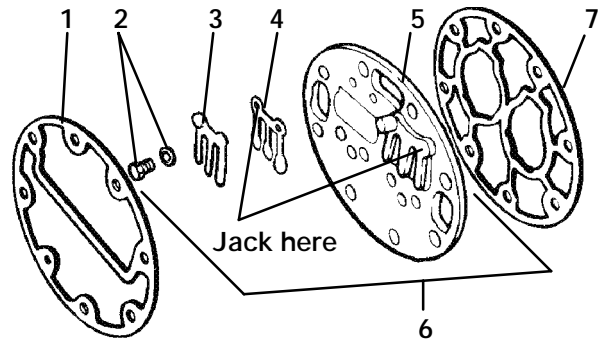
**Before disassembly of the compressor make sure to relieve the internal pressure very carefully by slightly loosening the bolts on both service valve flanges/blank valve pads, then lightly tap the sides of the valve flanges/pads with a hammer to break the seal.**

##### 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 4-1 and Table 4-2 for compressor wear limits and bolt 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.)
- b. Remove cylinder head capscrews. If the cylinder head is stuck, tap the center 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 outside discharge valve hold down capscrew as jack screw through the tapped holes of the valve plate after the valve stops and valves have been removed. Remove the 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 reassembly. Remove the bolts 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.)

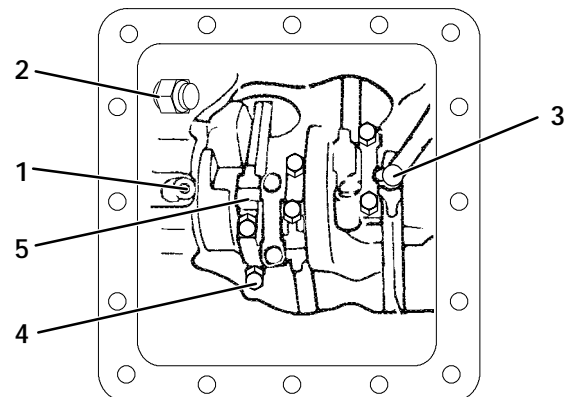


1. Cylinder Head Gasket
2. Discharge Valve Screw and Lockwasher
3. Discharge Valve Stop
4. Discharge Valve
5. Valve Plate
6. Valve Plate Assembly
7. Valve Plate Gasket

**Figure 4-6. Exploded View of Valve Plate**

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

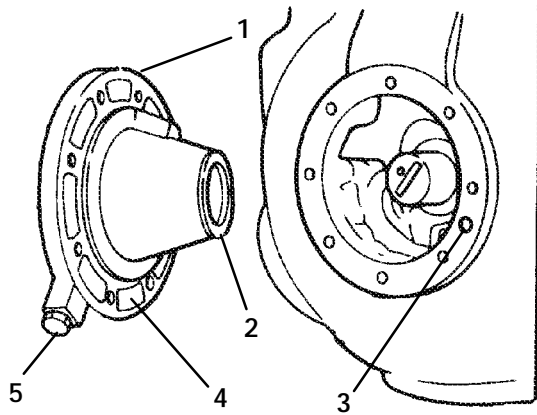
**Figure 4-7. Bottom Plate Removed**

##### 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.**

- 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,

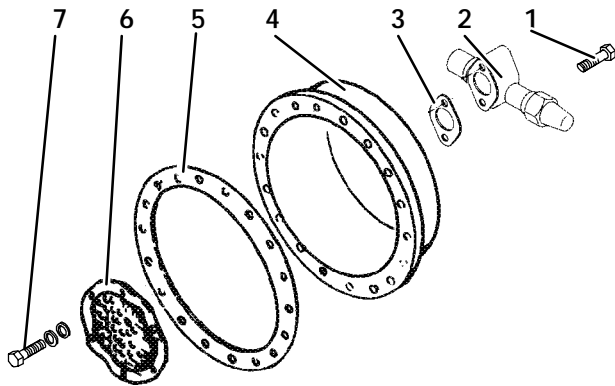
remove the remaining capscrew. Do not allow the cover to drop from its own weight. To prevent striking the winding, move the cover off horizontally and in line with the motor axis.



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

**Figure 4-8. Gear Oil Pump and Bearing Head**

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.



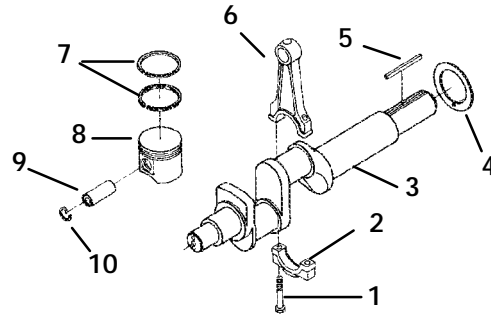
1. Valve Capscrew
2. Suction Service Valve
3. Valve Gasket
4. Motor End Cover
5. Motor End Cover Gasket
6. Suction Strainer
7. Strainer Screws and Washers

**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-compressor will facilitate removal. Each piston pin is locked in place by lock rings which are snapped into grooves in the piston wall.

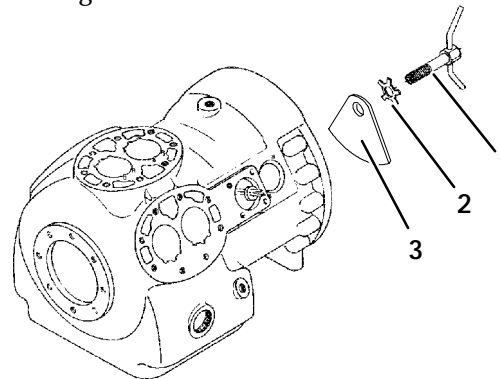


- |                    |                     |
|--------------------|---------------------|
| 1. Capscrew        | 6. Connecting Rod   |
| 2. Cap             | 7. Compression Ring |
| 3. Crankshaft      | 8. Piston           |
| 4. Thrust Washer   | 9. Pin              |
| 5. Rotor Drive Key | 10. Retainer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

**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.

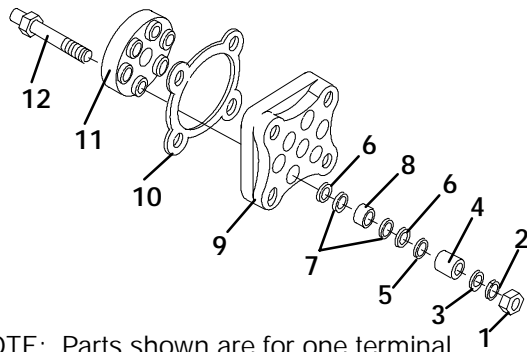


1. Equalizer Tube and Lockscrew Assy
2. Lockwasher
3. Counterweight – Motor End

**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.





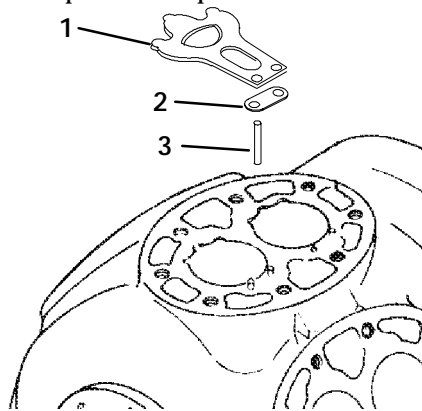
NOTE: Parts shown are for one terminal.

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 4-2, for applicable compressor torque values.



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

**Figure 4-13. Suction Valve & Positioning Springs**

##### 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.

##### 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)



**Compression ring**

**Figure 4-14. Piston Rings**

##### c. Installing the Components

1. 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 the crankshaft through the pump end of the compressor. Do not damage main bearings. 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 COMPRESSOR OIL LEVEL

##### CAUTION

**Use only Carrier Transicold approved Polyol Ester Oil (POE) – Castrol-Icematic SW20 compressor oil with R-134a. Buy in quantities of one quart or smaller. 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 to check the oil level. The correct oil level range should be between the bottom to 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

In an emergency 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 oil level at the compressor sight glass.

##### c. Adding Oil to Service Replacement Compressor

##### NOTE

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:*

First, make sure that what oil does exist in the compressor is the correct one, then add oil, (sections 1.3 and 4.10) 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 1.2 to 1.3 kg/cm<sup>2</sup> (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 1/4 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 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 filter-drier.
- 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 4.12)

## 4.12 FILTER-DRIER

If the sight glass appears to be flashing or bubbles are constantly moving through the sight glass when the suction modulation valve is fully open, 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. Pump unit down to 0 psi and replace filter-drier. (Refer to section 4.3)

b. Evacuate the unit per section 4.5 and open manual liquid line valve.

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

## 4.13 HIGH PRESSURE SWITCH

### 4.13.1 Replacing High Pressure Switch

a. Turn OFF unit start-stop switch. Frontseat both suction and discharge service valves to isolate compressor. Remove the refrigerant from the 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 1-3.)

c. Install a new high pressure switch after verifying switch settings. (Refer to section 4.13.2.)

d. Evacuate and dehydrate the compressor per section 4.5.

### 4.13.2 Checking High Pressure Switch

#### WARNING

**Do not use a nitrogen cylinder without a pressure regulator. Do not use oxygen in or near a refrigeration system as an explosion may occur.**

#### NOTE

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

a. Remove switch as outlined in section 4.13.1.

b. Connect ohmmeter or continuity light across switch terminals. Ohm meter will indicate no resistance and continuity light will be illuminated if switch closed after relieving compressor pressure.

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

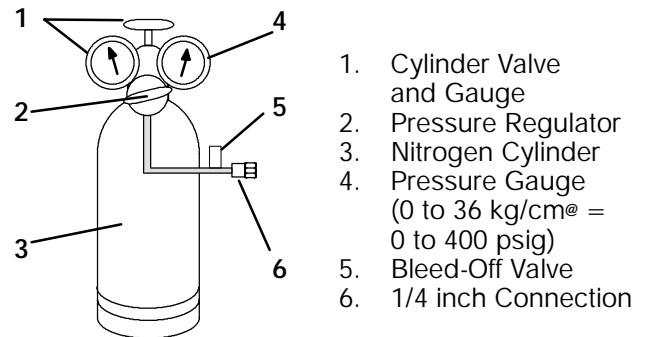
d. Set nitrogen pressure regulator at 26.4 kg/cm<sup>2</sup> (375 psig) with bleed-off valve closed.

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 should open at a static pressure up to 26 kg/cm<sup>2</sup> (350 psig). If light is used,

light will go out and if ohmmeter is used, the meter will indicate open circuits.

g. Slowly open bleed-off valve to decrease the pressure. The switch will close at 17.6 kg/cm<sup>2</sup> (250 psig).



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

## 4.14 EVAPORATOR COIL & 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 Evaporator Coil:*

a. Pump down unit. (See Figure 1-3 and refer to 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 4.6.2.

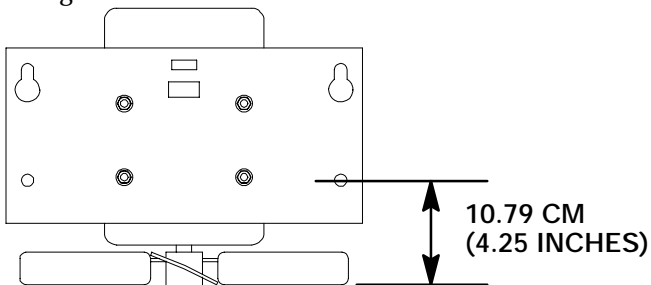
#### 4.15 EVAPORATOR FAN & MOTOR ASSEMBLY

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 section 1.4.f.) The fan motor bearings are factory lubricated and do not require additional grease.

##### WARNING

**Always turn OFF the unit circuit breakers (CB-1 & CB-2) and disconnect main power supply before working on moving parts.**

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



**Figure 4-16. Evaporator Fan Locating Dimension**

- Connect wiring per applicable wiring diagram and install motor and fan assembly in unit. Apply power, momentarily, to check fan rotation. (Refer to section 1.4.f.) If fan spins backwards, refer to section 4.26 for two-speed motors.

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

#### 4.16 EVAPORATOR COIL HEATERS

##### WARNING

**Before servicing unit, make sure the unit circuit breakers (CB-1 & CB-2) and the start-stop switch (ST) are in the OFF position. Also disconnect power plug and cable.**

- Remove the lower access panel (Figure 1-1) by removing the T.I.R. locking device lockwire and mounting screws.
- Determine which heater(s) need replacing by checking resistance on each heater as shown in section 1.4.e.
- Remove hold-down clamp securing heaters to coil.

- 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 or aluminum 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 the condenser fan grille before turning power OFF and disconnecting power plug.**

*To Replace Condenser Coil:*

- Remove the refrigerant charge per section 4.3.
- Remove the condenser coil guard.
- Unsolder discharge line and remove the line to the receiver or water-cooled condenser (if so equipped).
- Remove coil mounting hardware and then remove the coil.
- Install replacement coil and solder connections.
- Leak check the coil per section 4.4. Evacuate the unit per section 4.5 and then, charge the unit with refrigerant per section 4.6.1.

#### 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 through the front of the unit.

- Open condenser fan screen guard.
- 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.**

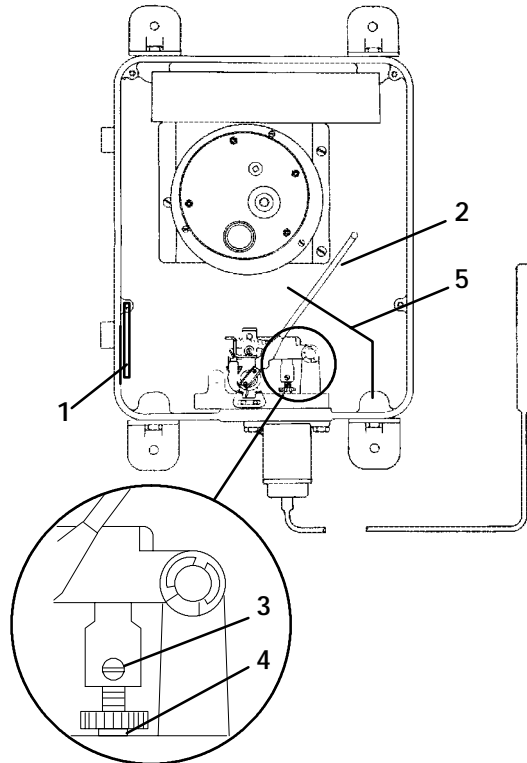
- Remove motor mounting hardware and replace the motor. It is recommended that new locknuts be used when replacing motor. Connect wiring per wiring diagram.
- Install fan loosely on motor shaft (hub side in). Install venturi. Apply “Loctite H” to fan set screws. Adjust fan within venturi so that the outer edge of the fan projects (7.9 mm = 5/16”) out from edge of venturi. Spin fan by hand to check clearance.
- 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.



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

**Figure 4-17. Partlow Recording Thermometer**

##### 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:

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

A resistance thermometer with RCA lead and 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 para. b.)

##### Ohmmeter:

1. Place one probe of ohmmeter in the middle of the receptacle provided on the chart platen, Figure 4-17, and ground other probe to unit.
2. Note reading of meter and using Table 4-3, convert resistance to temperature.

##### 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 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.

##### Unit Running:

Place set point at 0\_C (32\_F). After unit has pulled down to this temperature, allow the 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.

##### 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 the 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 the 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 upper 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 sections 4.18.a. through 4.18.d.)
9. Install inlet air grille and upper panel. Start unit and check recorder calibration.

## **CAUTION**

**Capillary tubing may be bent, but never sharper than 1/2" 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 POWER (AUTO) TRANSFORMER (OPTIONAL)**

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

- a. Make sure circuit breaker (CB-2) is in the ON position. If CB-2 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 (CB-1 and CB-2) 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.

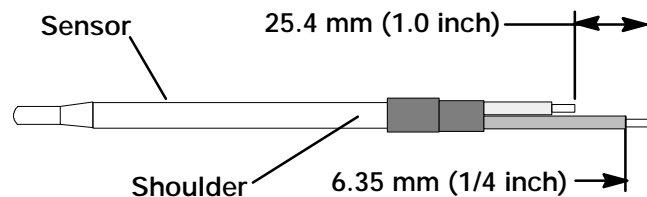
### **4.22 SENSOR CHECKOUT PROCEDURE (RRS, RTS, SRS & STS)**

- a. Place the sensor (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.
- b. Start unit and check air temperature/data readout on the microprocessor control panel. You should have a reading of 0\_C (32\_F); if not, continue on to the following step.

- c. Turn unit OFF and disconnect power supply.
- d. Remove two capscrews and lower the Microprocessor Control Panel.
- e. Remove three screws and loosen three other screws to remove cover (Item 3, Figure 4-25).
- f. In the box there are wires marked supply and return. Follow the wire to the plug connector and using the pins of the plug, measure the ohms resistance. Readings are shown in Table 4-4.

#### 4.22.1 Replacing 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") shorter than the other wire. (See Figure 4-18.)



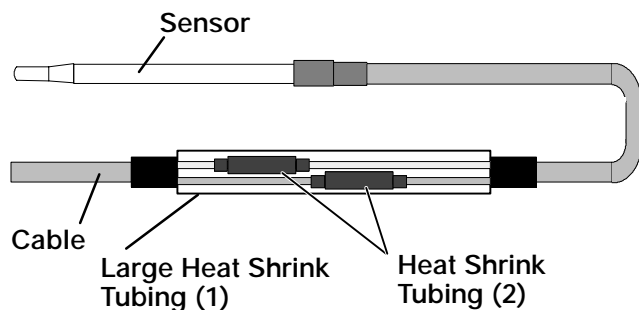
**Figure 4-18. Sensor (RRS, RTS, SRS & STS)**

- d. Cut one replacement sensor wire (opposite color) back 41 mm (1-5/8").
- e. Strip back insulation on all wiring 6.35mm (1/4").

#### 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 the cable and the two small pieces of heat shrink tubing over the wires before adding crimp fittings as shown in Figure 4-19.



**Figure 4-19. Sensor and Cable Assembly**

- 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 4-19.

- 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.

#### 4.23 SUCTION SOLENOID VALVE

##### a. Replacing the Coil

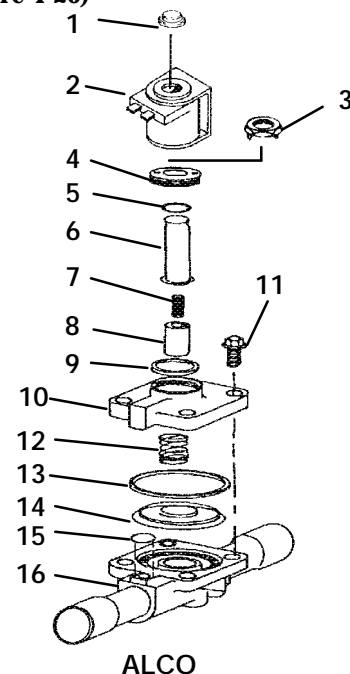
#### NOTE

The coil may be replaced without removing the refrigerant.

- 1. Disconnect leads. Remove snap cap or locknut. Lift off coil. (See Figure 4-20)

- 2. Verify coil type, voltage and frequency of old and new coil. This information appears on the coil housing.

##### b. Replacing Valve Internal Parts – Alco (See Figure 4-20)



- |                                  |               |
|----------------------------------|---------------|
| 1. Snap Cap                      | 9. Gasket     |
| 2. Coil                          | 10. Top Plate |
| 3. Installation/<br>Removal Tool | 11. Capscrews |
| 4. Enclosing Tube Collar         | 12. Spring    |
| 5. O-Ring                        | 13. Gasket    |
| 6. Enclosing Tube                | 14. Diaphragm |
| 7. Spring                        | 15. O-Ring    |
| 8. Plunger                       | 16. Body      |

**Figure 4-20. Suction Solenoid Valve – Alco**

1. Pump down the unit. (Refer to section 4.3)
2. Remove snap cap, and coil.
3. Remove enclosing tube collar (item 4, Figure 4-20) using installation/removal tool supplied with repair kit (item 3).
4. Check plunger for restriction due to: (a) Corroded or worn parts; (b) Foreign material lodged in valve; (c) Bent or dented enclosing tube.
5. Remove top plate, diaphragm spring, diaphragm and body gaskets.
6. Install new parts, assemble in reverse order of disassembly.
7. Torque the 4 capscrews to 40 inch pounds.
8. Do not overtighten enclosing tube assembly. Torque to a value of 1.15 mkg (100 inch pounds).
9. Remove supplied installation/removal tool. Install coil, and snap cap.
10. Dehydrate and evacuate the system. (Refer to section 4.5) Charge unit with refrigerant per section 4.6.2.
11. Connect leads. Start unit and check operation.

#### 4.24 SUCTION MODULATION VALVE (SMV)

##### NOTE

When repairing 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 4-21) Proper alignment of these items is achieved only at the factory.

##### a. Coil Checkout Procedure

##### WARNING

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

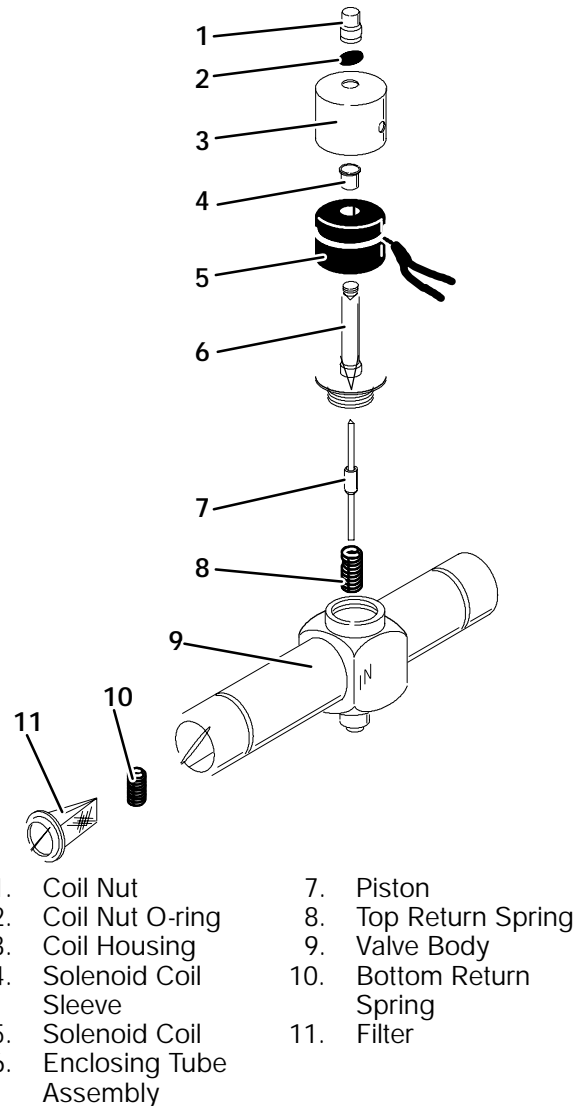
1. Disconnect the modulation valve coil wires from their terminal locations (Refer to section 5).
2. Using a reliable digital ohmmeter, test each lead's resistance to ground. If the resistance indicates a ground short is present, inspect the length of wiring for damaged or exposed wires. Replace where 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

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

##### 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.



**Figure 4-21. Suction Modulation Valve**

##### b. Replacing the Coil

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

##### c. To Replace Valve

1. Pump down the unit per section 4.3.
2. Remove two bolts from suction service valve.
3. Melt solder at modulating valve connection and rotate valve and tubing enough to clear compressor. Remove valve and tubing. Replace defective suction modulation solenoid valve being careful to wrap body of replacement valve with a wet cloth while brazing. The coil need not be removed.

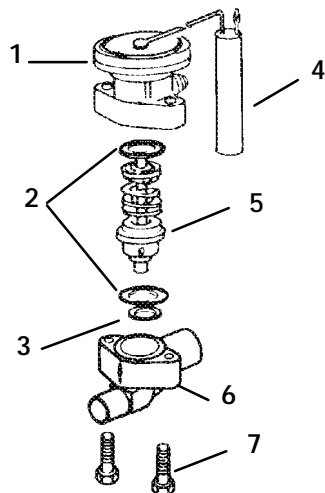


4. Install new suction service valve gasket and install bolts in suction service valve. Torque to a value of 2.77 to 4.15 mkg (20 to 30 ft/lb).
5. Solder all connections and leak check same.
6. Dehydrate and evacuate the unit per section 4.5 and then add refrigerant charge per section 4.6.2.

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



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

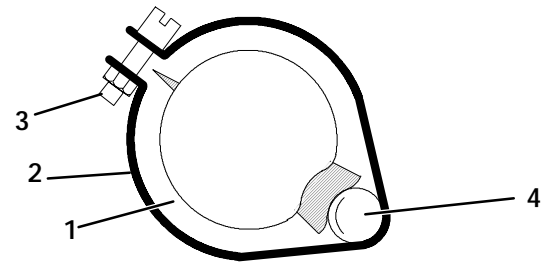
**Figure 4-22. Thermostatic Expansion Valve**

#### a. Removing Expansion Valve

1. Pump down the unit 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 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 4.6.2.
3. Clean suction line with sandpaper before installing bulb to ensure proper heat transfer. Strap thermal bulb to suction line, making sure bulb is placed firmly into the indentation of the suction line. See Figure 4-23 for bulb placement.



1. Suction Line
2. TXV Bulb Clamp
3. Nut and Bolt

**Figure 4-23. Thermostatic Expansion Valve Bulb**

4. Check superheat. (Refer to section 1.3 and see Table 4-6.) Verify at  $-18_C$  ( $0_F$ ) container box temperature.

#### c. Checking Superheat

##### NOTE

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

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 sensor.
3. Connect an accurate gauge to the service port.
4. Run unit until box temperature has stabilized. Set controller  $5.5_C$  ( $10_F$ ) below container temperature.

##### NOTE

Suction pressure must be  $0.5 \text{ kg/cm}^2$  (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  $3.44 \text{ kg/cm}^2$  (49 psig).

5. From the temperature/pressure chart (Table 4-6), 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.

**4.26 EVAPORATOR FAN MOTOR CAPACITORS**

The evaporator fan motors are of the permanent-split capacitor type. The motor is equipped with one capacitor (used in the 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) cause the motor to run in high speed.

Controller settings below -10\_C (+14\_F) 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 the 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 the unit and capacitor may be serviced after disconnecting power plug.

(b) *If container is full*, turn the 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 the 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* of capacitor with one of the same value.

2. *Volt-ohmmeter set 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.

**4.27 HUMIDISTAT**

**a. Maintenance**

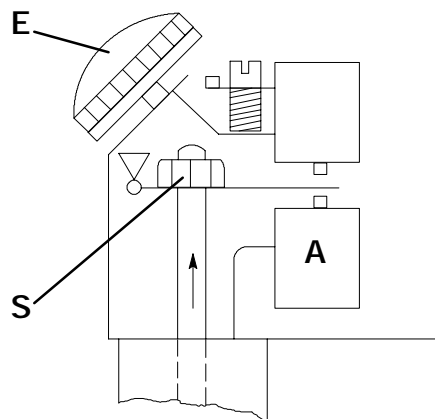
Soiled sensing elements can be cleaned by dipping the stem in soapy fresh water or fresh water with washing powder (max. 80\_C = 176\_F).

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 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:



**Figure 4-24. Humidistat**

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%

## 4.28 MICROPROCESSOR CONTROLLER

### NOTE

For manual override operation of the microprocessor, refer to Table 4-7.

### CAUTION

**When doing any arc welding on the unit or container, disconnect all connectors from controller and remove ground lead going to I/O board to prevent any damage due to electrostatic discharge.**

#### a. Handling of Microprocessor Controllers

Here is a list of guidelines that should be followed when handling a microprocessor controller. These steps should be implemented when replacing the controller, when doing *any* arc welding on the unit, or *when service to the refrigeration unit requires handling and removal of the controller*.

1. Obtain a grounding wrist strap and a static dissipation mat. The wrist strap, when properly grounded, will dissipate any potential built up on the body. The dissipation mat will provide a static free work surface to place and/or service the microprocessor controller. Note: Use a dissipation mat such as the 3M 8501 Static Protective Field Service Kit or equivalent. For information write: Static Control Systems Division/3m, P.O. Box 2963, Austin, Texas 78769-2963.

2. Disconnect power to the unit.

3. Attach the ground or clip end of the wrist strap to any exposed metal area on the refrigeration unit frame (bolts, screws, etc.).

4. Carefully remove the microprocessor controller. Do not touch any of the electrical components if possible. Place the controller on the static mat. If arc welding is to be performed on the unit, it is not necessary to remove controller. Simply disconnect all connectors from controller and remove ground lead going to I/O board.

5. At this point, if you are servicing the refrigeration unit, you are free to remove the ground strap from your wrist and complete your work.

5a. Upon completion of your service work put the wrist strap back on, and re-install the controller into the refrigeration unit.

6. If you are replacing the controller, do not remove the wrist strap. Remove the new microprocessor controller from its packaging and install it on the refrigeration unit. Place the old controller into the same packaging that accompanied the new controller. *Make sure that you package it in the exact same manner*.

### NOTE

This packaging has been designed to protect the controller from both physical and electrostatic discharge damage during storage and transit.

#### b. Removing and Installing Microprocessor Control Box

1. Remove two screws (item 5, Figure 4-25) and swing control panel (item 6) down.

2. Remove three screws and loosen three other screws to remove cover (item 3).

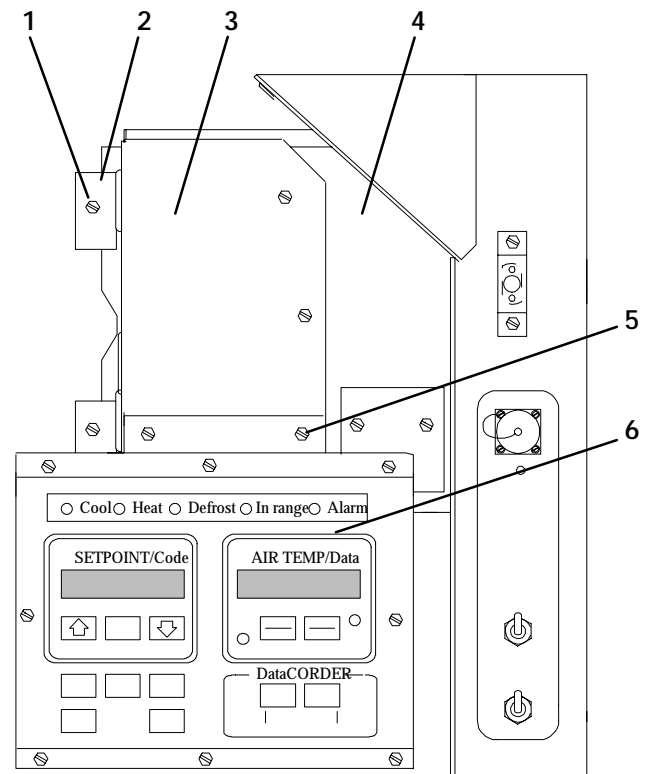
3. Disconnect all plug connectors and move wiring out of the way.

4. Remove two screws (item 1) and slide microprocessor control box (item 4) and two spacers (item 2) to the left and out.

### NOTE

There are two spacers in the right hand side of the electrical box. DO NOT LOOSEN these spacers as they are factory positioned.

5. Install microprocessor control box by reversing the above steps.



1. Screw
2. Spacer
3. Cover
4. Microprocessor Control Box
5. Screw
6. Microprocessor Control Panel

**Figure 4-25. Microprocessor Control Box**

## 4.29 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 their suggestions in planning the procedure. They 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. Their 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<sup>2</sup> (0 to 500 psig) on the compressor discharge service valve.

For example: if the discharge pressure is 10.3 kg/cm<sup>2</sup> (146.4 psig), and referring to Table 4-6, R-134a pressure-temperature chart, the 10.3 kg/cm<sup>2</sup> (146.4 psig) converts to 43\_C (110\_F).

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

- Turn unit off and disconnect main power.
- 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.

#### What You Will Need:

- Oakite composition No. 22, available as a powder in 68 kg (150 lb) and 136 kg (300 lb).
- 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.
- Fresh clean water.
- Acid proof pump and containers, or bottles with rubber hose.

#### What You Will Do – (Summary):

- Drain water from condenser tubing circuit. Clean water tubes with Oakite No. 22 to remove mud and slime.
- Flush.
- De-scale water tubes with Oakite No. 32 to remove scale.
- Flush.
- Neutralize.
- Flush.
- Put unit back in service under normal load and check head (discharge) pressure.

#### Detailed Procedure:

- 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.
- To remove slime or mud, use Oakite composition No. 22, mixed 170 grams (6 ounces) per 3.785 liters (1 U.S. gallon) of water. Warm this solution and circulate through the tubes until all slime and mud has been removed.
- After cleaning, flush tubes thoroughly with fresh clean water.
- 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 (1 U.S. pint) of the acid (Oakite No. 32) to 2.8 liters (3 U.S. quarts) of 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.**

- Fill the tubes with this solution by filling from the bottom. See Figure 4-26. Important: – be sure to provide a vent at the top for escaping gas.

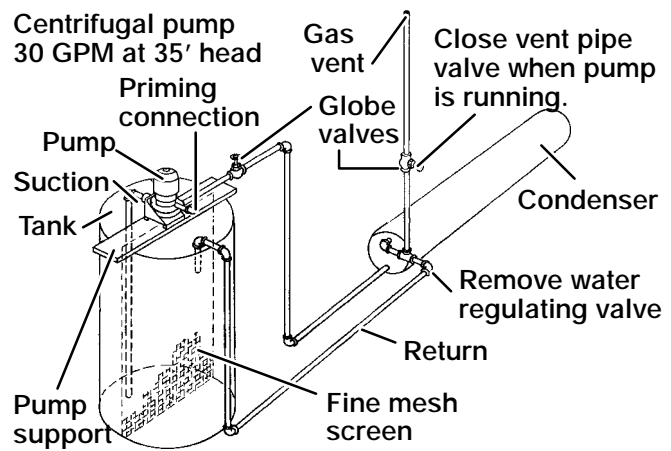


Figure 4-26. Water-Cooled Condenser Cleaning – Forced Circulation

6. 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 4-27) 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.*

7. 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.

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

9. Next circulate a 56.7 gram (2 ounce) per 3.785 liter (1 U.S. gallon) solution of Oakite No. 22 thru the tubes to neutralize. Drain this solution.

10. 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.

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

#### 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.

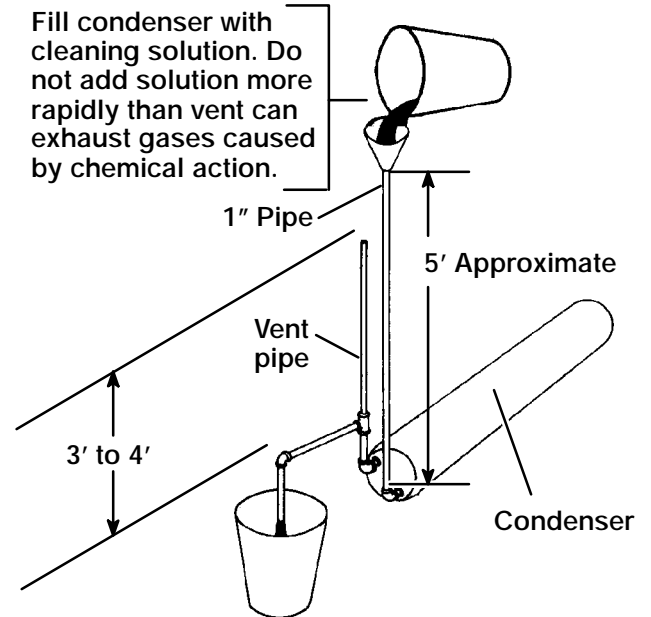


Figure 4-27. Water-Cooled Condenser Cleaning – Gravity Circulation

**Table 4-1. 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						
Piston Pin Bearing	1.3768	34.9707	0.6878	17.4701	.0010	0.0254
CRANKPIN DIAMETER			1.3735	34.8869	.0025	0.0635
Throw	1.072	27.2288	1.070	27.1780		
THRUST WASHER (Thickness)	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	0.002	00.0508	0.0010	00.0254	.0020	0.0508

**Table 4-2. 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 4-3. 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 4-5. Recommended Bolt Torque Values**

BOLT DIA.	THREADS	TORQUE	MKG
<b>FREE SPINNING</b>			
#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
<b>NONFREE SPINNING (LOCKNUTS ETC.)</b>			
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. RRS, RTS, SRS & STS Sensor Temperature-Resistance Chart**

Temperature Centigrade	Temperature Fahrenheit	Resistance (Ohms)
<b>SENSOR, Resistance Temperature Detector (RTD)</b>		
<b>-- PART NO. 12-01119-00</b>		
0	32	100   .039
25	77	109.7   .05
<b>SENSOR, RTD -- PART NO. 12-00306-00</b>		
0	32	100   .039
25	77	109.9   .05
<b>SENSOR, Thermistor -- PART NO. 12-00278-01</b>		
0	32	32,650   91
25	77	10,000   50



**Table 4-6. Temperature-Pressure Chart – R-134a**  
**BOLD FIGURES = Inches Mercury Vacuum (cm Hg Vac)**

LIGHT FIGURES = psig (kg/cm<sup>2</sup>)

TEMPERATURE		PRESSURE			TEMPERATURE		PRESSURE		
°F	°C	Psig	Kg/cm <sup>2</sup>	Bar	°F	°C	Psig	Kg/cm <sup>2</sup>	Bar
-40	-40	<b>14.6</b>	<b>37.08</b>	--.49	30	-1	26.1	1.84	1.80
-35	-37	<b>12.3</b>	<b>31.25</b>	--.42	32	0	27.8	1.95	1.92
-30	-34	<b>9.7</b>	<b>24.64</b>	--.33	34	1	29.6	2.08	2.04
-25	-32	<b>6.7</b>	<b>17.00</b>	--.23	36	2	31.3	2.20	2.16
-20	-29	<b>3.5</b>	<b>8.89</b>	--.12	38	3	33.2	2.33	2.29
-18	-28	<b>2.1</b>	<b>5.33</b>	--.07	40	4	35.1	2.47	2.42
-16	-27	<b>0.6</b>	<b>1.52</b>	--.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

**Table 4-7. Manual Override Operation of Microprocessor**

MODE	STEP	OPERATION	DISCONNECT WIRE	JUMPER WIRE
Full Cooling	1	Condenser Fan	PD14 to TB15 from TB15	TB15 to CFC1
	2	Compressor	PD2 to TB7 from TB7	TB7 to CC1
	3	Evaporator Fan	PD6 to TB14 from TB14	TB14 to EFC1
Low Heating	3	Evaporator Fan	Perform step 3	Perform step 3
High Heating	3 & 4	Resistance Heaters & Evap. Fans	Perform steps 3 & 4	Perform steps 3 & 4
Defrost	4	Resistance Heaters	PD9 to TB16 from TB16	TB16 to HRC1

**WARNING**

**Make sure power to unit is OFF (CB-1 & CB-2) and power plug(s) disconnected before working inside the control box.**

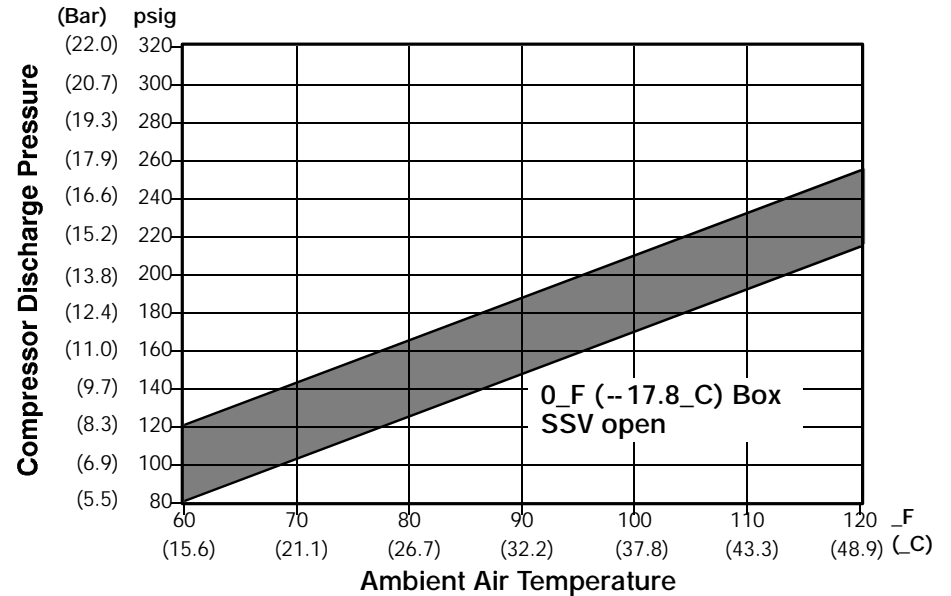
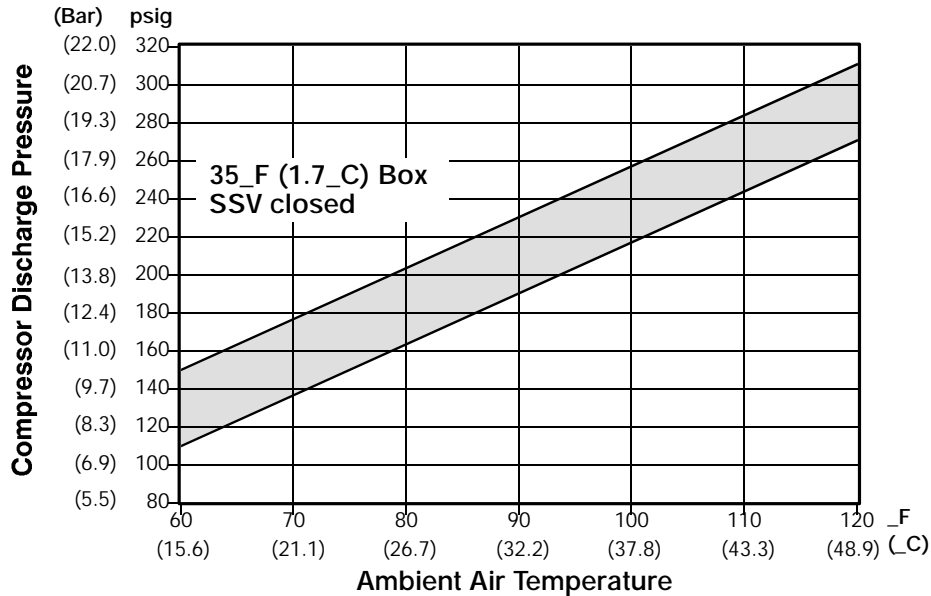
**CAUTION**

**Overheating and cycling of heaters by HTT will result if unit is left in a defrost condition (step 4) after all frost has been melted from the evaporator coil and water ceases running from the drain hose.**

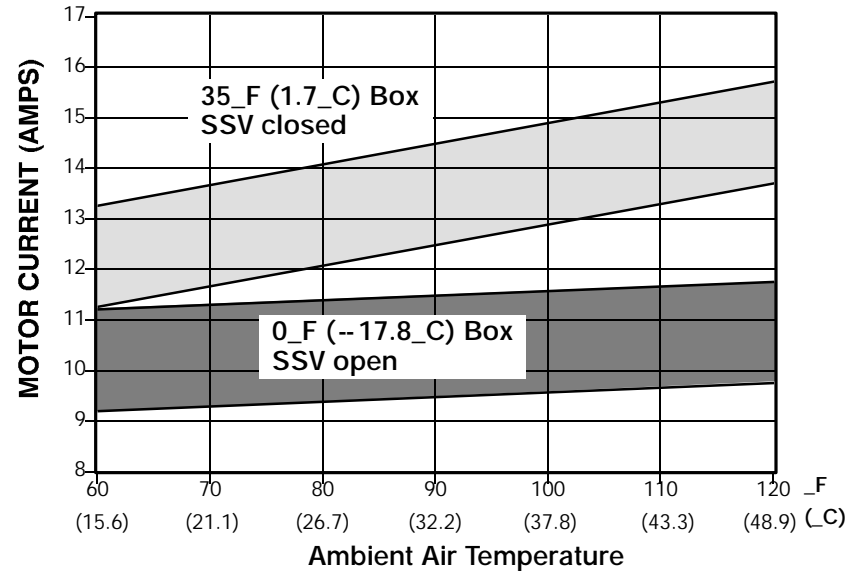
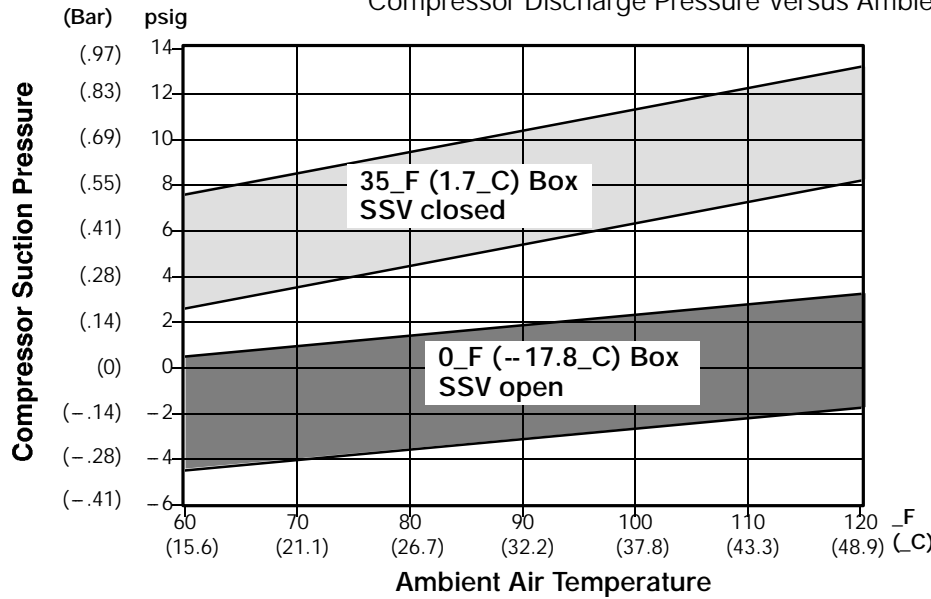
**NOTES**

1. If microprocessor controller alarm functions remain operational, manual override jumpering will result in false alarms being indicated.
2. Defrosting will only occur when step 4 alone is performed (steps 1, 2 & 3 interrupted), and prior operation has been at frost forming temperatures.
3. When performing the emergency jump bypass of the microprocessor the unit may still be started/stopped using start/stop switch (ST).
4. On units with Dual Speed evaporator fans, a jumper wire should be placed between TB14 and ESC1.

Note: Curves to be used as troubleshooting guide only for model series 69NT40-449 and 69NT40-459-4 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 4-28. 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 recommended precautions that must be understood and applied during operation and maintenance of the equipment covered herein.

#### 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.**

#### 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

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

#### WARNING

**Do not use a nitrogen cylinder without a pressure regulator. Do not use oxygen in or near a refrigeration system as an explosion may occur.**

#### WARNING

**Always turn OFF the unit circuit breakers (CB-1 & CB-2) and disconnect main power supply before working on moving parts.**

#### WARNING

**Before servicing unit, make sure the unit circuit breakers (CB-1 & CB-2) and the start-stop switch (ST) are in the OFF position. Also disconnect power plug and cable.**

#### WARNING

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

#### CAUTION

**When doing any arc welding on the unit or container, disconnect all connectors from controller and remove ground lead going to I/O board to prevent any damage due to electrostatic discharge.**

#### CAUTION

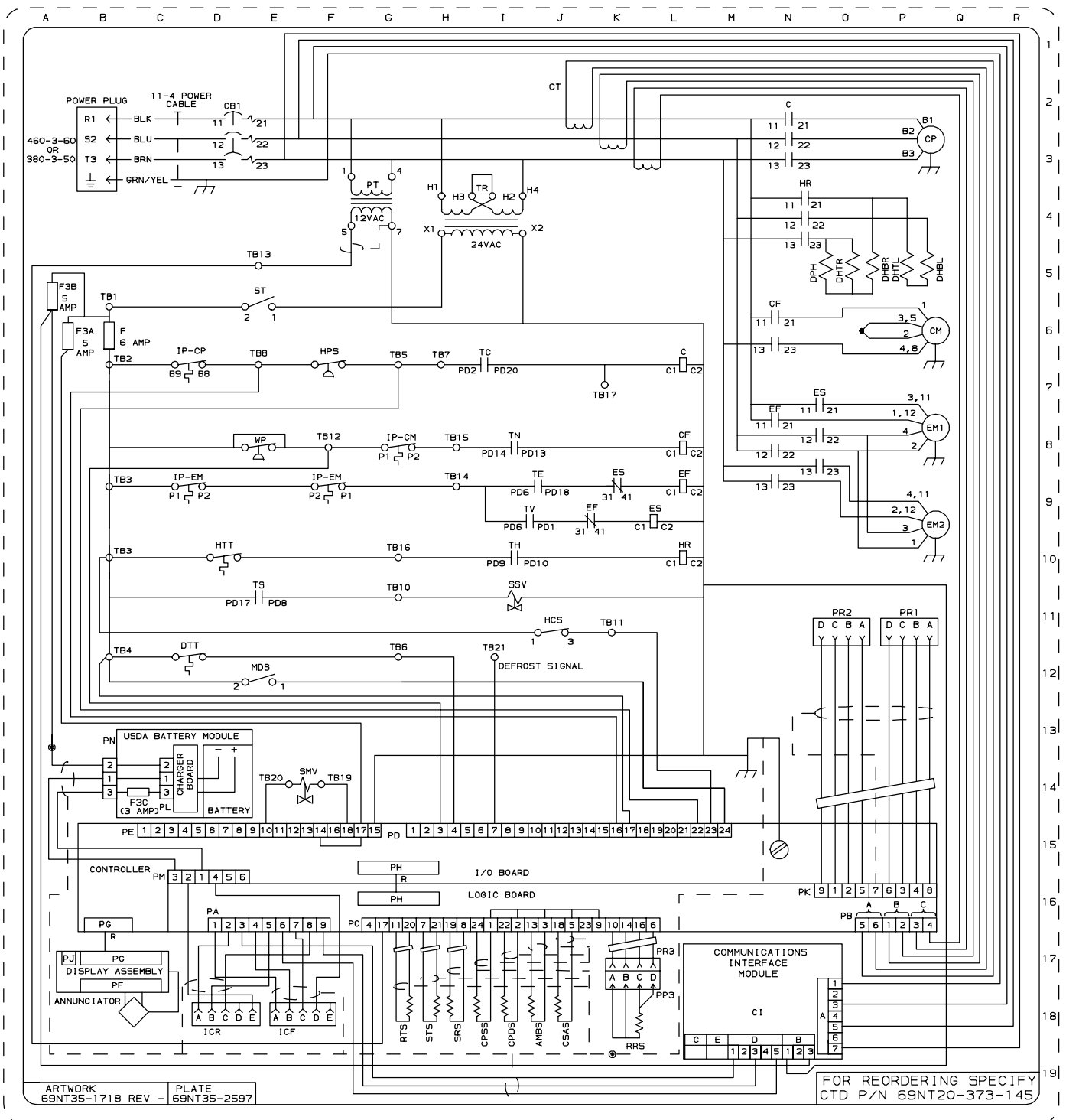
**Use only Carrier Transicold approved Polyol Ester Oil (POE) – Castrol-Icematic SW20 compressor oil with R-134a. Buy in small quantities (one quart). When using this hygroscopic oil, immediately reseal. Do not leave container of oil open or contamination will occur.**

#### NOTE

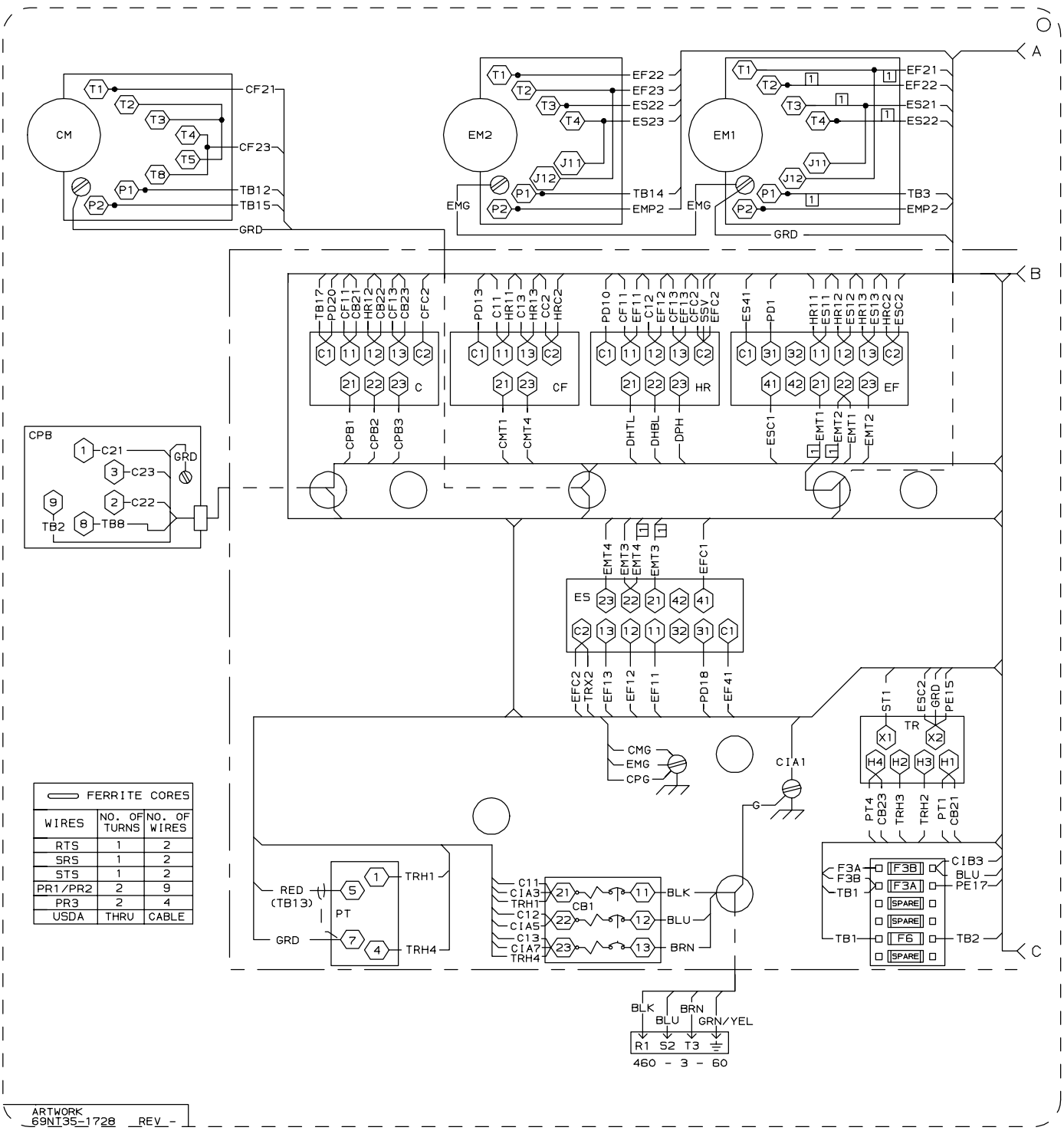
To avoid damage to the earth's ozone layer, use a refrigerant recovery system whenever removing refrigerant. When working with refrigerants you must comply with all local government environmental laws, U.S.A. EPA section 608.

<u>ZONE</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>
J18	AMBS	— AMBIENT SENSOR
L7, N2	C	— COMPRESSOR CONTACTOR
D2	CB1	— CIRCUIT BREAKER 460V
L8, N6	CF	— CONDENSER FAN CONTACTOR
N18	CI	— COMMUNICATIONS INTERFACE MODULE
G8, Q6	CM	— CONDENSER FAN MOTOR
D7, Q3	CP	— COMPRESSOR MOTOR
I18	CPDS	— COMPRESSOR DISCHARGE SENSOR
I18	CPSS	— COMPRESSOR SUCTION SENSOR
J18	CSAS	— CONDENSER SATURATION SENSOR
J2	CT	— CURRENT TRANSFORMER
Q5	DHBL	— DEFROST HEATER — BOTTOM LEFT
P5	DHBR	— DEFROST HEATER — BOTTOM RIGHT
P5	DHTL	— DEFROST HEATER — TOP LEFT
O5	DHTR	— DEFROST HEATER — TOP RIGHT
N5	DPH	— DRAIN PAN HEATER
C12	DTT	— DEFROST TERMINATION THERMOSTAT
K9, L8, N7	EF	— EVAPORATOR FAN CONTACTOR (HIGH SPEED)
D8, F8, Q8, Q9	EM	— EVAPORATOR FAN MOTOR
K8, L9, O7	ES	— EVAPORATOR FAN CONTACTOR (LOW SPEED)
A5, B6, C14	F	— FUSE
	FLA	— FULL LOAD AMPS
J11	HCS	— HUMIDITY CONTROL SWITCH
F7	HPS	— HIGH PRESSURE SWITCH
L10, N4	HR	— HEATER CONTACTOR
D10	HTT	— HEAT TERMINATION THERMOSTAT
D18, E18	IC	— INTERROGATOR CONNECTOR
C7, C8, F8, G8	IP	— INTERNAL PROTECTOR
E12	MDS	— MANUAL DEFROST SWITCH
L17	PP	— PROBE PLUG (RTN)
L17, O11, P11	PR	— PROBE RECEPTACLE (USDA)
G4	PT	— POTENTIAL TRANSFORMER
B16, G16	R	— RIBBON CABLE
K19	RRS	— RETURN RECORDER SENSOR
G18	RTS	— RETURN TEMPERATURE SENSOR
F14	SMV	— SOLENOID MODULATING VALVE
H18	SRS	— SUPPLY RECORDER SENSOR
I10	SSV	— SUCTION SOLENOID VALVE
E6	ST	— START-STOP SWITCH
H18	STS	— SUPPLY TEMPERATURE SENSOR
	TB	— TERMINAL BLOCK CONNECTION
J7	TC	— CONTROLLER RELAY (COOLING)
J8	TE	— CONTROLLER RELAY (HIGH SPEED EVAP.)
I10	TH	— CONTROLLER RELAY (HEATING)
I8	TN	— CONTROLLER RELAY (CONDENSER FAN)
I4	TR	— TRANSFORMER
E11	TS	— CONTROLLER RELAY (SUCTION SOLENOID VALVE)
I9	TV	— CONTROLLER RELAY (LOW SPEED EVAP.)
E8	WP	— WATER PRESSURE SWITCH

**Figure 5-1. Electrical Wiring Schematic (Models 69NT40-449-18)  
(Sheet 1 of 2)**



**Figure 5-1. Electrical Wiring Schematic (Models 69NT40-449-18)**  
 (Sheet 2 of 2)



**Figure 5-2. Electrical Wiring Diagram (Models 69NT40-449-18)**  
**(Sheet 1 of 2)**

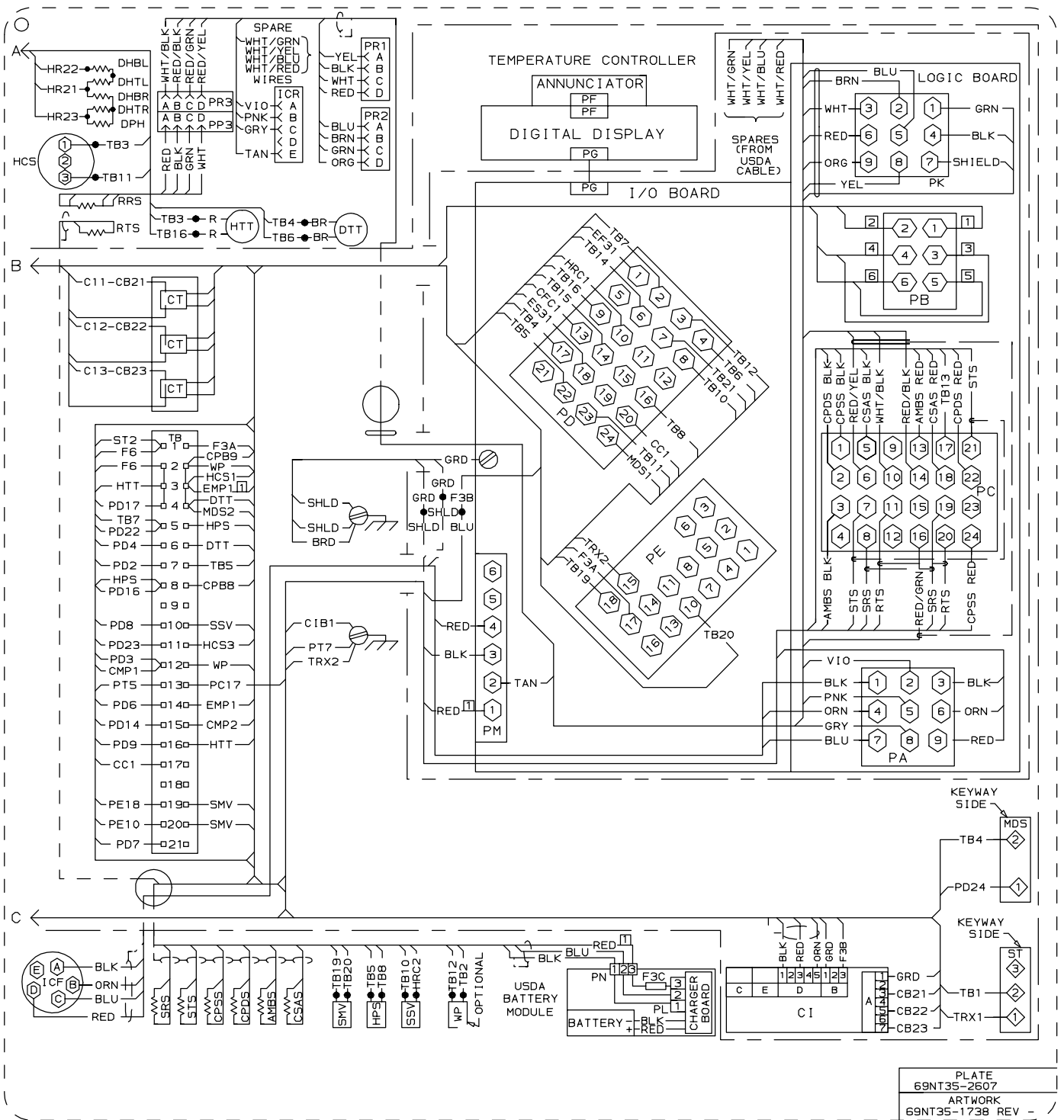


Figure 5-2. Electrical Wiring Diagram (Models 69NT40-449-18)  
(Sheet 2 of 2)



<u>ZONE</u>	<u>SYMBOL</u>		<u>DESCRIPTION</u>
J18	AMBS	—	AMBIENT SENSOR
I7,L3	C	—	COMPRESSOR CONTACTOR
D2	CB1	—	CIRCUIT BREAKER 460V
D3	CB2	—	CIRCUIT BREAKER 230V
L9,L6	CF	—	CONDENSER FAN CONTACTOR
N18	CI	—	COMMUNICATIONS INTERFACE MODULE
I7	CL	—	COOL LIGHT (WHITE)
G9,Q6	CM	—	CONDENSER FAN MOTOR
C7,P3	CP	—	COMPRESSOR MOTOR
I18	CPDS	—	COMPRESSOR DISCHARGE SENSOR
I18	CPSS	—	COMPRESSOR SUCTION SENSOR
J18	CSAS	—	CONDENSER SATURATION SENSOR
J3	CT	—	CURRENT TRANSFORMER
N5	DHBL	—	DEFROST HEATER - BOTTOM LEFT
M5	DHBR	—	DEFROST HEATER - BOTTOM RIGHT
M5	DHTL	—	DEFROST HEATER - TOP LEFT
L5	DHTR	—	DEFROST HEATER - TOP RIGHT
K12	DL	—	DEFROST LIGHT (AMBER)
L5	DPH	—	DRAIN PAN HEATER
C12	DTT	—	DEFROST TERMINATION THERMOSTAT
L9,N7	EF	—	EVAPORATOR FAN CONTACTOR
C9,F9,Q7,Q8	EM	—	EVAPORATOR FAN MOTOR
A6,B6,C14	F	—	FUSE
F5	FT	—	FUSE, TRANSFRESH
	FLA	—	FULL LOAD AMPS
E7	HPS	—	HIGH PRESSURE SWITCH
L4,L10	HR	—	HEATER CONTACTOR
D10	HTT	—	HEAT TERMINATION THERMOSTAT
E18	IC	—	INTERROGATOR CONNECTOR
C7,C9,F9,G9	IP	—	INTERNAL PROTECTOR
K11	IRL	—	IN-RANGE LIGHT (GREEN)
D12	MDS	—	MANUAL DEFROST SWITCH
G4	PT	—	POTENTIAL TRANSFORMER
B16,G16	R	—	RIBBON CABLE
I7,J11,J12	RM	—	REMOTE MONITORING PLUG
K18	RRS	—	RETURN RECORDER SENSOR
G18	RTS	—	RETURN TEMPERATURE SENSOR
F14	SMV	—	SOLENOID MODULATING VALVE
H18	SRS	—	SUPPLY RECORDER SENSOR
I11	SSV	—	SUCTION SOLENOID VALVE
D6	ST	—	START-STOP SWITCH
H18	STS	—	SUPPLY TEMPERATURE SENSOR
	TB	—	TERMINAL BLOCK CONNECTION
G7	TC	—	CONTROLLER RELAY (COOLING)
M10	TCC	—	TRANSFRESH COMMUNICATION CONNECTOR
I9	TE	—	CONTROLLER RELAY (EVAP.)
O9	TFC	—	TRANSFRESH CONTROLLER
F11	TI	—	CONTROLLER RELAY (IN-RANGE)
K10	TH	—	CONTROLLER RELAY (HEATING)
K9	TN	—	CONTROLLER RELAY (CONDENSER FAN)
H5	TR	—	TRANSFORMER
P11	TRC1	—	TRANSFRESH REAR CONNECTOR
P11	TRC2	—	TRANSFRESH REAR CONNECTOR
C11	TS	—	CONTROLLER RELAY (SUCTION SOLENOID VALVE)
	VS	—	VOLTAGE SWITCH
D9	WP	—	WATER PRESSURE SWITCH

**Figure 5-3. Electrical Wiring Schematic (Model 69NT40-449-21)  
(Sheet 1 of 2)**

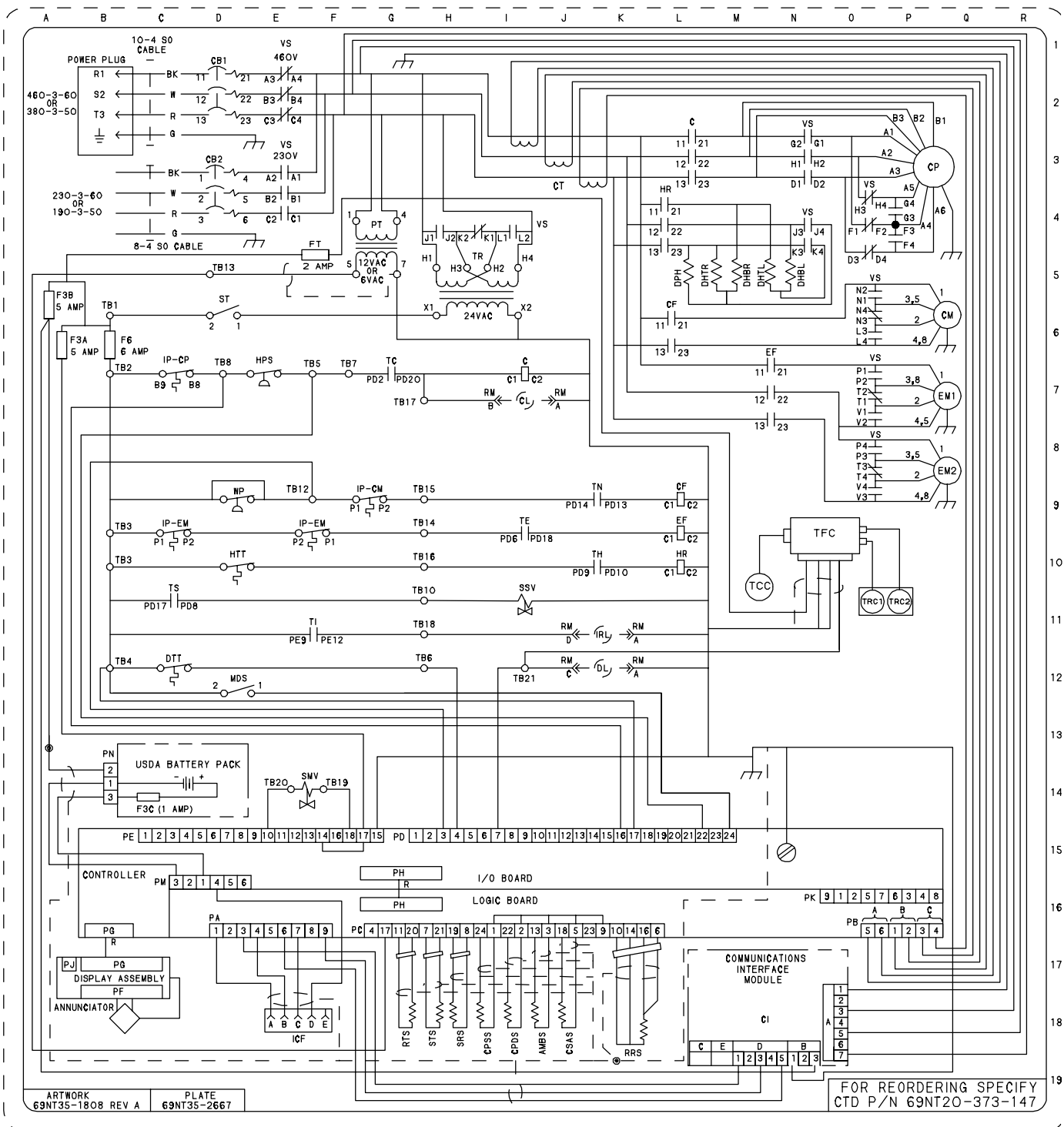
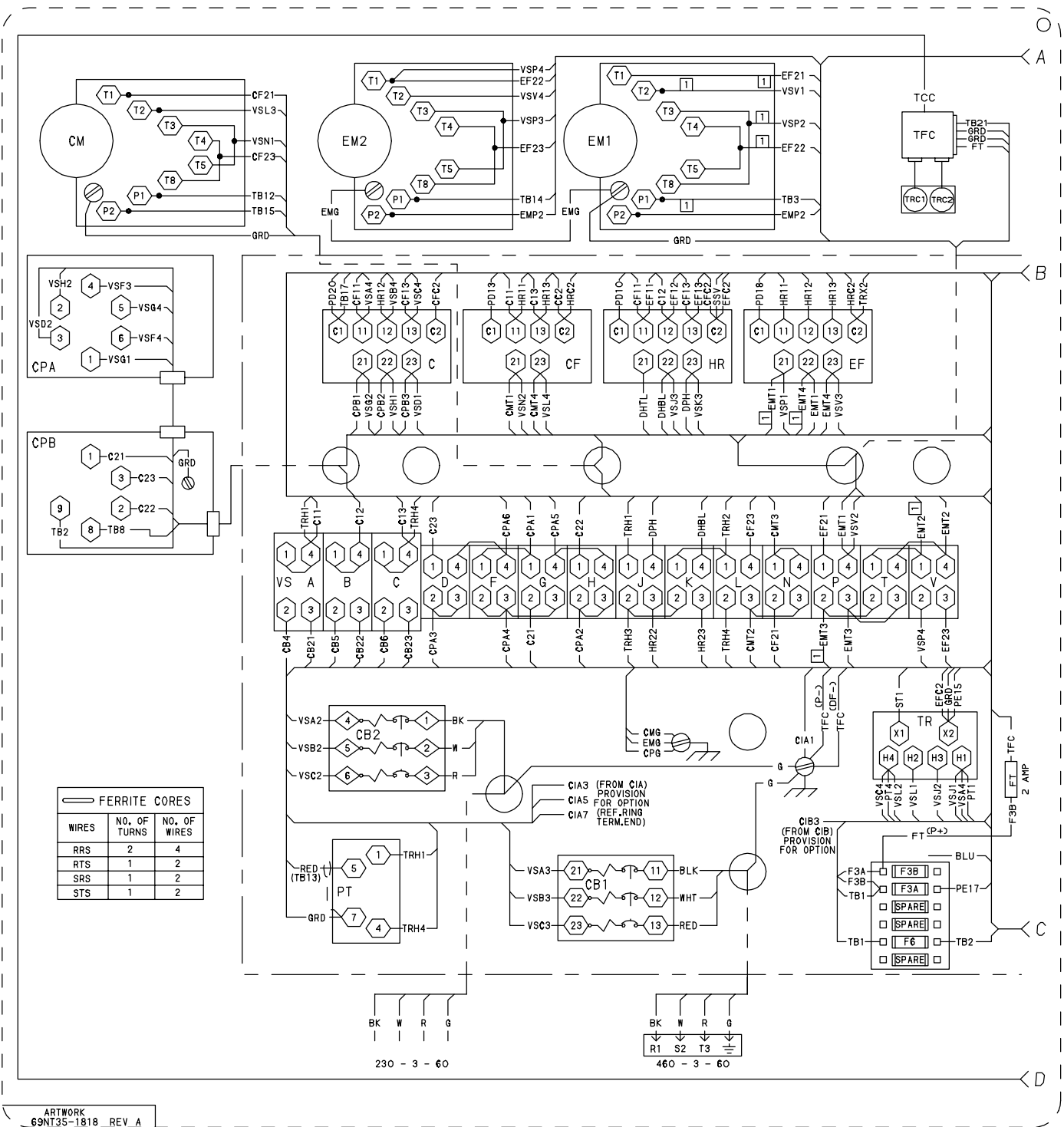
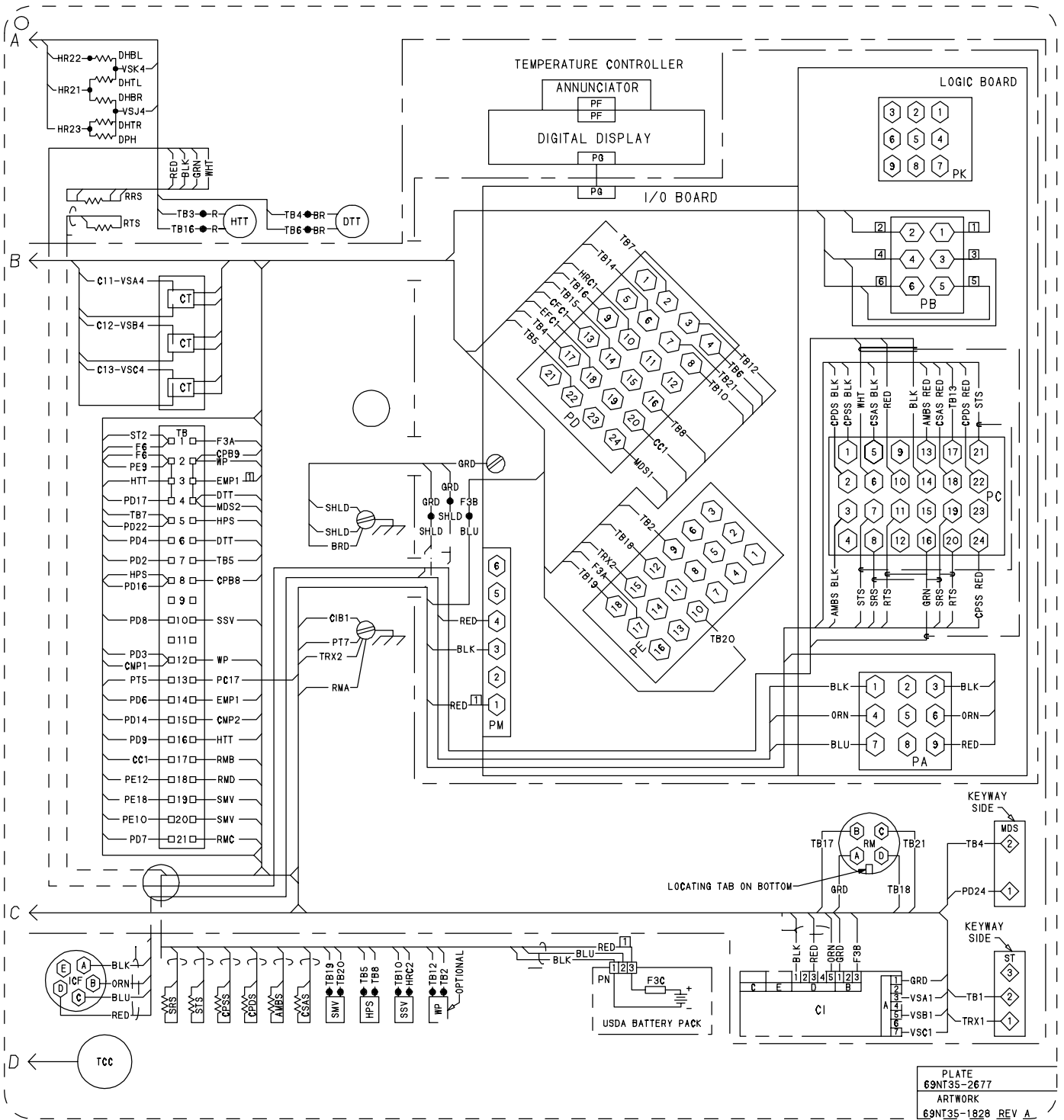


Figure 5-3. Electrical Wiring Schematic (Model 69NT40-449-21)  
(Sheet 2 of 2)



**Figure 5-4. Electrical Wiring Diagram (Model 69NT40-449-21)**  
 (Sheet 1 of 2)



<u>ZONE</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>
J18	AMBS	— AMBIENT SENSOR
I7,L3	C	— COMPRESSOR CONTACTOR
D2	CB1	— CIRCUIT BREAKER 460V
D3	CB2	— CIRCUIT BREAKER 230V
L9,L6	CF	— CONDENSER FAN CONTACTOR
N18	CI	— COMMUNICATIONS INTERFACE MODULE
I7	CL	— COOL LIGHT (WHITE)
G9,Q6	CM	— CONDENSER FAN MOTOR
C7,P3	CP	— COMPRESSOR MOTOR
I18	CPDS	— COMPRESSOR DISCHARGE SENSOR
I18	CPSS	— COMPRESSOR SUCTION SENSOR
J18	CSAS	— CONDENSER SATURATION SENSOR
J3	CT	— CURRENT TRANSFORMER
N5	DHBL	— DEFROST HEATER - BOTTOM LEFT
M5	DHBR	— DEFROST HEATER - BOTTOM RIGHT
M5	DHTL	— DEFROST HEATER - TOP LEFT
L5	DHTR	— DEFROST HEATER - TOP RIGHT
K12	DL	— DEFROST LIGHT (AMBER)
L5	DPH	— DRAIN PAN HEATER
C12	DTT	— DEFROST TERMINATION THERMOSTAT
L9,N7	EF	— EVAPORATOR FAN CONTACTOR
C9,F9,Q7,Q8	EM	— EVAPORATOR FAN MOTOR
A6,B6,C14	F	— FUSE
	FLA	— FULL LOAD AMPS
E7	HPS	— HIGH PRESSURE SWITCH
L4,L10	HR	— HEATER CONTACTOR
D10	HTT	— HEAT TERMINATION THERMOSTAT
E18	IC	— INTERROGATOR CONNECTOR
C7,C9,F9,G9	IP	— INTERNAL PROTECTOR
K11	IRL	— IN-RANGE LIGHT (GREEN)
D12	MDS	— MANUAL DEFROST SWITCH
G4	PT	— POTENTIAL TRANSFORMER
B16,G16	R	— RIBBON CABLE
I7,J11,J12	RM	— REMOTE MONITORING PLUG
K18	RRS	— RETURN RECORDER SENSOR
G18	RTS	— RETURN TEMPERATURE SENSOR
F14	SMV	— SOLENOID MODULATING VALVE
H18	SRS	— SUPPLY RECORDER SENSOR
I11	SSV	— SUCTION SOLENOID VALVE
D6	ST	— START-STOP SWITCH
H18	STS	— SUPPLY TEMPERATURE SENSOR
	TB	— TERMINAL BLOCK CONNECTION
G7	TC	— CONTROLLER RELAY (COOLING)
I9	TE	— CONTROLLER RELAY ( EVAP.)
F11	TI	— CONTROLLER RELAY (IN-RANGE)
K10	TH	— CONTROLLER RELAY (HEATING)
K9	TN	— CONTROLLER RELAY (CONDENSER FAN)
H5	TR	— TRANSFORMER
C11	TS	— CONTROLLER RELAY (SUCTION SOLENOID VALVE)
	VS	— VOLTAGE SWITCH
D9	WP	— WATER PRESSURE SWITCH

**Figure 5-5. Electrical Wiring Schematic (Model 69NT40-449-17,-22,-23)  
(Sheet 1 of 2)**

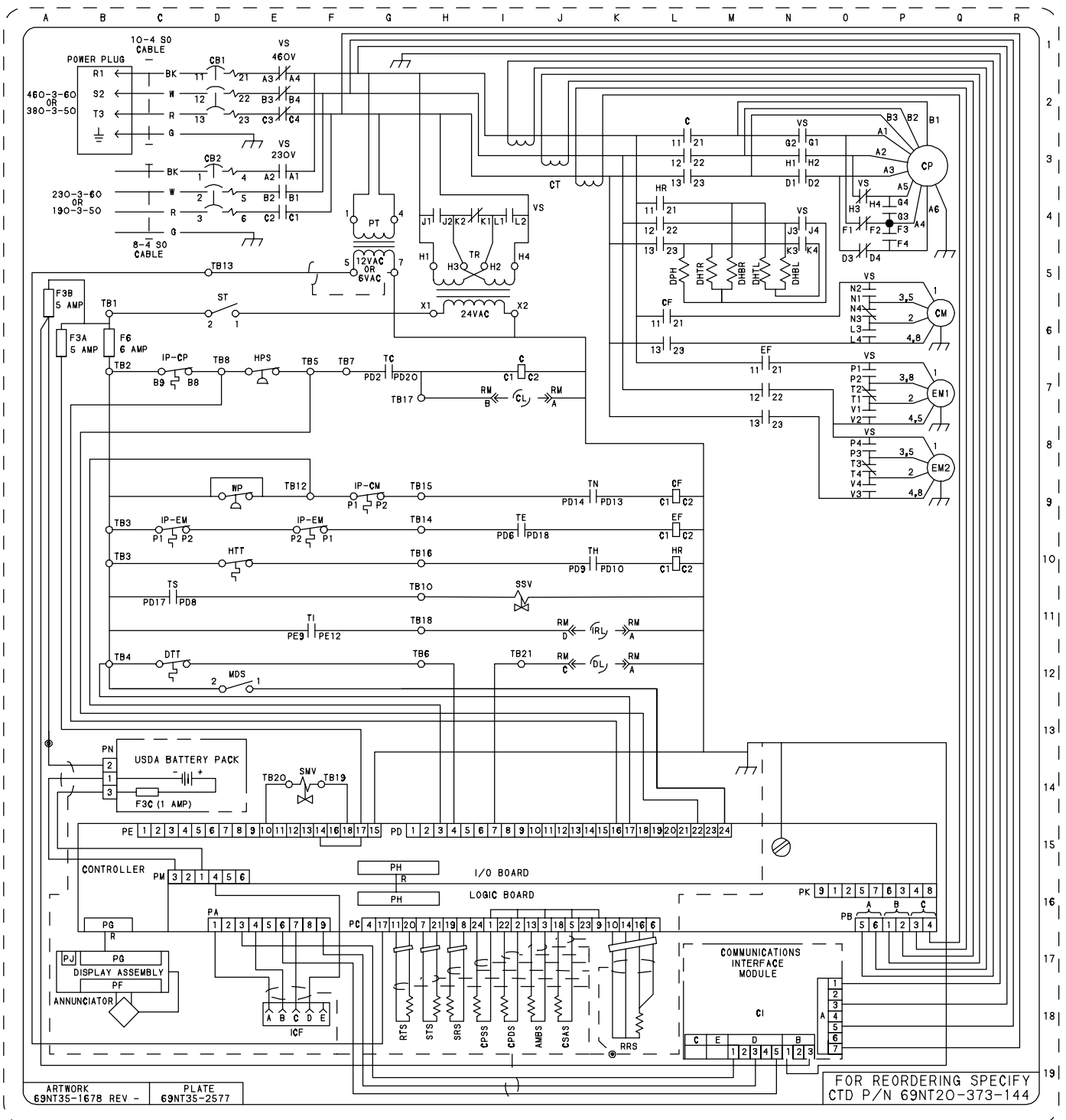


Figure 5-5. Electrical Wiring Schematic (Model 69NT40-449-17,-22,-23)  
(Sheet 2 of 2)

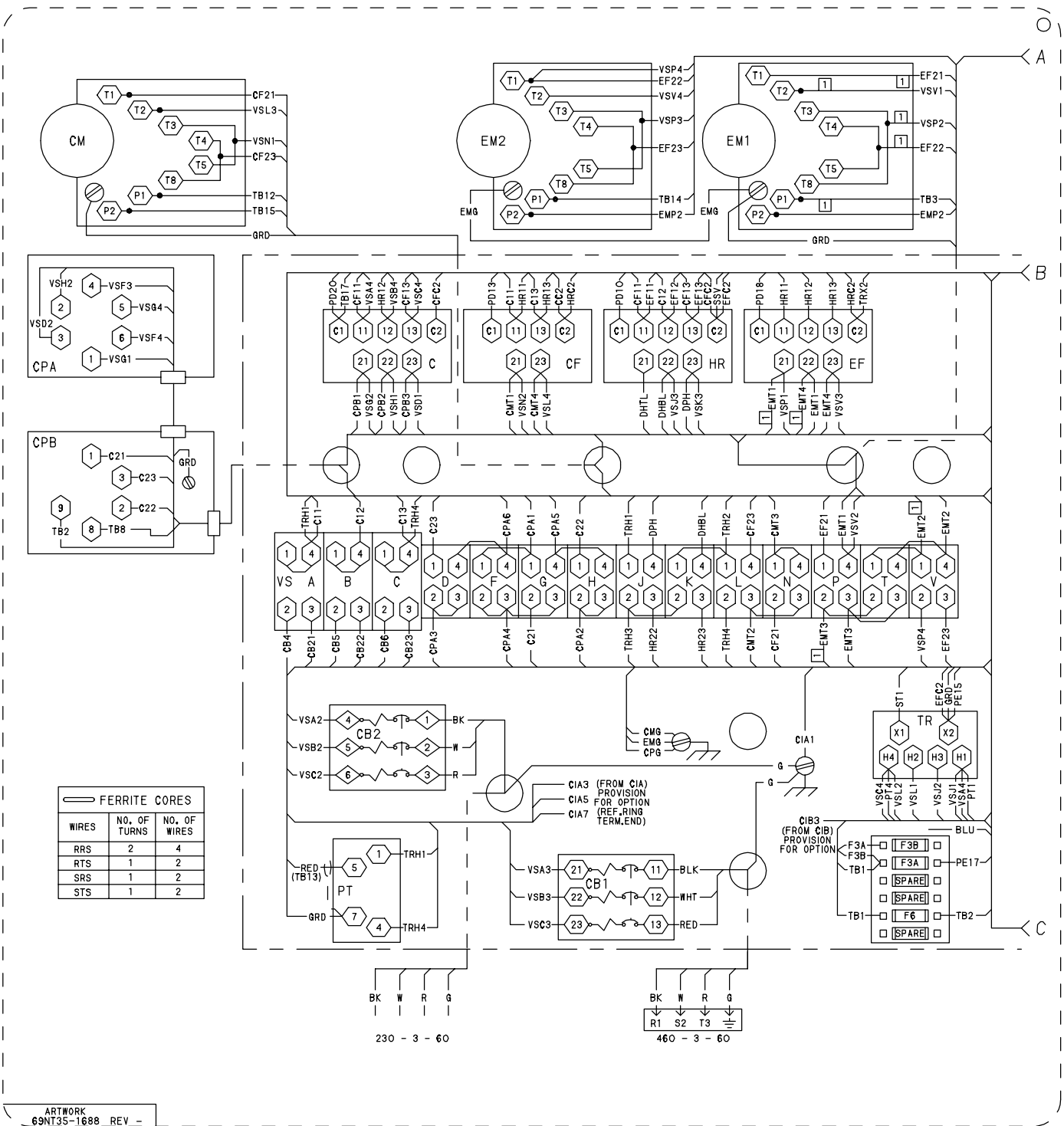


Figure 5-6. Electrical Wiring Diagram (Model 69NT40-449-17,-22,-23)  
(Sheet 1 of 2)

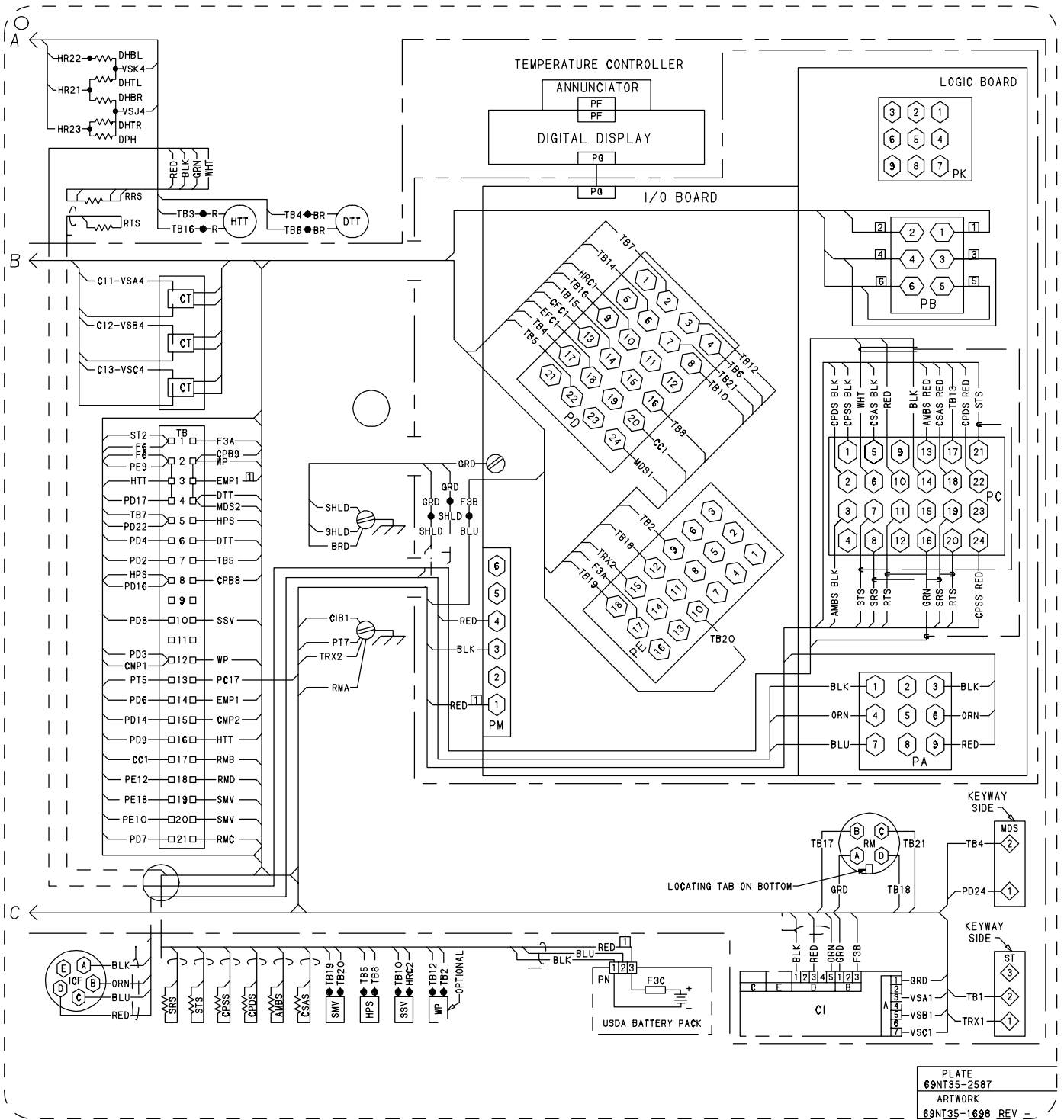


Figure 5-6. Electrical Wiring Diagram (Model 69NT40-449-17,-22,-23)  
(Sheet 2 of 2)

PLATE  
69NT35-2587  
ARTWORK  
69NT35-1698 REV



<u>ZONE</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>
J18	AMBS	— AMBIENT SENSOR
B14, M13	BMS	— BATTERY MODULE SWITCH
L7, N2	C	— COMPRESSOR CONTACTOR
D1	CB1	— CIRCUIT BREAKER 460V
C3	CB2	— CIRCUIT BREAKER 230V
L8, N6	CF	— CONDENSER FAN CONTACTOR
N18	CI	— COMMUNICATIONS INTERFACE MODULE
K7	CL	— COOL LIGHT (WHITE)
G8, Q6	CM	— CONDENSER FAN MOTOR
D7, Q3	CP	— COMPRESSOR MOTOR
I18	CPDS	— COMPRESSOR DISCHARGE SENSOR
I18	CPSS	— COMPRESSOR SUCTION SENSOR
J18	CSAS	— CONDENSER SATURATION SENSOR
J2	CT	— CURRENT TRANSFORMER
Q5	DHBL	— DEFROST HEATER - BOTTOM LEFT
P5	DHBR	— DEFROST HEATER - BOTTOM RIGHT
P5	DHTL	— DEFROST HEATER - TOP LEFT
O5	DHTR	— DEFROST HEATER - TOP RIGHT
J12	DL	— DEFROST LIGHT (AMBER)
N5	DPH	— DRAIN PAN HEATER
C12	DTT	— DEFROST TERMINATION THERMOSTAT
K9, L8, N7	EF	— EVAPORATOR FAN CONTACTOR (HIGH SPEED)
D8, F8, Q8, Q9	EM	— EVAPORATOR FAN MOTOR
K8, L9, O7	ES	— EVAPORATOR FAN CONTACTOR (LOW SPEED)
A5, B6, C14, K6	F	— FUSE
F7	FLA	— FULL LOAD AMPS
L9, N4	HPS	— HIGH PRESSURE SWITCH
E9	HR	— HEATER CONTACTOR
D18, E18	HTT	— HEAT TERMINATION THERMOSTAT
C7, C8, F8, G8, H7	IC	— INTERROGATOR CONNECTOR
K11	IP	— INTERNAL PROTECTOR
E12	IRL	— IN-RANGE LIGHT (GREEN)
H4	MDS	— MANUAL DEFROST SWITCH
B16, G16	PT	— POTENTIAL TRANSFORMER
K7, K11, K12	R	— RIBBON CABLE
K19	RM	— REMOTE MONITORING RECEPTACLE
G18	RRS	— RETURN RECORDER SENSOR
F14	RTS	— RETURN TEMPERATURE SENSOR
H18	SMV	— SOLENOID MODULATING VALVE
I10	SRS	— SUPPLY RECORDER SENSOR
E6	SSV	— SUCTION SOLENOID VALVE
H18	ST	— START-STOP SWITCH
I7	STS	— SUPPLY TEMPERATURE SENSOR
J8	TB	— TERMINAL BLOCK CONNECTION
G11	TC	— CONTROLLER RELAY (COOLING)
I9	TE	— CONTROLLER RELAY (HIGH SPEED EVAP.)
I8	TI	— CONTROLLER RELAY (IN-RANGE)
J4	TH	— CONTROLLER RELAY (HEATING)
D4	TN	— CONTROLLER RELAY (CONDENSER FAN)
E11	TR	— TRANSFORMER
I9	TRANS	— TRANSFORMER (AUTO 230/460)
E2, E4	TS	— CONTROLLER RELAY (SUCTION SOLENOID VALVE)
D8	TV	— CONTROLLER RELAY (LOW SPEED EVAP.)
	VS	— VOLTAGE SWITCH
	WP	— WATER PRESSURE SWITCH (OPTIONAL)

**Figure 5-7. Electrical Wiring Schematic (Model 69NT40-449-7)  
(Sheet 1 of 2)**

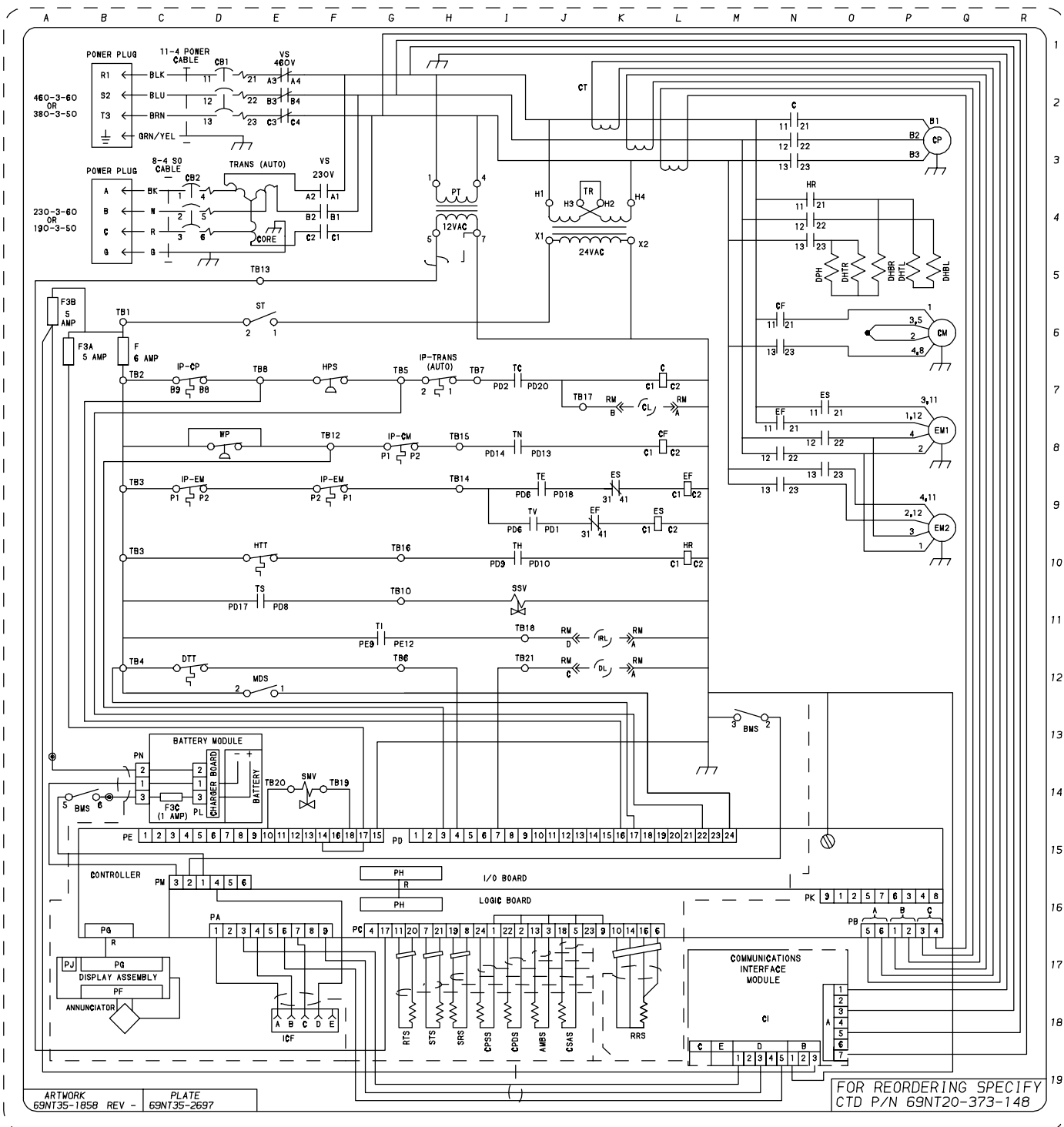
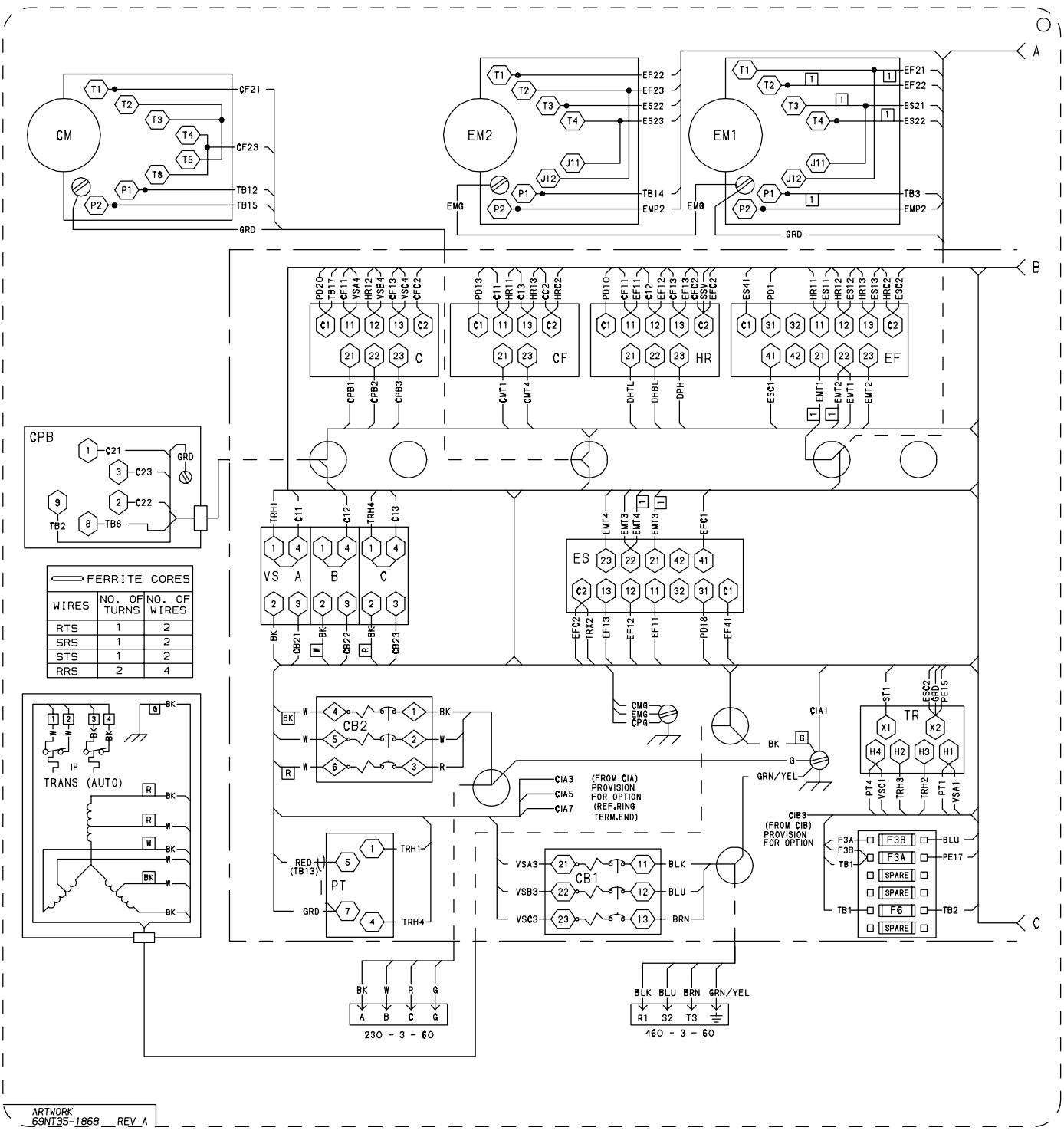
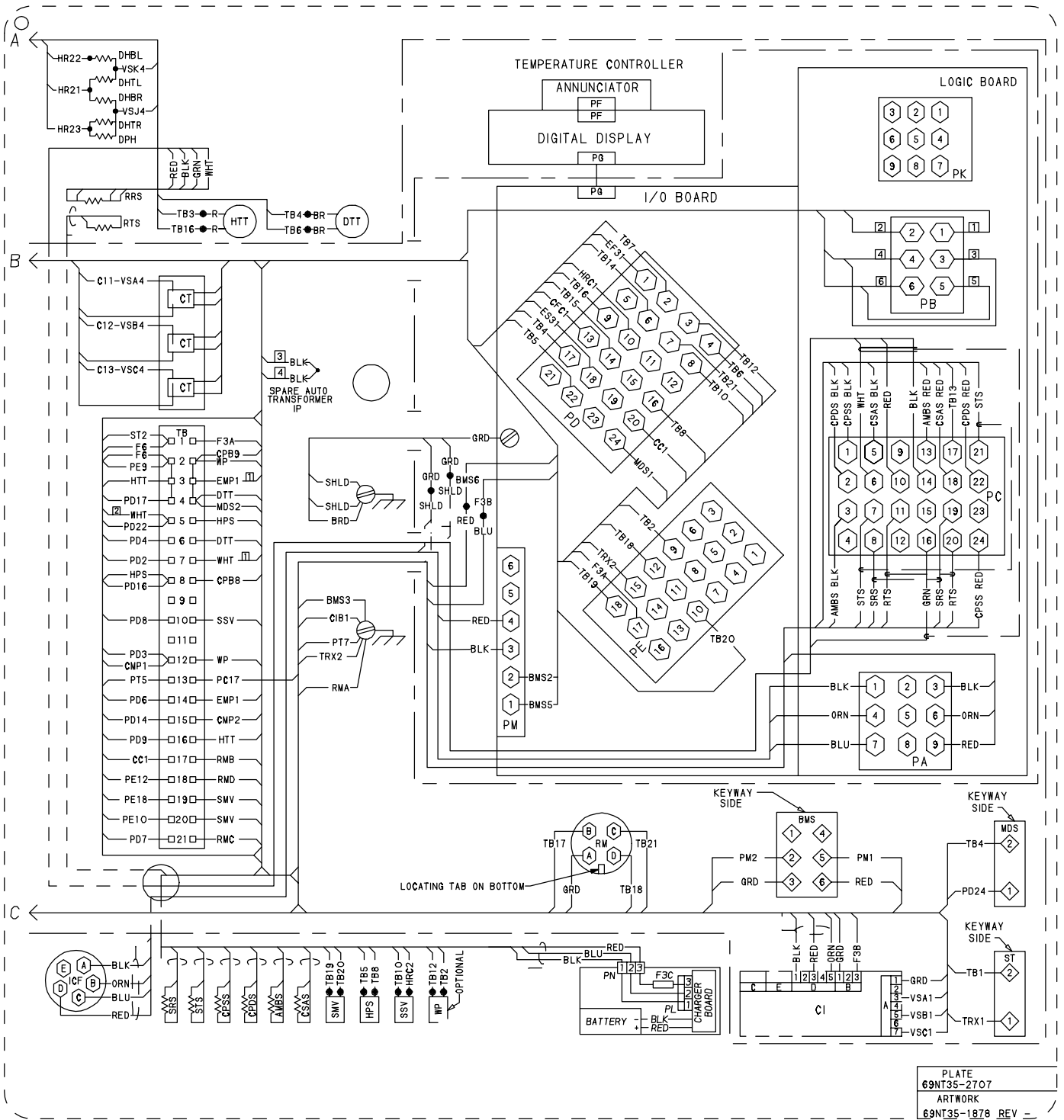


Figure 5-7. Electrical Wiring Schematic (Model 69NT40-449-7)  
(Sheet 2 of 2)



ARTWORK  
69NT35-1868 REV A

Figure 5-8. Electrical Wiring Diagram (Model 69NT40-449-7)  
(Sheet 1 of 2)

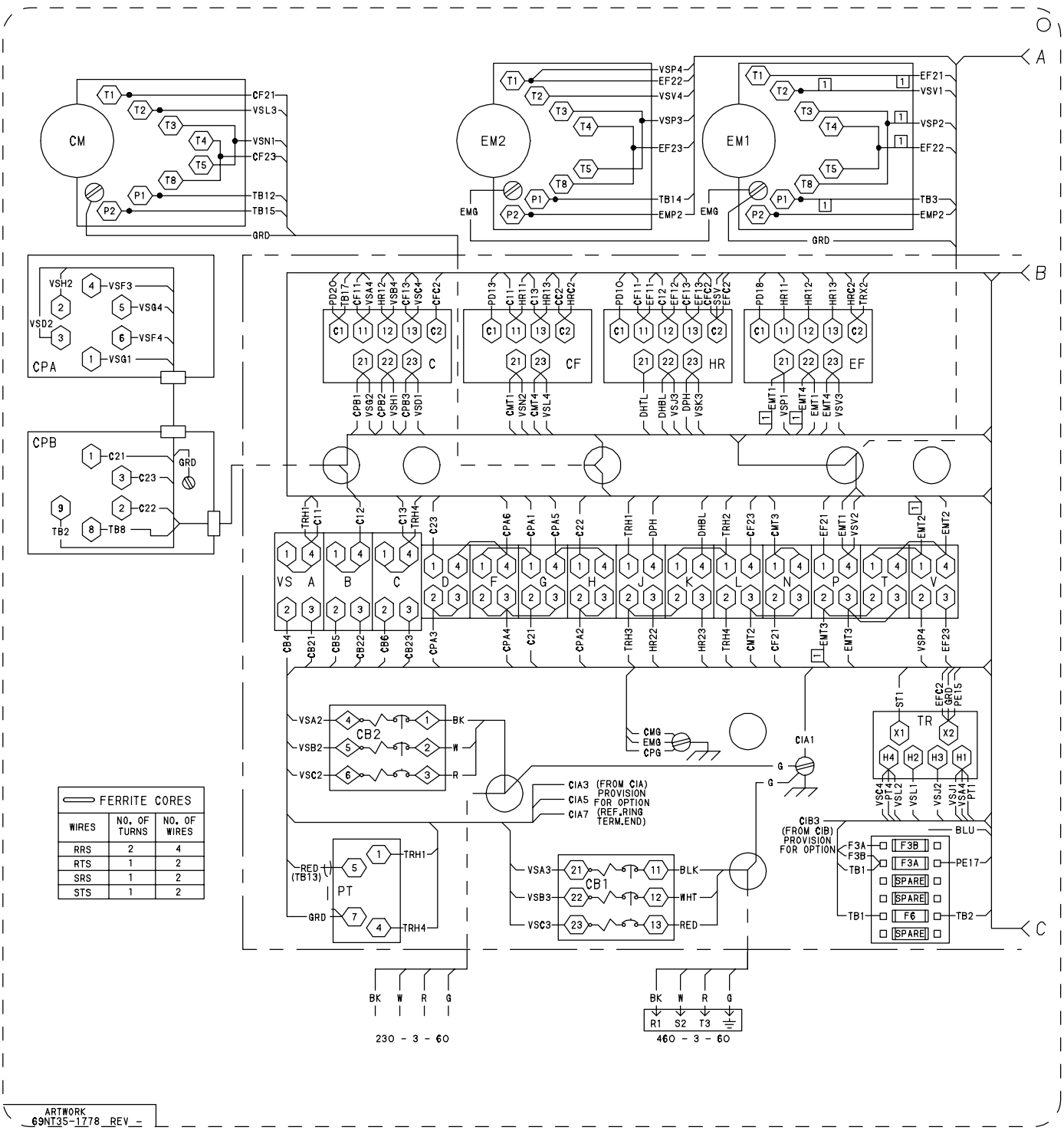


**Figure 5-8. Electrical Wiring Diagram (Model 69NT40-449-7)**  
**(Sheet 2 of 2)**

<u>ZONE</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>
J18	AMBS	— AMBIENT SENSOR
I7,L3	C	— COMPRESSOR CONTACTOR
D2	CB1	— CIRCUIT BREAKER 460V
D3	CB2	— CIRCUIT BREAKER 230V
L9,L6	CF	— CONDENSER FAN CONTACTOR
N18	CI	— COMMUNICATIONS INTERFACE MODULE
I7	CL	— COOL LIGHT (WHITE)
G9,Q6	CM	— CONDENSER FAN MOTOR
C7,P3	CP	— COMPRESSOR MOTOR
I18	CPDS	— COMPRESSOR DISCHARGE SENSOR
I18	CPSS	— COMPRESSOR SUCTION SENSOR
J18	CSAS	— CONDENSER SATURATION SENSOR
J3	CT	— CURRENT TRANSFORMER
N5	DHBL	— DEFROST HEATER - BOTTOM LEFT
M5	DHBR	— DEFROST HEATER - BOTTOM RIGHT
M5	DHTL	— DEFROST HEATER - TOP LEFT
L5	DHTR	— DEFROST HEATER - TOP RIGHT
K12	DL	— DEFROST LIGHT (AMBER)
L5	DPH	— DRAIN PAN HEATER
C12	DTT	— DEFROST TERMINATION THERMOSTAT
L9,N7	EF	— EVAPORATOR FAN CONTACTOR
C9,F9,Q7,Q8	EM	— EVAPORATOR FAN MOTOR
A6,B6,C14	F	— FUSE
	FLA	— FULL LOAD AMPS
E7	HPS	— HIGH PRESSURE SWITCH
L4,L10	HR	— HEATER CONTACTOR
D10	HTT	— HEAT TERMINATION THERMOSTAT
E18	ICF	— INTERROGATOR CONNECTOR - FRONT
D18	ICR	— INTERROGATOR CONNECTOR - REAR
C7,C9,F9,G9	IP	— INTERNAL PROTECTOR
K11	IRL	— IN-RANGE LIGHT (GREEN)
D12	MDS	— MANUAL DEFROST SWITCH
G4	PT	— POTENTIAL TRANSFORMER
N11,O11,P11	PR	— PROBE RECEPTACLE (USDA)
B16,G15	R	— RIBBON CABLE
I7,J11,J12	RM	— REMOTE MONITORING PLUG
K18	RRS	— RETURN RECORDER SENSOR
G18	RTS	— RETURN TEMPERATURE SENSOR
F14	SMV	— SOLENOID MODULATING VALVE
H18	SRS	— SUPPLY RECORDER SENSOR
I11	SSV	— SUCTION SOLENOID VALVE
D6	ST	— START-STOP SWITCH (CIRCUIT BREAKER)
H18	STS	— SUPPLY TEMPERATURE SENSOR
	TB	— TERMINAL BLOCK CONNECTION
G7	TC	— CONTROLLER RELAY (COOLING)
I9	TE	— CONTROLLER RELAY ( EVAP.)
F11	TI	— CONTROLLER RELAY (IN-RANGE)
K10	TH	— CONTROLLER RELAY (HEATING)
K9	TN	— CONTROLLER RELAY (CONDENSER FAN)
H5	TR	— TRANSFORMER
C11	TS	— CONTROLLER RELAY (SUCTION SOLENOID VALVE)
	VS	— VOLTAGE SWITCH
D9	WP	— WATER PRESSURE SWITCH

**Figure 5-9. Electrical Wiring Schematic (Model 69NT40-449-15)  
(Sheet 1 of 2)**





**Figure 5-10. Electrical Wiring Diagram (Model 69NT40-449-15)**  
(Sheet 1 of 2)

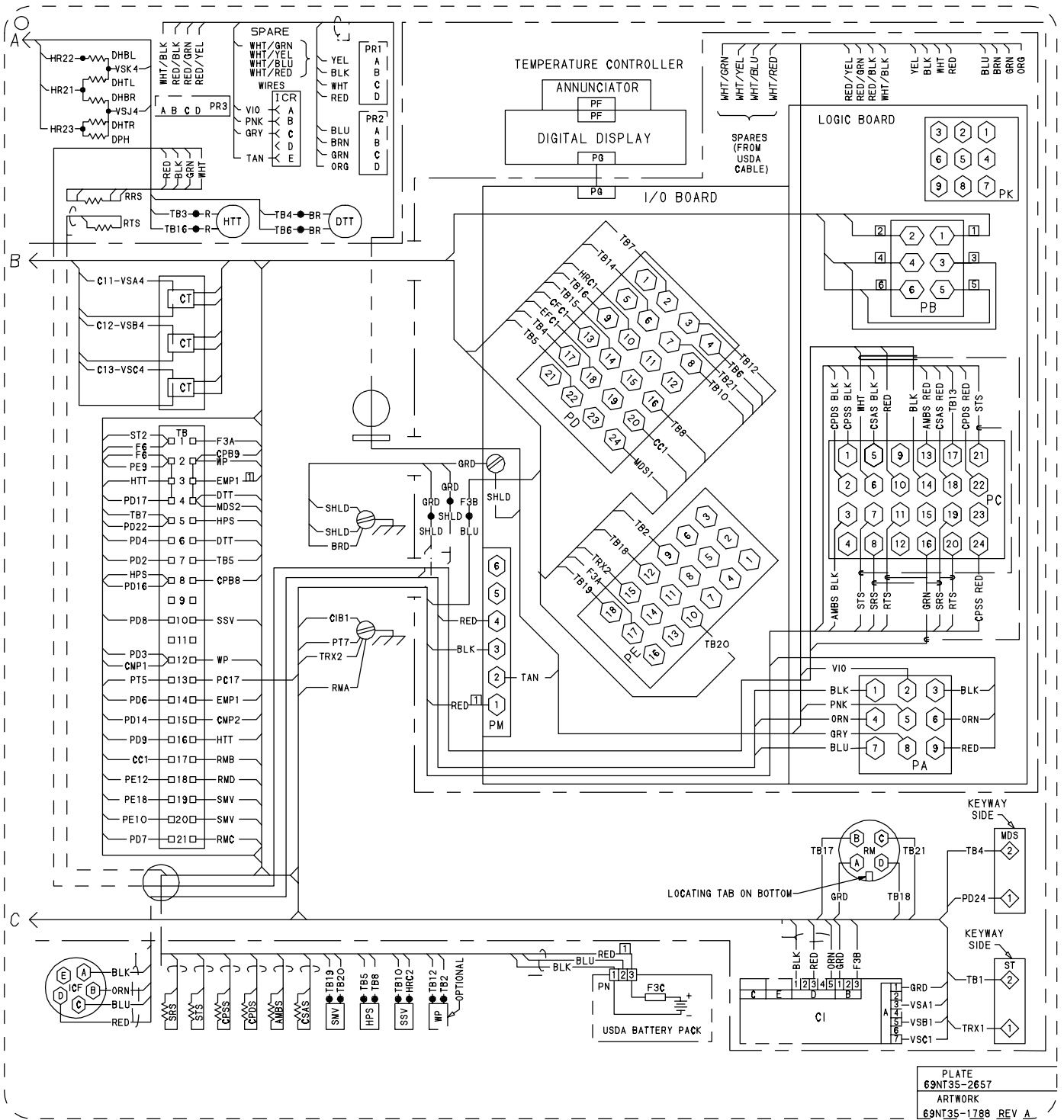


Figure 5-10. Electrical Wiring Diagram (Model 69NT40-449-15)  
(Sheet 2 of 2)



<u>ZONE</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>
J18	AMBS-	AMBIENT SENSOR
L7, N2	C	COMPRESSOR CONTACTOR
D2	CB1	CIRCUIT BREAKER 460V
L8, N6	CF	CONDENSER FAN CONTACTOR
N18	CI	COMMUNICATIONS INTERFACE MODULE
G8, Q6	CM	CONDENSER FAN MOTOR
D7, Q3	CP	COMPRESSOR MOTOR
I18	CPDS-	COMPRESSOR DISCHARGE SENSOR
I18	CPSS-	COMPRESSOR SUCTION SENSOR
J18	CSAS-	CONDENSER SATURATION SENSOR
J2	CT	CURRENT TRANSFORMER
Q5	DHBL-	DEFROST HEATER - BOTTOM LEFT
P5	DHBR-	DEFROST HEATER - BOTTOM RIGHT
P5	DHTL-	DEFROST HEATER - TOP LEFT
O5	DHTR-	DEFROST HEATER - TOP RIGHT
N5	DPH	DRAIN PAN HEATER
C12	DTT	DEFROST TERMINATION THERMOSTAT
K9, L8, N7	EF	EVAPORATOR FAN CONTACTOR (HIGH SPEED)
D8, F8, Q8, Q9	EM	EVAPORATOR FAN MOTOR
K8, L9, O7	ES	EVAPORATOR FAN CONTACTOR (LOW SPEED)
A5, B6, C14	F	FUSE
C5	FT	FUSE, TRANSFRESH
	FLA	FULL LOAD AMPS
J11	HCS	HUMIDITY CONTROL SWITCH
F7	HPS	HIGH PRESSURE SWITCH
L10, N4	HR	HEATER CONTACTOR
D10	HTT	HEAT TERMINATION THERMOSTAT
D18, E18	IC	INTERROGATOR CONNECTOR
C7, C8, F8, G8	IP	INTERNAL PROTECTOR
E12	MDS	MANUAL DEFROST SWITCH
L17	PP	PROBE PLUG (RTN)
L17, O11, P11	PR	PROBE RECEPTACLE (USDA)
G4	PT	POTENTIAL TRANSFORMER
B16, G16	R	RIBBON CABLE
K19	RRS	RETURN RECORDER SENSOR
G18	RTS	RETURN TEMPERATURE SENSOR
F14	SMV	SOLENOID MODULATING VALVE
H18	SRS	SUPPLY RECORDER SENSOR
I10	SSV	SUCTION SOLENOID VALVE
E6	ST	START-STOP SWITCH
H18	STS	SUPPLY TEMPERATURE SENSOR
	TB	TERMINAL BLOCK CONNECTION
J7	TC	CONTROLLER RELAY (COOLING)
J4	TCC	TRANSFRESH COMMUNICATION CONNECTOR
J8	TE	CONTROLLER RELAY (HIGH SPEED EVAP.)
K4	TFC	TRANSFRESH CONTROLLER
I10	TH	CONTROLLER RELAY (HEATING)
I8	TN	CONTROLLER RELAY (CONDENSER FAN)
I4	TR	TRANSFORMER
L5	TRC1-	TRANSFRESH REAR CONNECTOR
L5	TRC2-	TRANSFRESH REAR CONNECTOR
E11	TS	CONTROLLER RELAY (SUCTION SOLENOID VALVE)
I9	TV	CONTROLLER RELAY (LOW SPEED EVAP.)
E8	WP	WATER PRESSURE SWITCH

**Figure 5-11. Electrical Wiring Schematic (Model 69NT40-449-27)  
(Sheet 1 of 2)**

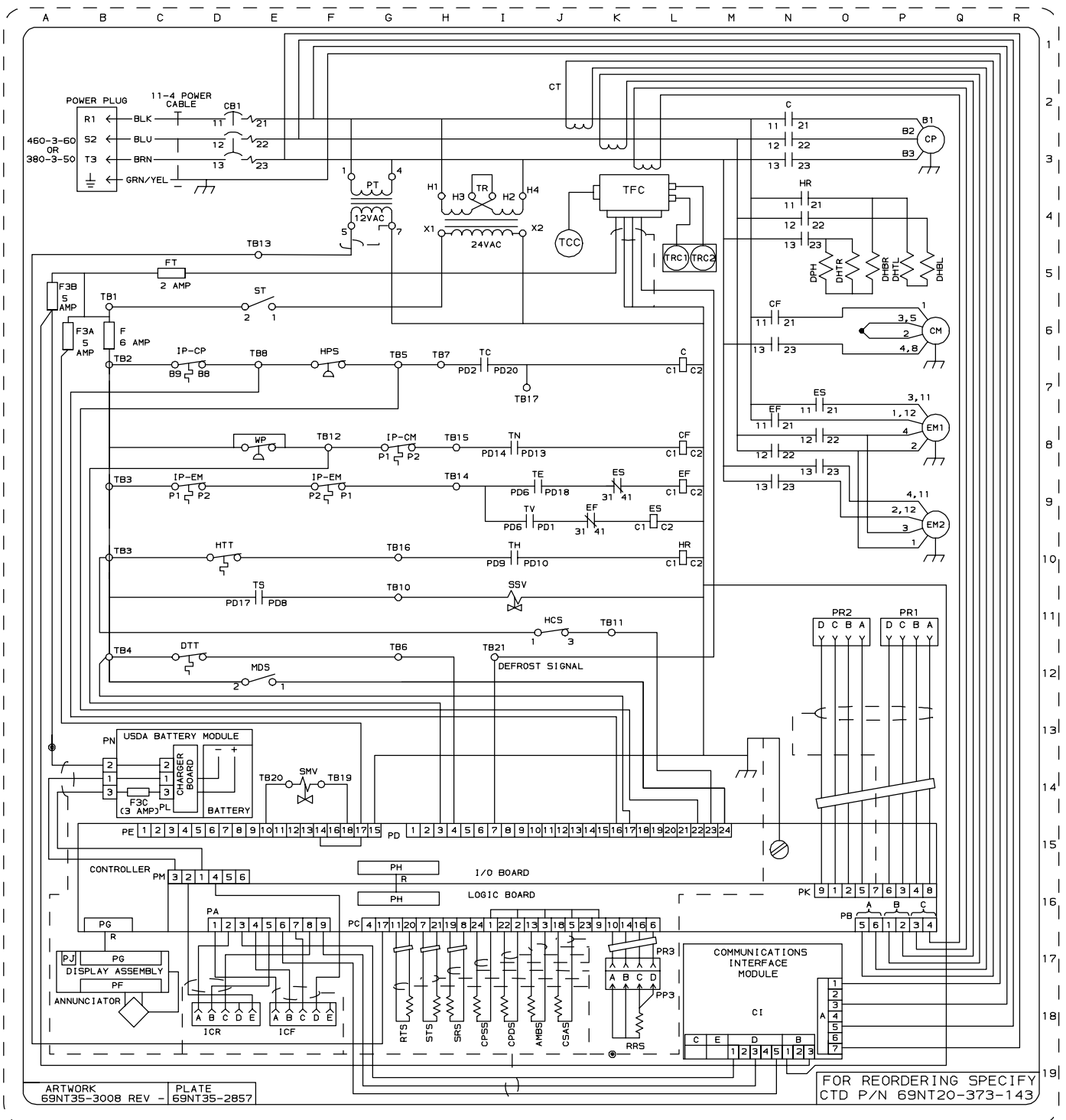
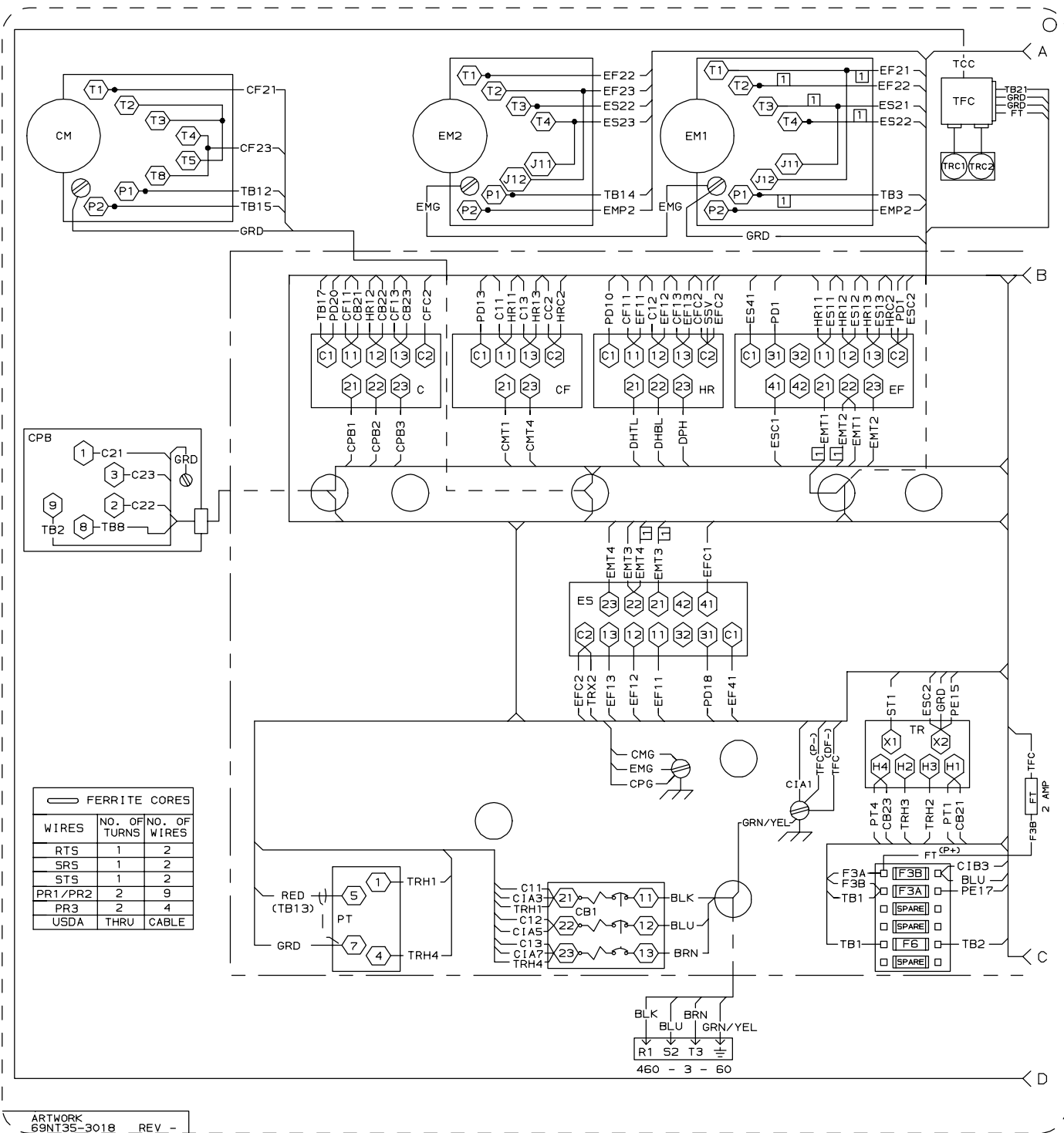


Figure 5-11. Electrical Wiring Schematic (Model 69NT40-449-27)  
(Sheet 2 of 2)



**Figure 5-12. Electrical Wiring Diagram (Model 69NT40-449-27)**  
 (Sheet 1 of 2)

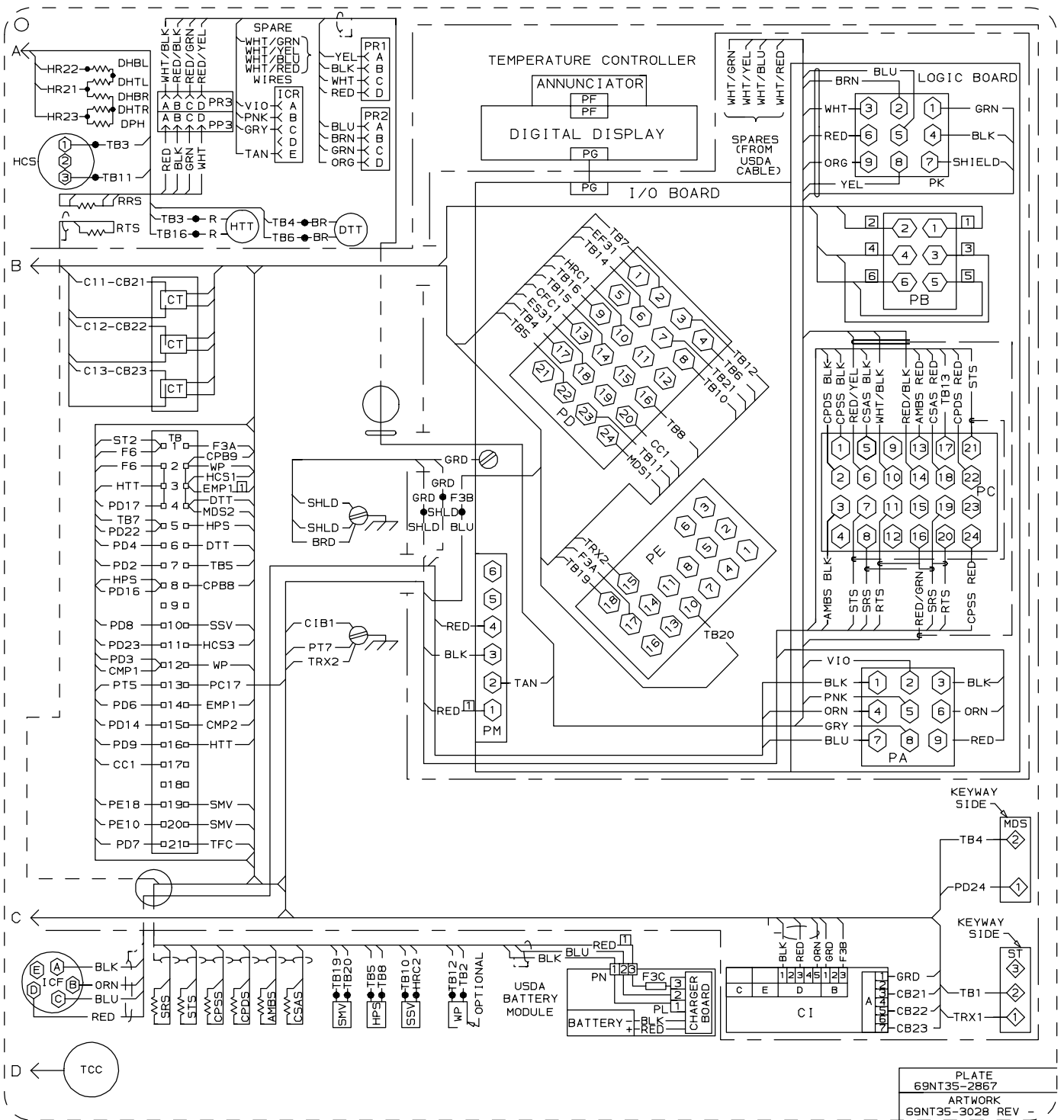


PLATE  
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ARTWORK  
69NT35-3028 REV

Figure 5-12. Electrical Wiring Diagram (Model 69NT40-449-27)  
(Sheet 2 of 2)

<u>ZONE</u>	<u>SYMBOL</u>	<u>LEGEND</u>	
			<u>DESCRIPTION</u>
J18	AMBS	—	AMBIENT SENSOR
L7, N2	C	=	COMPRESSOR CONTACTOR
D1	CB1	—	CIRCUIT BREAKER 460V
C3	CB2	—	CIRCUIT BREAKER 230V
L8, N6	CF	—	CONDENSER FAN CONTACTOR
N18	CI	—	COMMUNICATIONS INTERFACE MODULE
K7	CL	—	COOL LIGHT (WHITE)
G8, Q6	CM	—	CONDENSER FAN MOTOR
D7, Q3	CP	—	COMPRESSOR MOTOR
I18	CPDS	—	COMPRESSOR DISCHARGE SENSOR
I18	CPSS	—	COMPRESSOR SUCTION SENSOR
J18	CSAS	—	CONDENSER SATURATION SENSOR
J2	CT	—	CURRENT TRANSFORMER
Q5	DHBL	—	DEFROST HEATER - BOTTOM LEFT
P5	DHBR	—	DEFROST HEATER - BOTTOM RIGHT
P5	DHTL	—	DEFROST HEATER - TOP LEFT
O5	DHTR	—	DEFROST HEATER - TOP RIGHT
J12	DL	—	DEFROST LIGHT (AMBER)
N5	DPH	—	DRAIN PAN HEATER
C12	DTT	—	DEFROST TERMINATION THERMOSTAT
K9, L8, N7	EF	—	EVAPORATOR FAN CONTACTOR (HIGH SPEED)
D8, F8, Q8, Q9	EM	—	EVAPORATOR FAN MOTOR
K8, L9, O7	ES	—	EVAPORATOR FAN CONTACTOR (LOW SPEED)
A5, B6, C14, K6	F	—	FUSE
	FLA	—	FULL LOAD AMPS
F7	HPS	—	HIGH PRESSURE SWITCH
L9, N4	HR	—	HEATER CONTACTOR
E9	HTT	—	HEAT TERMINATION THERMOSTAT
D18, E18	IC	—	INTERROGATOR CONNECTOR
C7, C8, F8, G8, H7	IP	—	INTERNAL PROTECTOR
K11	IRL	—	IN-RANGE LIGHT (GREEN)
E12	MDS	—	MANUAL DEFROST SWITCH
H4	PT	—	POTENTIAL TRANSFORMER
B16, G16	R	—	RIBBON CABLE
K7, K11, K12	RM	—	REMOTE MONITORING RECEPTACLE
K19	RRS	—	RETURN RECORDER SENSOR
G18	RTS	—	RETURN TEMPERATURE SENSOR
F14	SMV	—	SOLENOID MODULATING VALVE
H18	SRS	—	SUPPLY RECORDER SENSOR
I10	SSV	—	SUCTION SOLENOID VALVE
E6	ST	—	START-STOP SWITCH
H18	STS	—	SUPPLY TEMPERATURE SENSOR
	TB	—	TERMINAL BLOCK CONNECTION
I7	TC	—	CONTROLLER RELAY (COOLING)
J8	TE	—	CONTROLLER RELAY (HIGH SPEED EVAP.)
G11	TI	—	CONTROLLER RELAY (IN-RANGE)
I9	TH	—	CONTROLLER RELAY (HEATING)
I8	TN	—	CONTROLLER RELAY (CONDENSER FAN)
J4	TR	—	TRANSFORMER
D4	TRANS	—	TRANSFORMER (AUTO 230/460)
E11	TS	—	CONTROLLER RELAY (SUCTION SOLENOID VALVE)
I9	TV	—	CONTROLLER RELAY (LOW SPEED EVAP.)
E2, E4	VS	—	VOLTAGE SWITCH
D8	WP	—	WATER PRESSURE SWITCH (OPTIONAL)

**Figure 5-13. Electrical Wiring Schematic (Model 69NT40-449-28)  
(Sheet 1 of 2)**

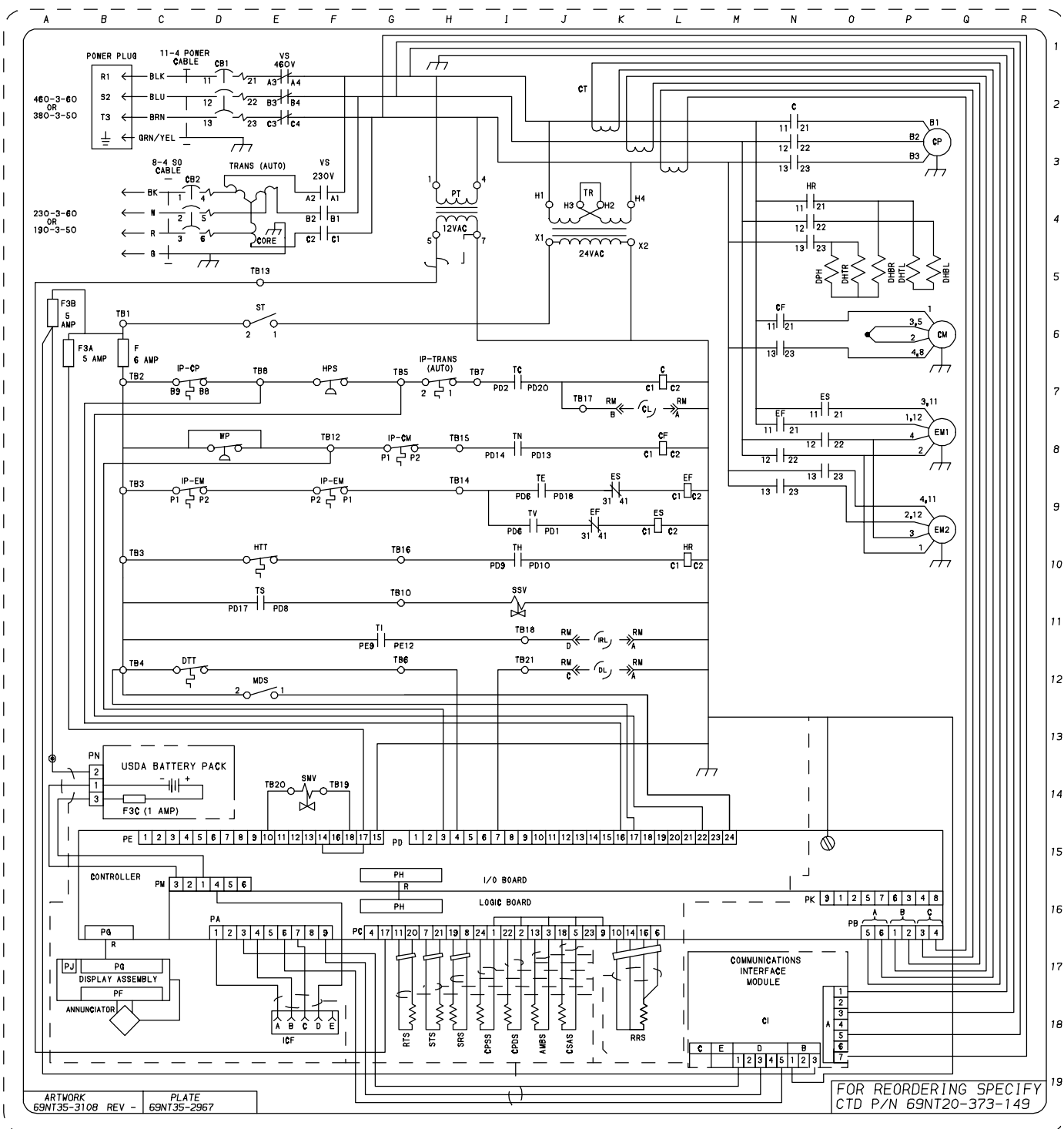


Figure 5-13. Electrical Wiring Schematic (Model 69NT40-449-28)  
(Sheet 2 of 2)

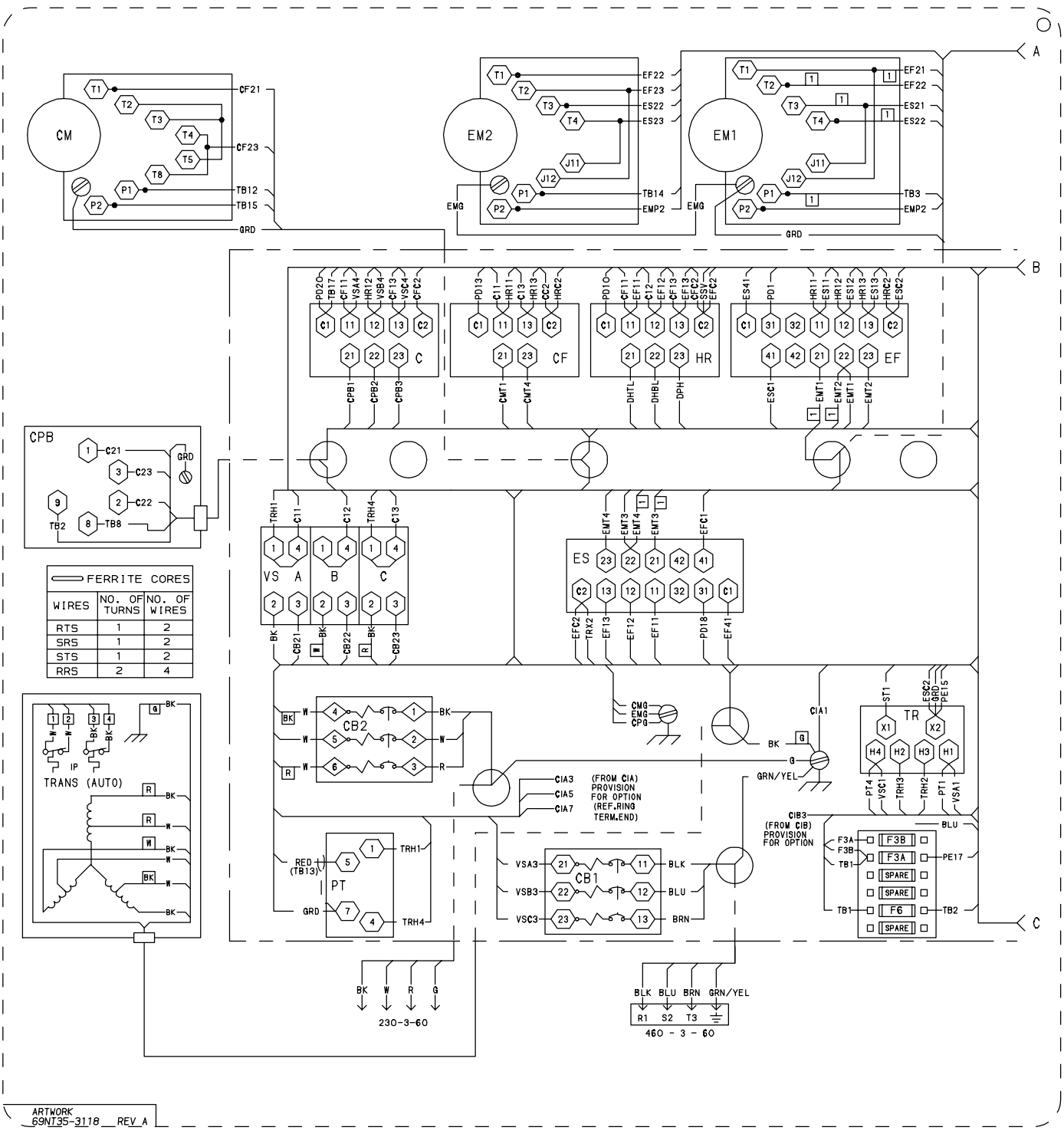


Figure 5-14. Electrical Wiring Diagram (Model 69NT40-449-28)  
(Sheet 1 of 2)

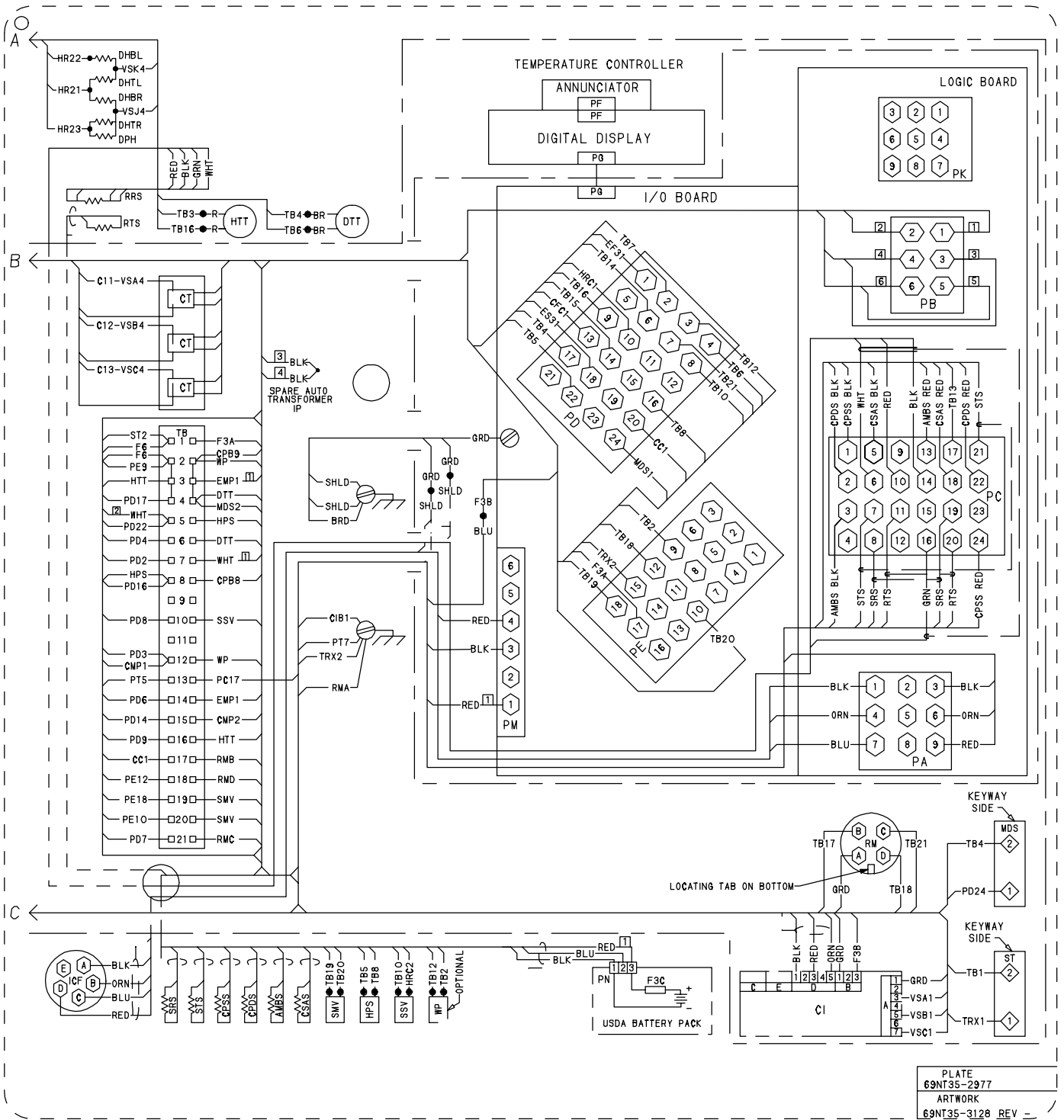


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ARTWORK  
69NT35-3128 REV

Figure 5-14. Electrical Wiring Diagram (Model 69NT40-449-28)  
(Sheet 2 of 2)



## LEGEND

ZONE	SYMBOL	DESCRIPTION
J18	AMBS-	AMBIENT SENSOR
L7,N2	C	COMPRESSOR CONTACTOR
D2	CB1	CIRCUIT BREAKER 460V
L8,N6	CF	CONDENSER FAN CONTACTOR
D8	CFS	CONDENSER FAN SWITCH
N18	CI	COMMUNICATIONS INTERFACE MODULE
G8,Q6	CM	CONDENSER FAN MOTOR
D7,Q3	CP	COMPRESSOR MOTOR
I18	CPDS-	COMPRESSOR DISCHARGE SENSOR
I18	CPSS-	COMPRESSOR SUCTION SENSOR
J18	CSAS-	CONDENSER SATURATION SENSOR
J2	CT	CURRENT TRANSFORMER
Q5	DHBL-	DEFROST HEATER - BOTTOM LEFT
P5	DHBR-	DEFROST HEATER - BOTTOM RIGHT
P5	DHTL-	DEFROST HEATER - TOP LEFT
O5	DHTR-	DEFROST HEATER - TOP RIGHT
N5	DPH	DRAIN PAN HEATER
C12	DTT	DEFROST TERMINATION THERMOSTAT
K9,L8,N7	EF	EVAPORATOR FAN CONTACTOR (HIGH SPEED)
D8,F8, Q8,Q9	EM	EVAPORATOR FAN MOTOR
K8,L9,O7	ES	EVAPORATOR FAN CONTACTOR (LOW SPEED)
A5,B6,C14	F	FUSE
	FLA	FULL LOAD AMPS
	HCS	HUMIDITY CONTROL SWITCH
F7	HPS	HIGH PRESSURE SWITCH
L10,N4	HR	HEATER CONTACTOR
D10	HTT	HEAT TERMINATION THERMOSTAT
D18,E18	IC	INTERROGATOR CONNECTOR
C7,C8,F8,G8	IP	INTERNAL PROTECTOR
E12	MDS	MANUAL DEFROST SWITCH
L17	PP	PROBE PLUG (RTN)
G4	PT	POTENTIAL TRANSFORMER
B16,G16	R	RIBBON CABLE
K19	RRS	RETURN RECORDER SENSOR
G18	RTS	RETURN TEMPERATURE SENSOR
F14	SMV	SOLENOID MODULATING VALVE
H18	SRS	SUPPLY RECORDER SENSOR
I10	SSV	SUCTION SOLENOID VALVE
E6	ST	START-STOP SWITCH
H18	STS	SUPPLY TEMPERATURE SENSOR
	TB	TERMINAL BLOCK CONNECTION
J7	TC	CONTROLLER RELAY (COOLING)
J8	TE	CONTROLLER RELAY (HIGH SPEED EVAP.)
I10	TH	CONTROLLER RELAY (HEATING)
I8	TN	CONTROLLER RELAY (CONDENSER FAN)
I4	TR	TRANSFORMER
E11	TS	CONTROLLER RELAY (SUCTION SOLENOID VALVE)
K6	TT	HOUR METER
I9	TV	CONTROLLER RELAY (LOW SPEED EVAP.)

**Figure 5-15. Electrical Wiring Schematic (Model 69NT40-459-4)**  
(Sheet 1 of 2)

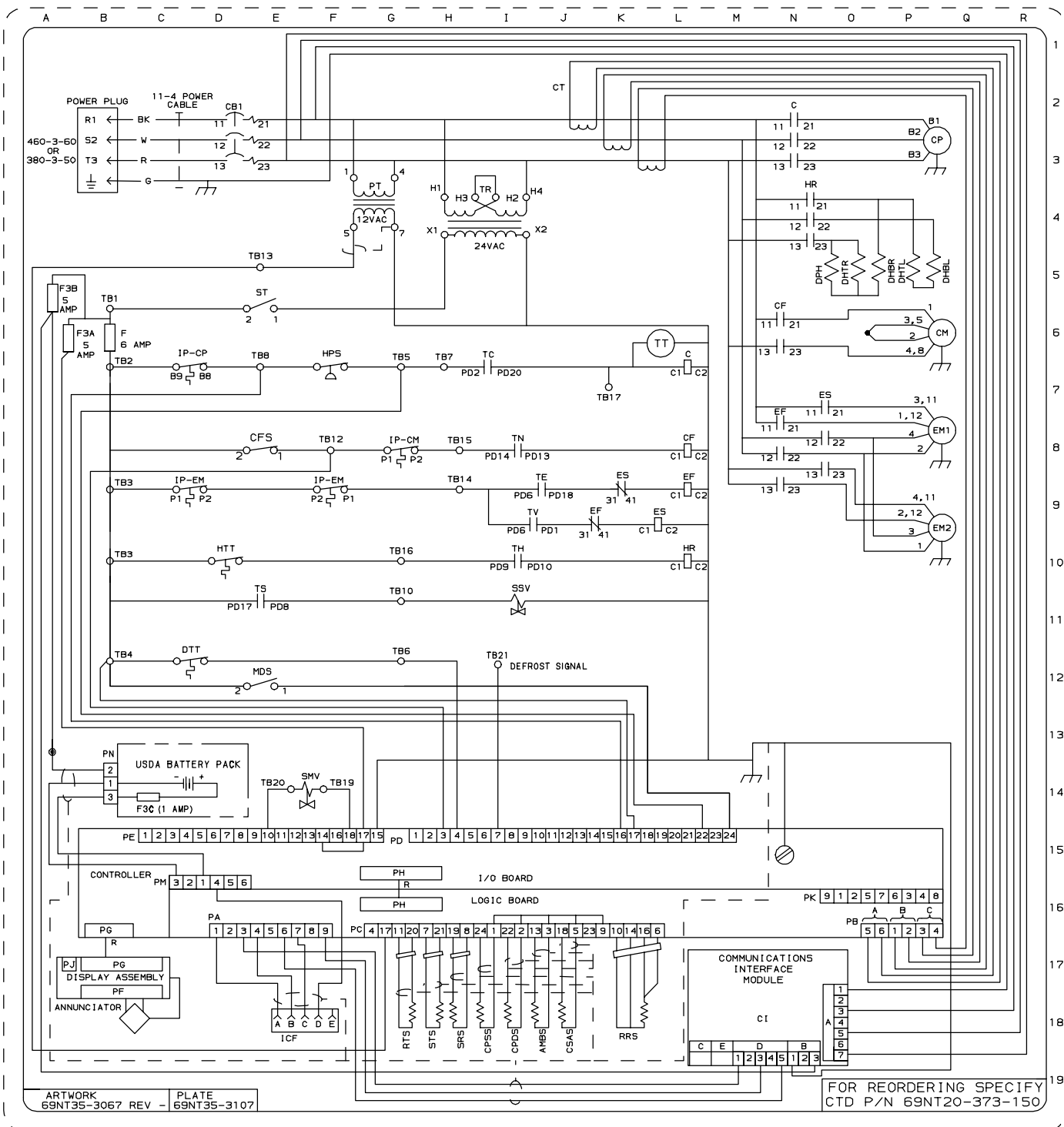
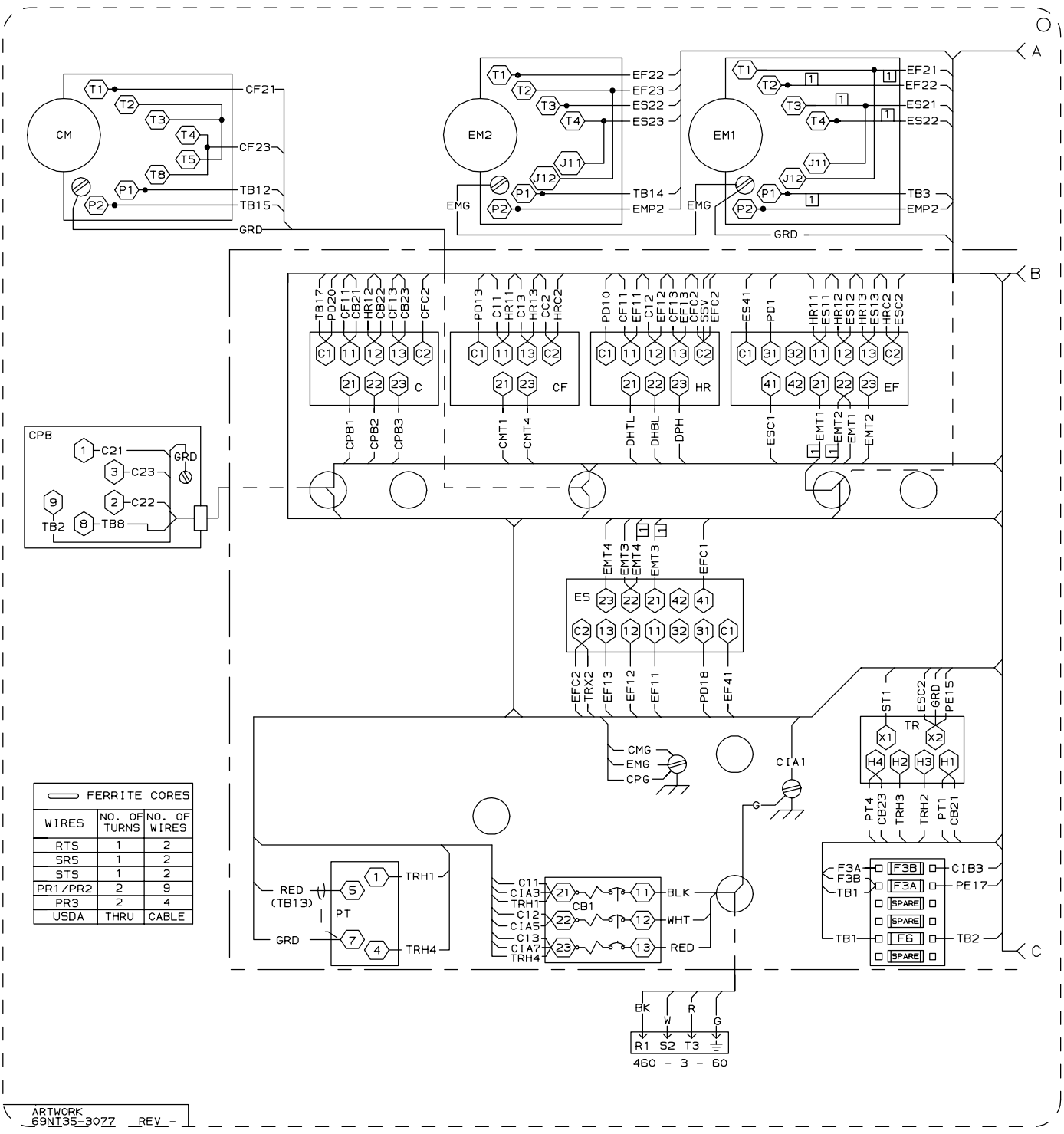


Figure 5-15. Electrical Wiring Schematic (Model 69NT40-459-4)  
(Sheet 2 of 2)



**Figure 5-16. Electrical Wiring Diagram (Model 69NT40-459-4)**  
**(Sheet 1 of 2)**

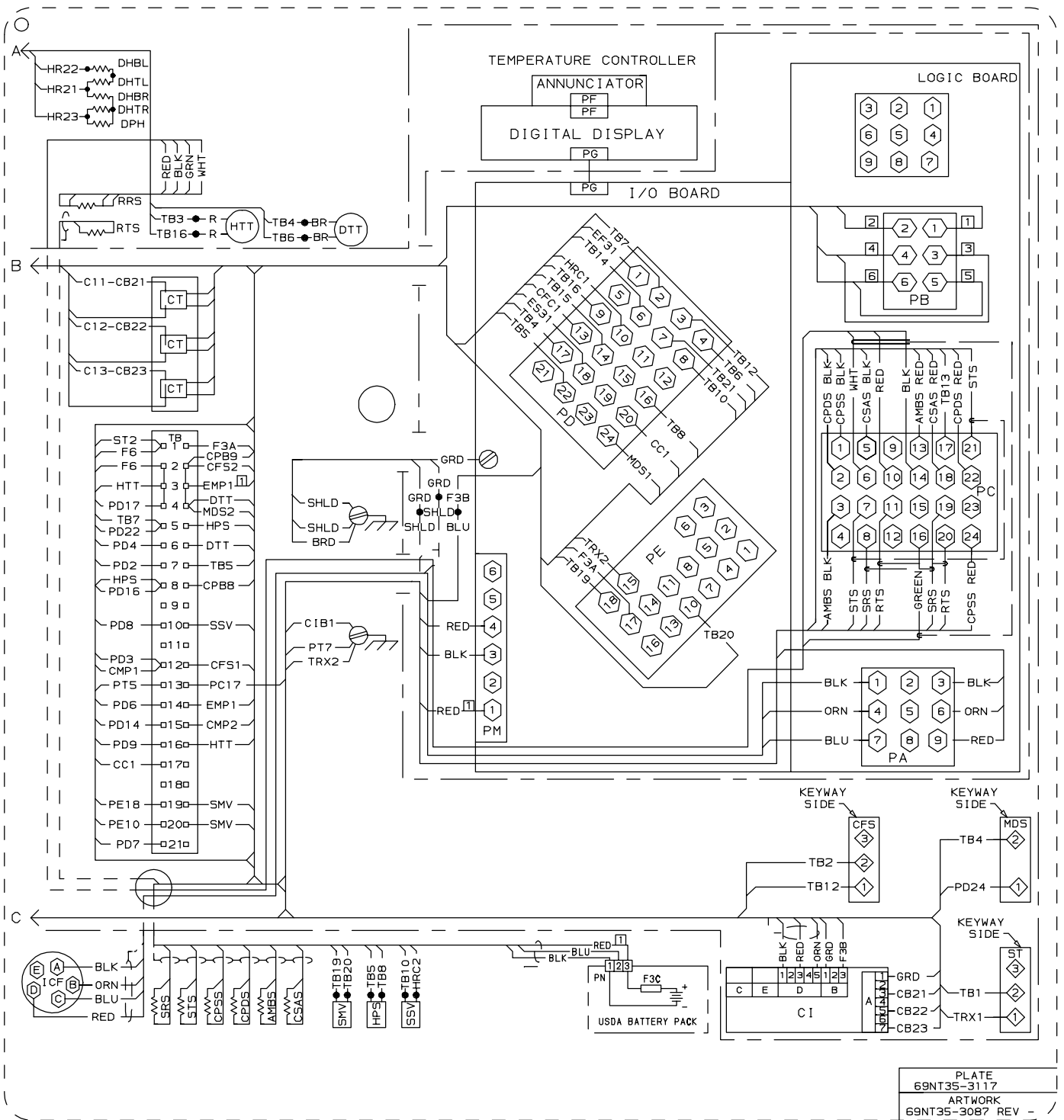


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ARTWORK  
69NT35-3087 REV

Figure 5-16. Electrical Wiring Diagram (Model 69NT40-459-4)  
(Sheet 2 of 2)

## LEGEND

<u>ZONE</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>
J18	AMBS	— AMBIENT SENSOR
L7, N2	C	— COMPRESSOR CONTACTOR
D2	CB1	— CIRCUIT BREAKER 460V
L8, N6	CF	— CONDENSER FAN CONTACTOR
E8	CFS	— CONDENSER FAN SWITCH
N18	CI	— COMMUNICATIONS INTERFACE MODULE
G8, Q6	CM	— CONDENSER FAN MOTOR
D7, Q3	CP	— COMPRESSOR MOTOR
I18	CPDS	— COMPRESSOR DISCHARGE SENSOR
I18	CPSS	— COMPRESSOR SUCTION SENSOR
J18	CSAS	— CONDENSER SATURATION SENSOR
J2	CT	— CURRENT TRANSFORMER
Q5	DHBL	— DEFROST HEATER — BOTTOM LEFT
P5	DHBR	— DEFROST HEATER — BOTTOM RIGHT
P5	DHTL	— DEFROST HEATER — TOP LEFT
O5	DHTR	— DEFROST HEATER — TOP RIGHT
N5	DPH	— DRAIN PAN HEATER
C12	DTT	— DEFROST TERMINATION THERMOSTAT
K9, L8, N7	EF	— EVAPORATOR FAN CONTACTOR (HIGH SPEED)
D8, F8, Q8, Q9	EM	— EVAPORATOR FAN MOTOR
K8, L9, O7	ES	— EVAPORATOR FAN CONTACTOR (LOW SPEED)
A5, B6, C14	F	— FUSE
	FLA	— FULL LOAD AMPS
J11	HCS	— HUMIDITY CONTROL SWITCH
F7	HPS	— HIGH PRESSURE SWITCH
L10, N4	HR	— HEATER CONTACTOR
D10	HTT	— HEAT TERMINATION THERMOSTAT
D18, E18	IC	— INTERROGATOR CONNECTOR
C7, C8, F8, G8	IP	— INTERNAL PROTECTOR
E12	MDS	— MANUAL DEFROST SWITCH
L17	PP	— PROBE PLUG (RTN)
L17, O11, P11	PR	— PROBE RECEPTACLE (USDA)
G4	PT	— POTENTIAL TRANSFORMER
B16, G16	R	— RIBBON CABLE
K19	RRS	— RETURN RECORDER SENSOR
G18	RTS	— RETURN TEMPERATURE SENSOR
F14	SMV	— SOLENOID MODULATING VALVE
H18	SRS	— SUPPLY RECORDER SENSOR
I10	SSV	— SUCTION SOLENOID VALVE
E6	ST	— START-STOP SWITCH
H18	STS	— SUPPLY TEMPERATURE SENSOR
	TB	— TERMINAL BLOCK CONNECTION
J7	TC	— CONTROLLER RELAY (COOLING)
J8	TE	— CONTROLLER RELAY (HIGH SPEED EVAP.)
I10	TH	— CONTROLLER RELAY (HEATING)
I8	TN	— CONTROLLER RELAY (CONDENSER FAN)
I4	TR	— TRANSFORMER
E11	TS	— CONTROLLER RELAY (SUCTION SOLENOID VALVE)
I9	TV	— CONTROLLER RELAY (LOW SPEED EVAP.)

**Figure 5-17. Electrical Wiring Schematic (Model 69NT40-449-29)  
(Sheet 1 of 2)**

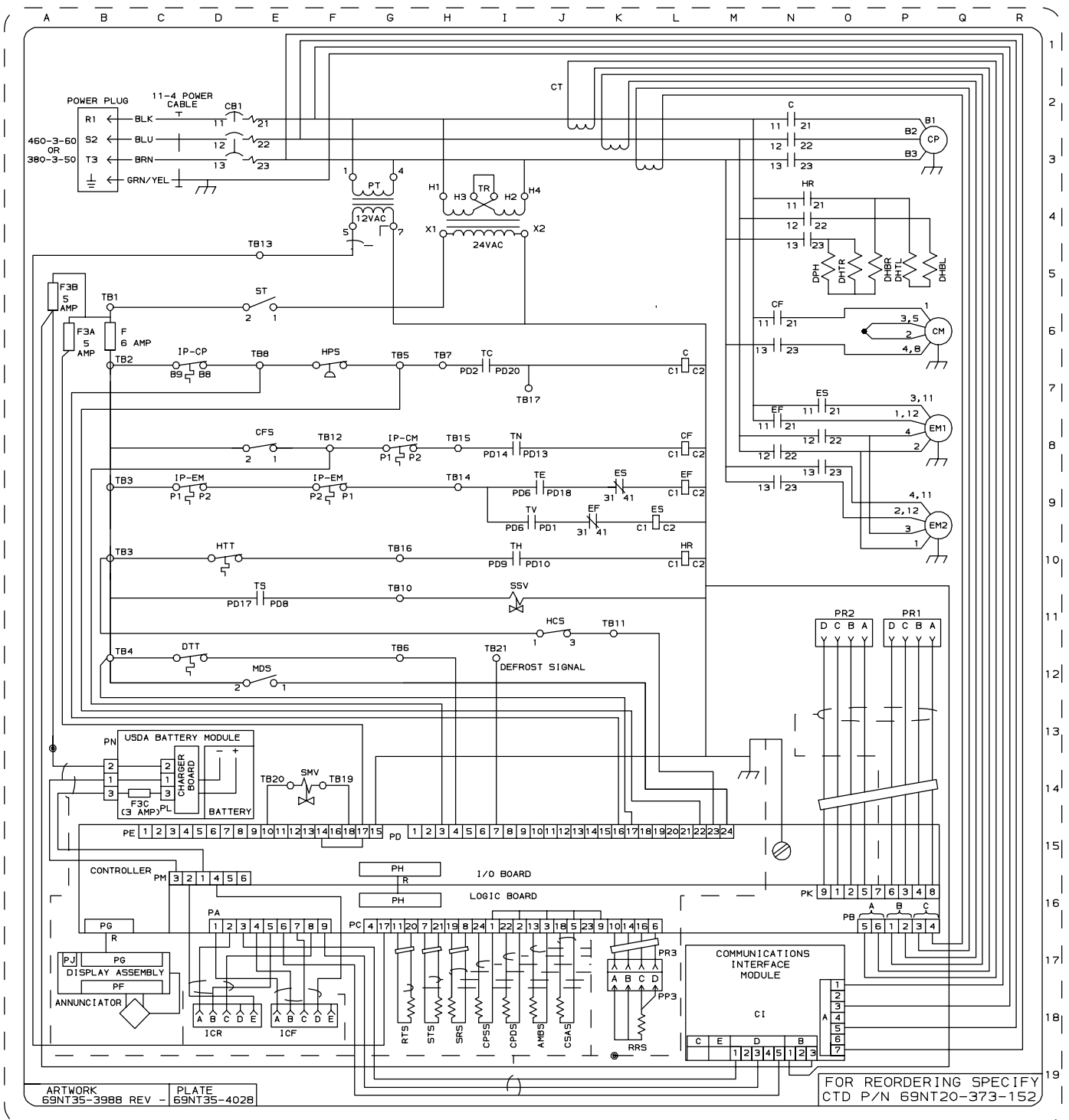


Figure 5-17. Electrical Wiring Schematic (Model 69NT40-449-29)  
(Sheet 2 of 2)

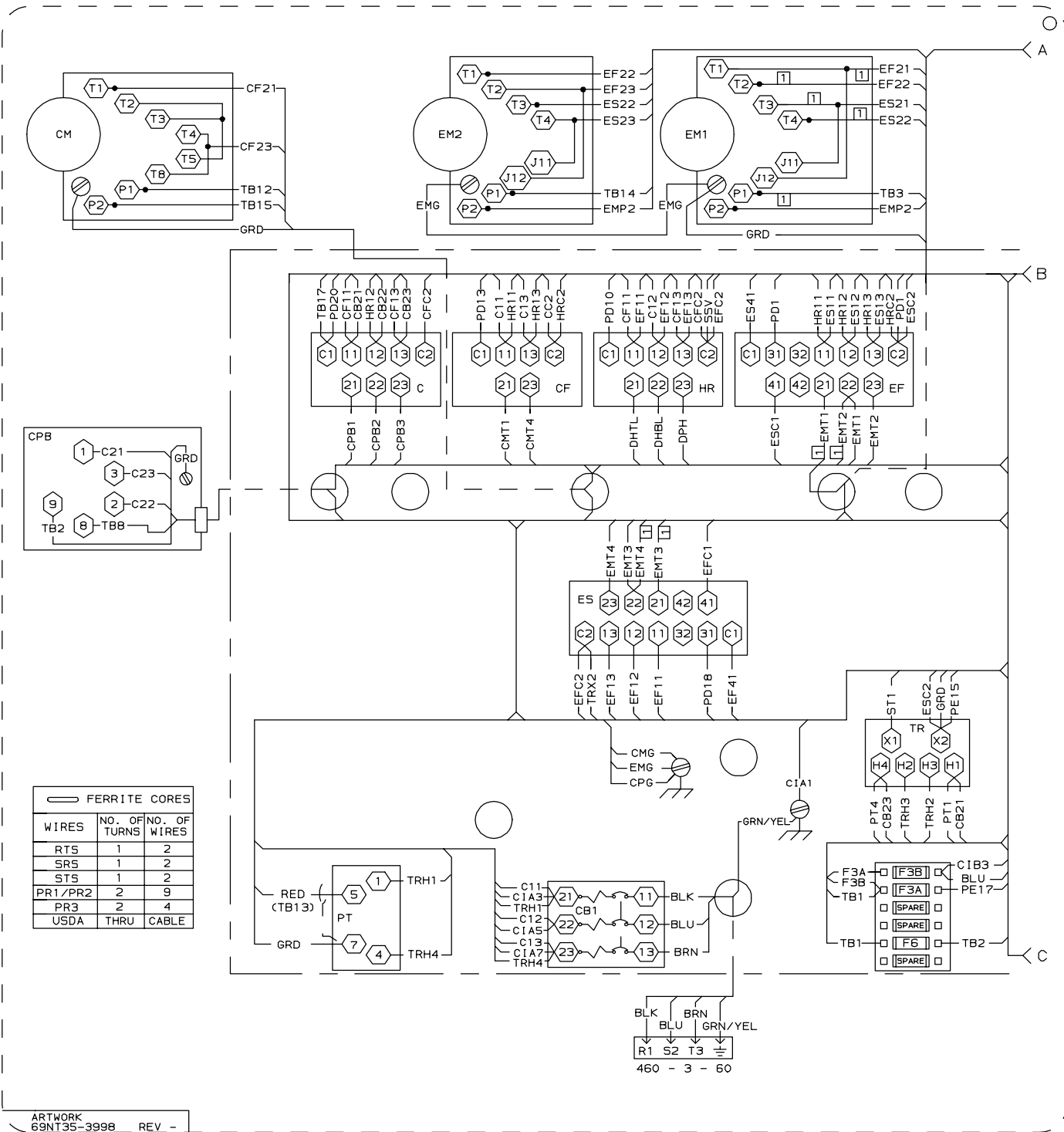


Figure 5-18. Electrical Wiring Diagram (Model 69NT40-449-29)  
(Sheet 1 of 2)

