Carrier
TRANSICOLD

Container Refrigeration Unit

Models 69NT40-511-200 to 69NT40-511-299

OPERATION AND SERVICE

T-294 Rev A

Carrier

TRANSICOLD

OPERATION AND SERVICE MANUAL

CONTAINER REFRIGERATION UNIT

MODELS 69NT40-511-200 to 69NT40-511-299

Carrier Transicold Division, Carrier Corporation, P.O. Box 4805, Syracuse, N.Y. 13221

Carrier

A United Technologies Company

SAFETY SUMMARY

GENERAL SAFETY NOTICES

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. The general safety notices are presented in the following three sections labeled: First Aid, Operating Precautions and Maintenance Precautions. A listing of the specific warnings and cautions appearing elsewhere in the manual follows the general safety notices.

FIRST AID

An injury, no matter how slight, should never go unattended. Always obtain first aid or medical attention immediately.

OPERATING PRECAUTIONS

Always wear safety glasses.

Keep hands, clothing and tools clear of the evaporator and condenser fans.

No work should be performed on the unit until all circuit breakers, start-stop switches are turned off, and power supply is disconnected.

Always work in pairs. Never work on the equipment alone.

In case of severe vibration or unusual noise, stop the unit and investigate.

MAINTENANCE PRECAUTIONS

Beware of unannounced starting of the evaporator and condenser fans. Do not open the condenser fan grille or evaporator access panels before turning power off, disconnecting and securing the power plug.

Be sure power is turned off before working on motors, controllers, solenoid valves and electrical control switches. Tag circuit breaker and power supply to prevent accidental energizing of circuit.

Do not bypass any electrical safety devices, e.g. bridging an overload, or using any sort of jumper wires. Problems with the system should be diagnosed, and any necessary repairs performed, by qualified service personnel.

When performing any arc welding on the unit or container, disconnect all wire harness connectors from the modules in both control boxes. Do not remove wire harness from the modules unless you are grounded to the unit frame with a static safe wrist strap.

In case of electrical fire, open circuit switch and extinguish with CO_2 (never use water).

SPECIFIC WARNING AND CAUTION STATEMENTS

To help identify the label hazards on the Unit and explain the level of awareness each one carries, an explanation is given with the appropriate consequences:

DANGER – means an immediate hazard which WILL result in severe personal injury or death.

WARNING – means to warn against hazards or unsafe conditions which COULD result in severe personal injury or death.

CAUTION – means to warn against potential hazard or unsafe practice which could result in minor personal injury, product or property damage.

The statements listed below are applicable to the refrigeration unit and appear elsewhere in this manual. These recommended precautions must be understood and applied during operation and maintenance of the equipment covered herein.

WARNING

When servicing the unit, use caution when handling R-134a. The refrigerant when in contact with high temperatures (about 1000_F) will decompose into highly corrosive and toxic compounds.

WARNING

Be sure to avoid refrigerant coming in contact with the eyes. Should refrigerant come in contact with the eyes, wash eyes for a minimum of 15 minutes with potable water only. THE USE OF MINERAL OIL OR REFRIGERANT OILS IS NOT RECOMMENDED.

WARNING

Be sure to avoid refrigerant coming in contact with the skin. Should refrigerant come in contact with the skin, it should be treated as if the skin had been frostbitten or frozen.

WARNING

Be sure ventilation in the workspace is adequate to keep the concentration of refrigerant below 1000 parts per million. If necessary, use portable blowers.

WARNING

Beware of rotating fan blades and unannounced starting of fans.

WARNING

Do not use a nitrogen cylinder without a pressure regulator. 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

Never fill a refrigerant cylinder beyond its rated capacity. Cylinder may rupture due to excessive pressure when exposed to high temperatures.

WARNING

When starting the unit, be sure that all manual refrigerant valves in the discharge line are open. Severe damage could occur from extremely high refrigerant pressures.

WARNING

When brazing (soldering) refrigeration system, residual oil can cause a fire and potential injury. Refer to proper procedure before starting repair.

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SECTION 1

INTRODUCTION

1.1 BRIEF UNIT DESCRIPTION

WARNING

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

This manual contains Operating Data, Electrical Data and Service Instructions for the refrigeration unit listed in Table 1-1.

NOTE

Beginning with early 1995 production, in addition to a model number, Carrier Transicold began using a parts identification (PID) number in the format NT0000. In the parts manual, the PID number is shown in boldface to point out parts variations within models. The PID number must be included when ordering and inquiring about your unit.

The unit, of lightweight aluminum frame construction, is an all electric, one piece, self-contained cooling and heating refrigeration unit (see Figure 2-1). The unit is designed to fit in the front of a container and to serve as the container front wall. Forklift 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, and 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 2.4). Other units are designed to operate on 380/460 volts AC, 3-phase 50/60 hertz power only. An external autotransformer is required for 190/230 vac operation (refer to Figure 2-7 and section 2.4).

Operating control power is provided by a control transformer which steps down the AC supply power source to 18 and 24 volts AC, single phase control power.

The temperature Controller/DataCORDER (Micro-Link 2i) is a microprocessor-based controller and an integrated electronic data logging device. Refer to sections 3.1 and 3.3. 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 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																
MODEL	PID	USDA Cold Treatment	Transformer	Water-Cooled Condenser	Condenser Coil		Suction & Discharge Pressure Option	Dehumidification	TransFresh	Communications Interface Module	Temperature Recorder	Power Factor Corrector (PFC)	Arctic Option	Hermetic Unit	Composite Control Box	Schematic & Diagra
					3 Row	4 Row										
69NT40-511-201	NT0448	P	X	X	–	X	–	P	–	X	–	X	–	X	–	77-01698-38
	NT0569	P	X	X	X	–	–	P	–	X	–	X	–	X	X	77-01698-60
69NT40-511-201	NT0602	P	X	X	X	–	–	P	X	X	–	X	–	X	X	77-01698-60

A = Factory Installed Pressure Gauges
B = Factory Installed Pressure Transducers
P = Provision
X = Features that apply to model
– = Features that are **not applicable** to model

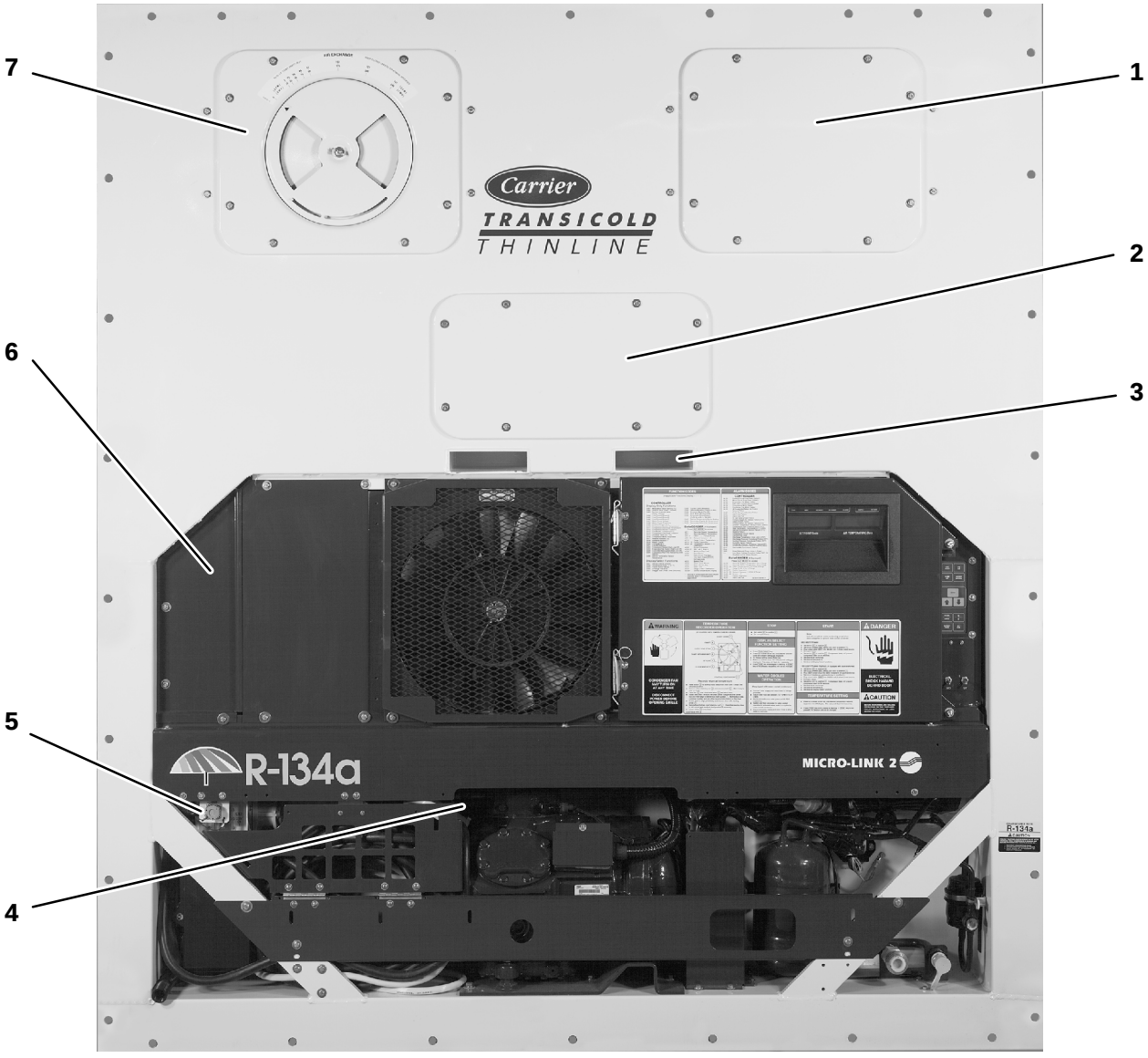
SECTION 2

DESCRIPTION

2.1 GENERAL DESCRIPTION

a. Refrigeration Unit – Front Section

The front section of the refrigeration unit shows access to most parts of the unit (i.e., compressor, condenser, receiver, etc.), which will be discussed in more detail of the following sections in 2.1. The upper access panels allow front entry into the evaporator section, and the center access panel allows access to the evaporator coil heaters. The unit model number, serial number and parts identification number will be found on the front of the unit to the left of the compressor.



1. Access Panel (For Evap. Fan Motor #1)
2. Access Panel (For Heater)
3. Fork Lift Pockets
4. Unit Serial Number, Model Number and Parts Identification Number (PID) Plate
5. Interrogator Connector (IC)
6. Lower Fresh Air Makeup Vent or Blank Plate – Optional
7. Upper Fresh Air Makeup Vent and Access Panel (For Evap. Fan Motor #2)

Figure 2-1. Refrigeration Unit – Front Section

b. Evaporator Section

The evaporator section (see Figure 2-2) contains the return temperature sensor (RTS), hermetic thermostatic expansion valve, dual-speed evaporator fan motors (EM1 and EM2) and fans (2), evaporator coil and heater (HR), drain pan heater (DPH), defrost heaters (DHBL, DHBR, DHTK and DHTR), defrost termination sensor (DTS), heat termination thermostat (HTT), interrogator and USDA receptacles, and heat exchanger.

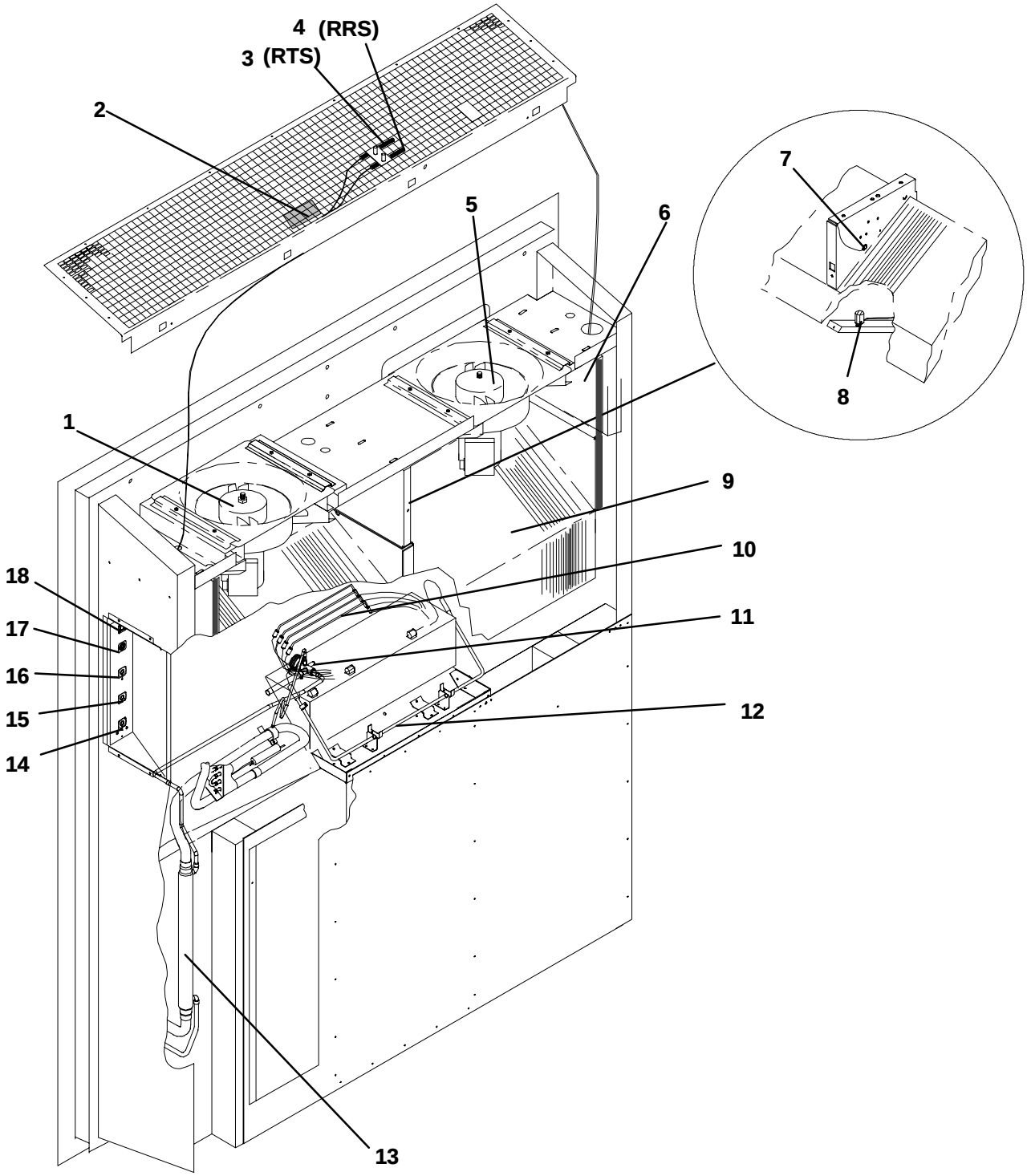
The evaporator fans circulate air throughout the container by pulling air in the top of the refrigeration unit, directing the air through the evaporator coil where it is either heated or cooled, and discharging the air through the bottom of the refrigeration unit into the container.

When transporting perishable (chilled) commodities, the fan motors will normally be in high speed above –10_C (+14_F), or –5_C (+23_F) optionally.

The evaporator coil heaters are accessible by removing the front lower access panel. The defrost termination sensor 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, disconnecting the evaporator fan connector and reaching through the access panel opening**.**

WARNING

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



1. Evaporator Fan Motor #1 (EM1)
2. Humidity Sensor (HS) – Optional
3. Return Temperature Sensor (RTS)
4. Return Recorder Sensor (RRS) – Optional
5. Evaporator Fan Motor #2 (EM2)
6. Power Factor Corrector (PFC)
7. Defrost Termination Sensor (DTS)
8. Heat Termination Thermostat (HTT)
9. Evaporator Coil
10. Evaporator Coil Heaters
11. Hermetic Thermostatic Expansion Valve
12. Drain Pan Heater (DPH)
13. Heat Exchanger
14. Interrogator Receptacle (IC) – Optional
15. USDA Probe Receptacle (PR2) – Optional
16. USDA Probe Receptacle (PR1) – Optional
17. USDA Probe Receptacle (PR3) – Optional
18. Cargo Probe Receptacle (PR4) – Optional

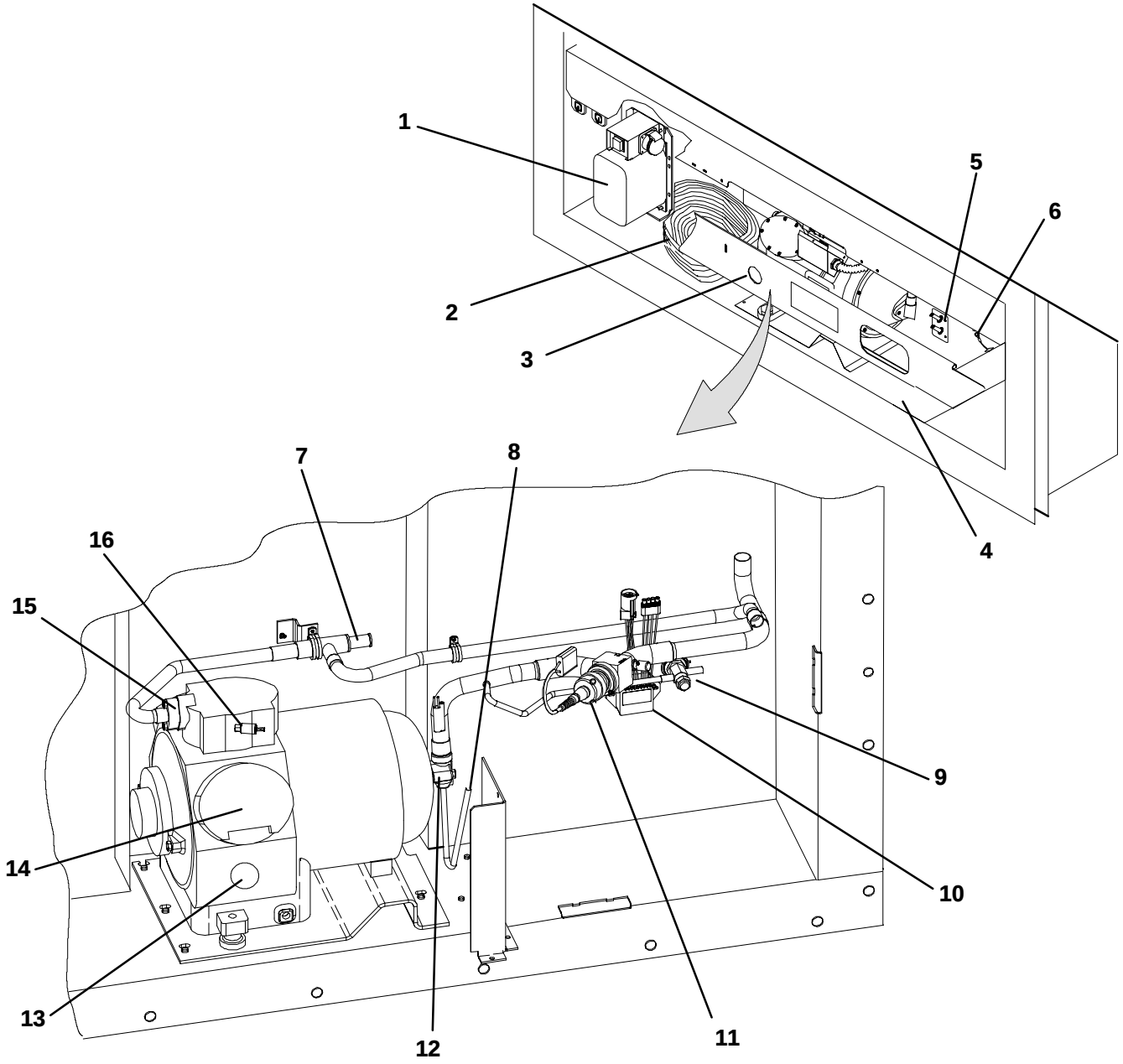
Figure 2-2. Evaporator Section

c. Compressor Section

The compressor section includes the compressor (with high pressure switch), power cable storage compartment, and autotransformer (TRANS), which is located to the left of the compressor.

This section also contains the stepper motor suction modulation valve (SMV), quench expansion valve, stepper motor drive (SD), and the discharge pressure regulator valve.

The supply temperature sensor (STS), and ambient sensor (AMBS) are located at the right side of the compressor, and the suction line process tube.

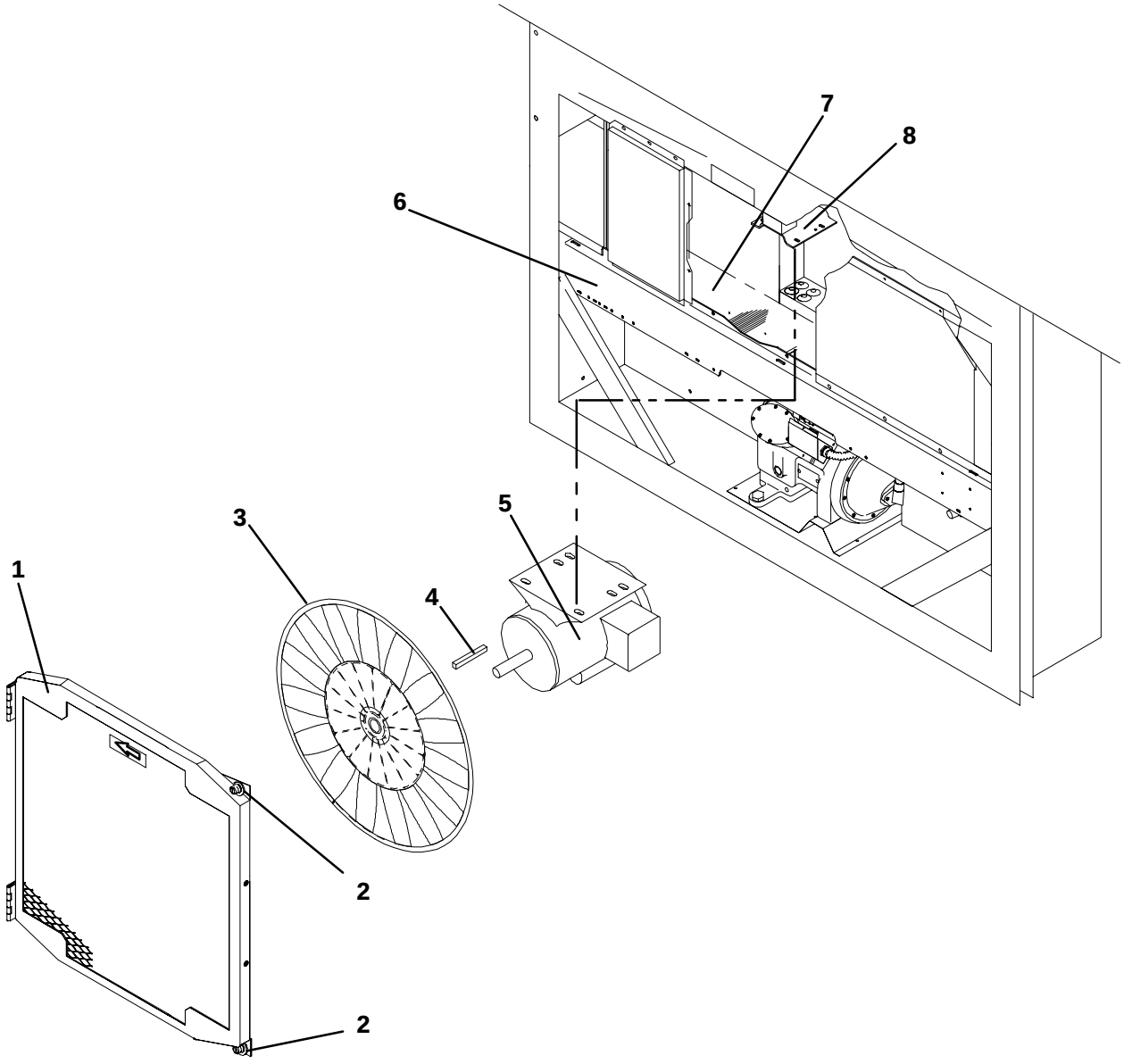


1. Power Autotransformer (TRANS)
2. Power Cables and Plug
3. Compressor Sight Glass View Port
4. Compressor Guard
5. Supply Temperature Sensor (STS)
6. Ambient Sensor (AMBS)
7. Discharge Pressure Regulator Valve
8. Suction Line Process Tube
9. Quench Expansion Valve
10. Stepper Motor Suction Modulation Valve (SMV)
11. Stepper Motor Drive (SD)
12. Suction Flange
13. Compressor Sight Glass
14. Compressor Motor (CP)
15. Discharge Flange
16. High Pressure Switch (HPS)

Figure 2-3. Compressor Section

d. Condenser Section

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

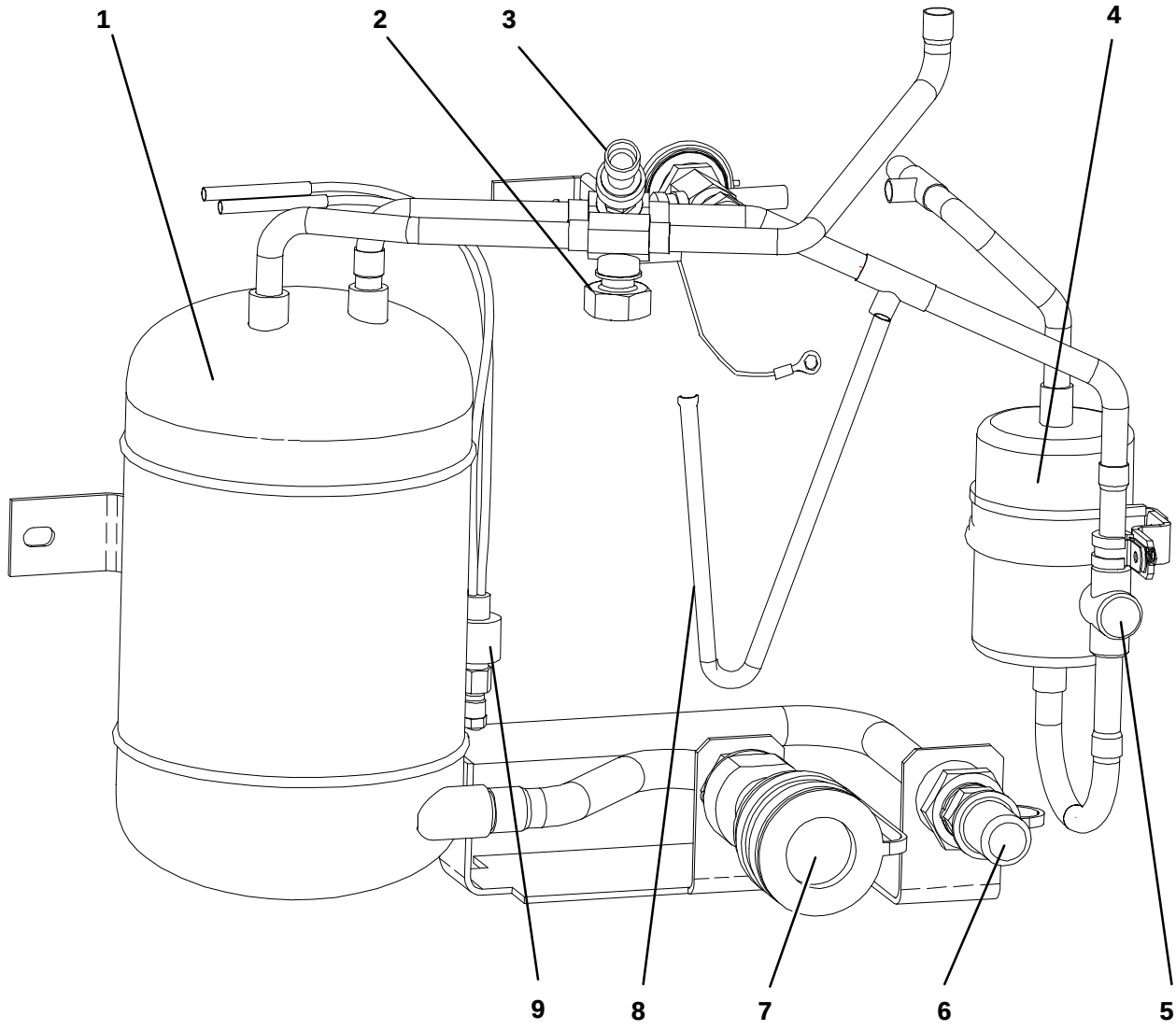


1. Grille and Venturi Assembly
2. Retaining Screw
3. Condenser Fan
4. Key
5. Condenser Fan Motor (CM)
6. Condenser Coil Cover
7. Condenser Coil
8. Condenser Motor Mounting Bracket

Figure 2-4. Condenser Section

e. Water-Cooled Condenser Section

The water-cooled condenser section consists of water-cooled condenser, sight glass, and rupture disc, condenser pressure transducer (CPT), filter-drier, water hook-up couplings, water pressure switch (WP), and the liquid line process tube

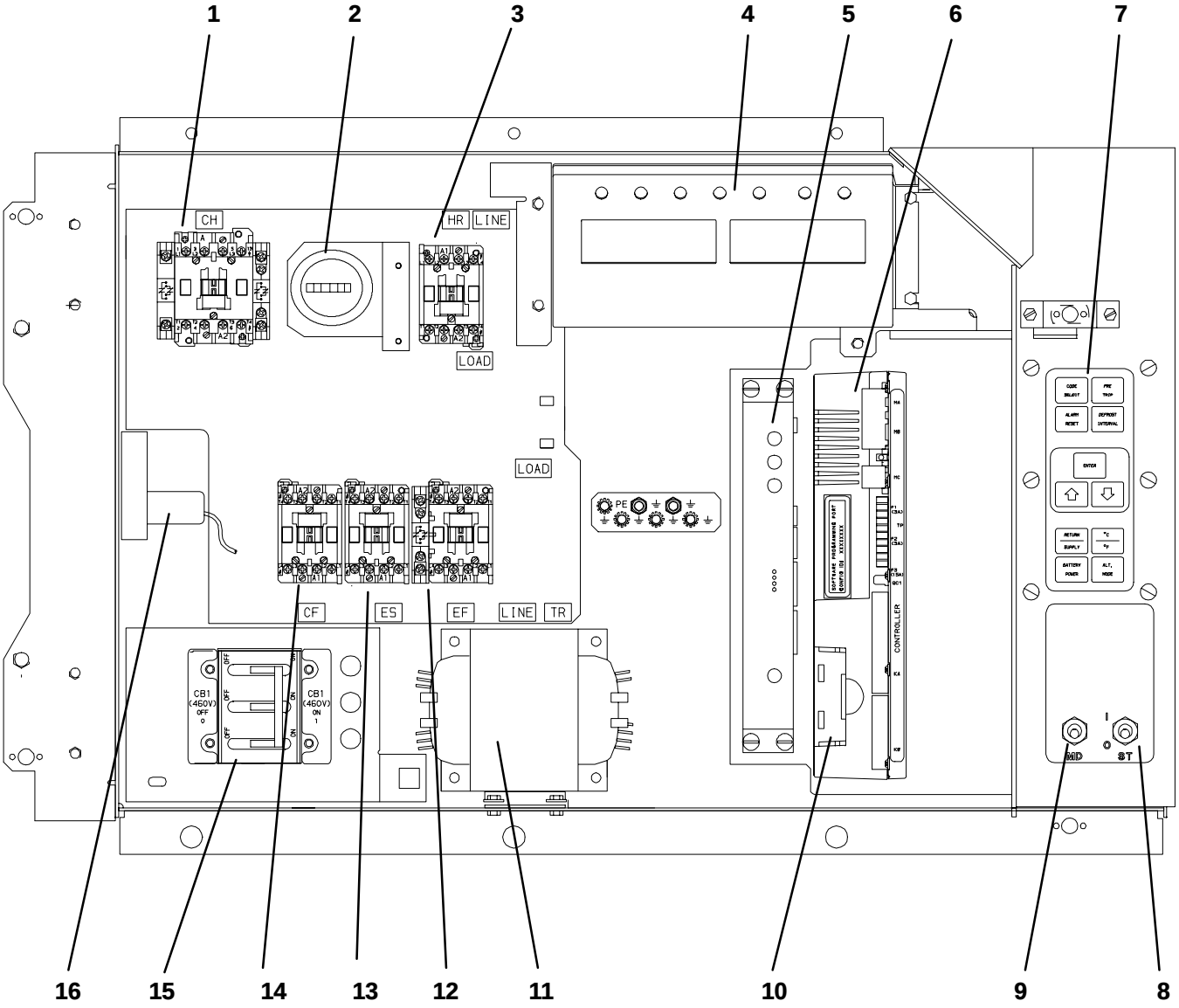


1. Water-Cooled Condenser
2. Rupture Disc
3. Condenser Pressure Transducer (CPT)
4. Filter-Drier
5. Moisture Liquid Indicator/Sight Glass
6. Coupling (Water In)
7. Self Draining Coupling (Water Out)
8. Liquid Line Process Tube
9. Water Pressure Switch (WP)

Figure 2-5. Water-Cooled Condenser Section

f. Control Box Section

The control box (see Figure 2-6) includes the manual switches (ST and MDS), circuit breaker (CB-1), contactors (CF, CH, EF, ES and HR), hour meter (HM), transformer (TR), fuses (F), key pad (KP), display module, current sensor module (CS), Controller/DataCORDER module, and an optional remote monitoring unit (CI).



1. Compressor Contactor (CH)
2. Hour Meter (HM)
3. Heater Contactor (HR)
4. Display Module
5. Remote Monitoring Unit (CI) – Optional
6. Controller/DataCORDER Module
7. Key Pad
8. Start-Stop Switch (ST)
9. Manual Defrost Switch (MDS)
10. Controller/DataCORDER Battery Pack – Optional
11. Control Transformer (TR)
12. Evaporator Fan Contactor (EF) High Speed
13. Evaporator Fan Contactor (ES) Low Speed
14. Condenser Fan Contactor (CF)
15. Circuit Breaker (CB-1) – 460V
16. Current Sensor Module (CS)

Figure 2-6. Control Box Section

2.2 REFRIGERATION SYSTEM DATA

a. Compressor/Motor Assembly (CP)	Number of Cylinders	6		
	Model	06DR		
	CFM	41		
	Weight (Dry)	118 kg (260 lb)		
	Approved Oil	Castrol Icematic – SW20		
	Oil Charge	3.6 liters (7.6 U.S. pints)		
	Oil Sight Glass	The oil level range, with the compressor off, should be between the bottom and one-eighth level of the capacity of the sight glass.		
b. Expansion Valve Superheat	Verify at –18 _C (0_F) container box temperature	4.48 to 6.67 _C (8 to 12 _F)		
c. Heater Termination Thermostat (HTT)	Opens	54 (¦ 3) _C = 130 (¦ 5) _F		
	Closes	38 (¦ 4) _C = 100 (¦ 7) _F		
d. High Pressure Switch (HPS)	Cutout	25 (¦ 1.0) kg/cm@ = 350 (¦ 10) psig		
	Cut-In	18 (¦ 0.7) kg/cm@ = 250 (¦ 10) psig		
e. Refrigerant Charge	**Unit Configuration**	**Charge Requirements – R-134a**		
		2* row condenser	3* row condenser	4* row condenser
	Water-Cooled Condenser	4.5 kg (9.0 lbs)	4.88 kg (10.75 lbs)	5.22 kg (11.5 lbs)
		***** Refer to Table 1-1.		
NOTE When replacing components (f.) in section 2.2, refer to the installation instructions included with the ordered new part for additional information.				
f. Rupture Disc	Bursts at	35 ¦ 5% kg/cm@ = (500 ¦ 5% psig)		
	Torque (P/N 14-00215-03)	1.4 to 2 mkg (10 to 15 ft-lbs)		
	Torque (P/N 14-00215-04)	6.2 to 6.9 mkg (45 to 50 ft-lbs)		
g. Condenser Pressure Transducer (CPT)	Condenser Fan Starts	The condenser fan will start if the condenser pressure is greater than 14.06 kg/cm@ (200 psig) OR the condenser fan is OFF for more than 60 seconds.		
	Condenser Fan Stops	The condenser fan will stop if the condenser pressure is less than 9.14 kg/cm@ (130 psig) AND the condenser fan remains ON for at least 30 seconds.		
h. Unit Weight	Refer to unit model number plate, see Figure 2-1 for location of plate.			
i. Water Pressure Switch (WP)	Cut-In	0.5 ¦ 0.2 kg/cm@ (7 ¦ 3 psig)		
	Cutout	1.6 ¦ 0.4 kg/cm@ (22 ¦ 5 psig)		

2.3 ELECTRICAL DATA

a. Circuit Breaker (CB)	CB-1 Trips at	29 amps	
	CB-2 **(50 amp)** Trips at	62.5 amps	
	CB-2 **(70 amp)** Trips at	87.5 amps	
b. Compressor Motor (CP)	Full Load Amps (FLA)	17.6 amps @ 460 vac (with current limiting set at 21 amps)	
c. Condenser Fan Motor (CM)		**380 vac, Single Phase, 50 hz**	**460 vac, Single Phase, 60 hz**
	Full Load Amps	1.3 amps	1.6 amps
	Horsepower	0.43 hp	0.75 hp
	Rotations Per Minute	1425 rpm	1725 rpm
	Voltage and Frequency	360 – 460 vac ¦ 2.5 hz	400 – 500 vac ¦ 2.5 hz
	Bearing Lubrication	Factory lubricated, additional grease not required.	
	Rotation	Counter-clockwise when viewed from shaft end.	
d. Drain Pan Heaters (DPH)	Number of Heaters	1	
	Rating	750 watts +5 /–10 % @ 460 vac	
	Resistance (cold)	285 ¦ 7.5% ohms nominal	
	Type	Sheath	
e. Evaporator Coil Heaters (DHBL, DHBR, DHTL, DHTR)	Number of Heaters	4	
	Rating	750 watts +5/–10% each @ 230 vac	
	Resistance (cold)	66.8 to 77.2 ohms	
	Ambient	@ 20 _C (68_F)	
	Type	Sheath	
f. Evaporator Fan Motor(s) (EM)		**380 vac, Single Phase, 50 hz**	**460 vac, Single Phase, 60 hz**
	Full Load Amps High Speed	1.6 amps	2.0 amps
	Full Load Amps Low Speed	0.8 amps	1.0 amps
	Nominal Horsepower High Speed	0.70 hp	0.84 hp
	Nominal Horsepower Low Speed	0.09 hp	0.11 hp
	Rotations Per Minute High Speed	2850 rpm	3450 rpm
	Rotations Per Minute Low Speed	1425 rpm	1750 rpm
	Voltage and Frequency	360 – 460 vac ¦ 2.5 hz	400 – 500 vac ¦ 2.5 hz
	Voltage and Frequency – using modular transformer	180 – 230 vac ¦ 2.5 hz	200 – 250 vac ¦ 2.5 hz
	Bearing Lubrication	Factory lubricated, additional grease not required	
	Rotation	Clockwise when viewed from shaft end.	
g. Fuses (F)	Control Circuit	15 amps (F3)	
	Controller/DataCORDER	5 amps (F1 & F2)	
h. Compressor Crankcase Heater (CCH) – Optional		180 watts @ 460 vac	

i. Humidity Sensor (HS) – Optional	Orange wire	Power
	Red wire	Output
	Brown wire	Ground
	Input voltage	5 vdc
	Output voltage	0 to 3.3 vdc
	Output voltage readings verses relative humidity (RH) percentage:	
	30%	0.99 V
	50%	1.65 V
	70%	2.31 V
	90%	2.97 V

2.4 POWER AUTOTRANSFORMER (TRANS)

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 Autotransformer

The modular transformer (if equipped) is located under the condenser coil on the left-hand side of the unit (see Figure 2-7).

The modular transformer (item 1, Figure 2-7) provides 380/460 vac, 3-phase, 50/60 hertz power to the unit when the 230 vac (black) power cable is connected to a 190/230 vac, 3-phase power source. The module, in addition to the transformer, includes a 230 vac cable and a receptacle to accept the unit 460 vac power plug. The modular transformer may be equipped with an optional circuit breaker (CB-2).

WARNING

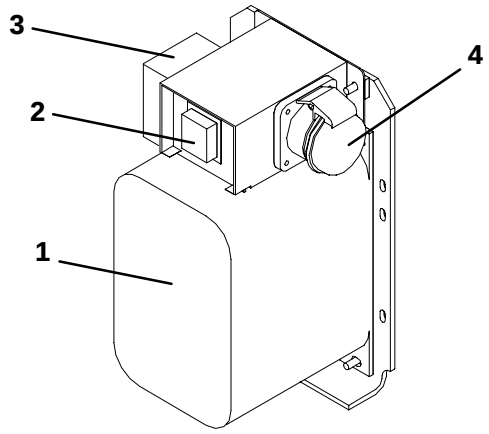
Do not attempt to unplug the power cable connected to the autotransformer before performing the following operations: Move the start-stop switch (ST), the unit circuit breaker(s), CB-1 and CB-2 (if equipped) and any external power source to their OFF positions.

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

1. Make sure that the start-stop switch (ST, on control panel) and circuit breaker (CB-2 if equipped, on the modular transformer) are in position "0" (OFF). Make sure the 460 vac power plug is locked into the receptacle on the modular transformer and circuit breaker (CB-1, in the control box) is in position "1" (ON).
2. Plug the 230 vac (black) cable into a de-energized 190/230 vac, 3-phase power source. Energize the power source. Set circuit breaker (CB-2 if equipped) to position "1" (ON). Close and secure control box door and place the start-stop switch (ST) in position "1" (ON) to start the unit.

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

1. Make sure start-stop switch (ST, on control panel) and circuit breaker (CB-1, in the control box) are in position "0" (OFF).
2. Plug the 460 vac (yellow) cable into a de-energized 380/460 vac, 3-phase power source. Energize the power source. Place circuit breaker (CB-1) in position "1" (ON). Close and secure control box door and then place the start-stop switch (ST) in position "1" (ON) to start the unit.



1. Dual Voltage Modular Transformer
2. Circuit Breaker (CB-2) 230V (Optional)
3. Transformer Bridging Unit (TBU)
4. 460 vac Power Receptacle

Figure 2-7. Power Autotransformer

2.5 REFRIGERATION CIRCUIT WITH THE WATER-COOLED CONDENSER

Starting at the compressor, the suction gas is compressed to a higher temperature and pressure.

When operating with the water-cooled condenser, the gas flows through the discharge line into the pressure regulator valve that is normally open. The pressure regulator valve may restrict the flow of refrigerant to maintain a minimum discharge pressure of 5 kg/cm^2 (70 psig).

Refrigerant gas then moves through the air-cooled coil to the water-cooled condenser. As the refrigerant flows across the water chilled coiled tube bundle, it is cooled to saturation temperature and exits the condenser as a high pressure/saturated liquid.

From the water-cooled condenser, the liquid refrigerant continues through the filter-drier (which keeps refrigerant clean and dry), and a heat exchanger that increases subcooling of liquid refrigerant to the thermostatic expansion valve. As the liquid refrigerant passes through the orifice of the hermetic 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 stepper motor suction modulation valve to the compressor.

The hermetic thermostatic expansion valve bulb (on the suction line near the evaporator coil outlet) controls the expansion valve, maintaining a constant superheat at the coil outlet regardless of load conditions.

2.6 WATER-COOLED CONDENSER

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

2.6.1 Water-Cooled Condenser with Water Pressure Switch (WP)

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

a. Connect the water supply line to the inlet side of condenser and the discharge line to the outlet side of the 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, unless overridden by the out-of-range lockout feature (if so equipped). The condenser fan motor will stop and will remain stopped until the water pressure switch closes, or it is overridden by the out-of-range lockout feature (if so equipped).

The refrigeration unit operating with the water-cooled condenser will perform as outlined in section 4.4 except that the condenser fan motor may be stopped in all modes.

To shift to air-cooled condenser operation, perform 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 2.2.)

2.6.2 Water-Cooled Condenser with Condenser Fan Switch (CFS) – Optional

For operation of the refrigeration unit with the water-cooled condenser with (CFS), perform the following:

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

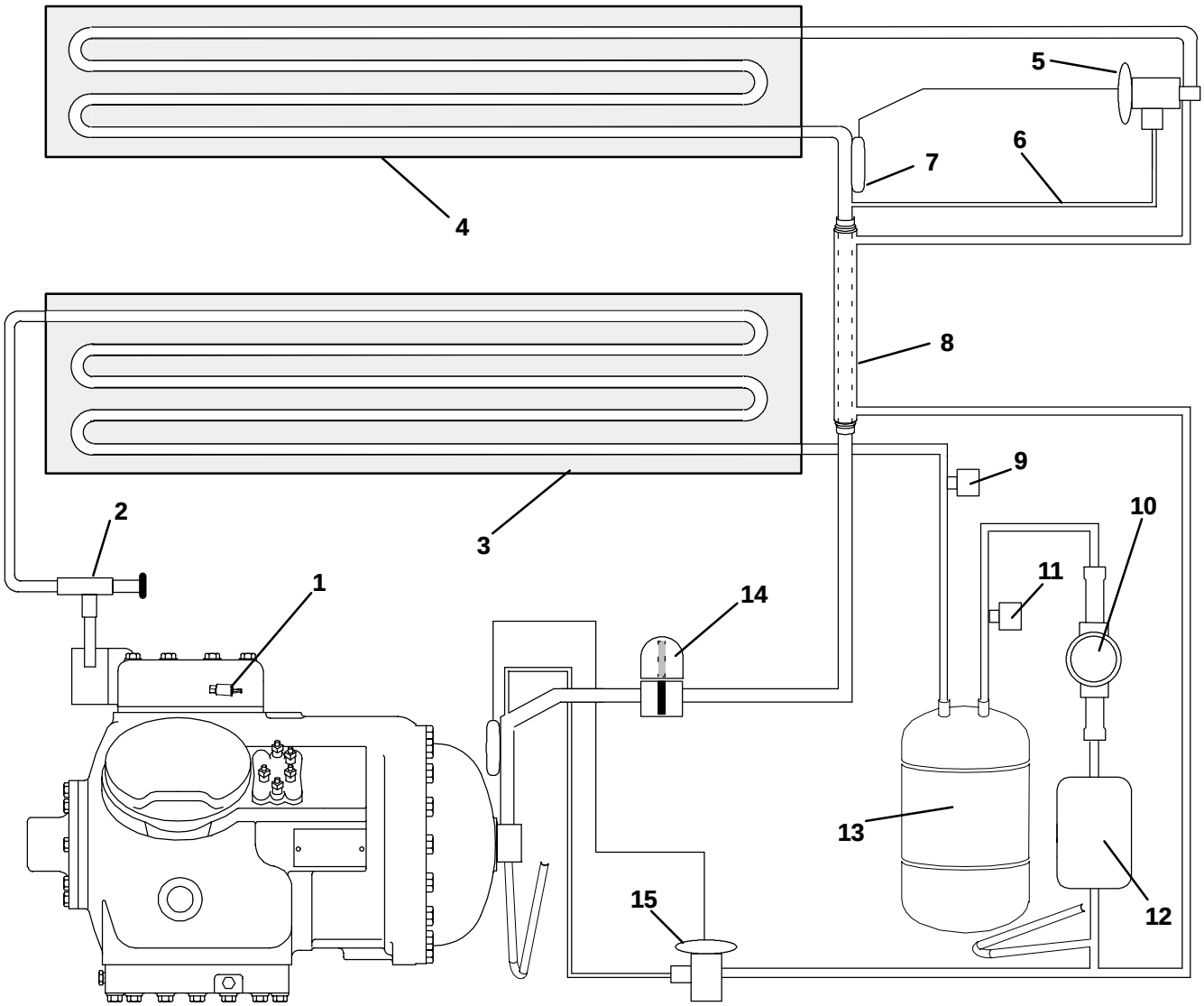
The refrigeration unit operating with the water-cooled condenser and the CFS switch in position "O," will perform as outlined in section 4.4 except that the condenser fan motor is stopped in all modes.

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, perform 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 4.4.



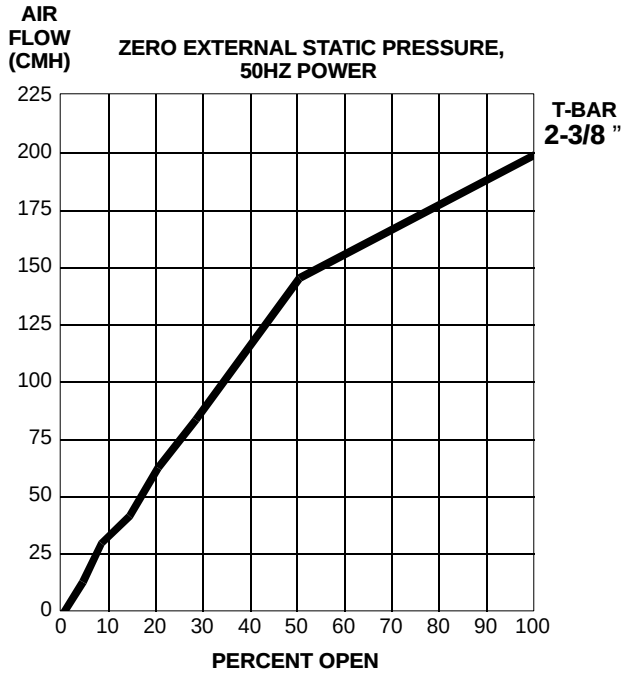
1. High Pressure Switch
2. Discharge Pressure Regulator Valve
3. Air-Cooled Condenser
4. Evaporator
5. Hermetic Thermostatic Expansion Valve
6. External Equalizer Line
7. Hermetic Thermostatic Expansion Valve Bulb
8. Heat Exchanger
9. Rupture Disc
10. Moisture-Liquid Indicator
11. Condenser Pressure Transducer (CPT)
12. Filter-Drier
13. Water-Cooled Condenser
14. Stepper Motor Suction Modulation Valve (SMV)
15. Quench Expansion Valve

Figure 2-8. Refrigeration Circuit with Water-Cooled Condenser

2.7 UPPER FRESH AIR MAKEUP VENT

The purpose of the upper fresh air makeup vent is to provide ventilation for commodities that require fresh air circulation. The vent *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 below gives air exchange values for an empty container. Higher values can be expected for a fully loaded container.



For 60HZ operation multiply air flow values from curve by 1.2

a. Full Open or Closed Positions

Maximum air flow is achieved by loosening the wing nut and rotating the disc to the maximum open position (100% open). The closed position is 0% air flow.

Two slots and a stop are designed into the disc for air flow adjustments. The first slot allows for a 0 to 30% air flow, and the second slot allows for a 30 to 100% air flow. To increase the percentage of air flow, the wing nut must be loosened, and the disc rotated until the desired percentage of air flow matches with the arrow on the disc. Tighten the wing nut. To clear the gap between the slots, loosen the wing nut until the disc clears the stop, and rotate the disc for the second slot.

The operator may also increase or decrease the air flow volume to meet the required air flow by aligning the arrow on the disc with the percentage of desired air flow marked on the supplied label (see Figure 2-1).

2.8 LOWER FRESH AIR MAKEUP VENT (Optional)

The purpose of the lower fresh air makeup vent is to provide ventilation for commodities that require fresh air circulation. The vent *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 across gives air exchange values for an empty container. Higher values can be expected for a fully loaded container.

a. Full Open or Closed Positions

The air slide is supplied with two adjustable air control discs. The fresh air makeup can be adjusted for 15, 35, 50 and 75 cubic meters per hour (CFM). The air flow has been established at 60 Hz power, and a 2 1/2 inch T bar, with 15 mm (0.6 inch) H_2O external static above free blow.

Maximum air flow is achieved by loosening the hex nuts and rotating each disc to the maximum open position (100% open). The closed position is 0% air flow.

The operator may also adjust the openings to increase or decrease the air flow volume to meet the required air flow.

NOTE

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

a. Air Sampling for Carbon Dioxide (CO_2) Level

Loosen hex nuts and move the cover until the arrow on the cover is aligned with the “atmosphere sampling port” label. Tighten the hex nuts and attach a 3/8 hose to the sampling port.

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

2.9 REMOTE MONITORING (RM) – Optional

NOTE

The in-range light will be illuminated if the container control air temperature is within the tolerance selected. Refer to section 3.1.4 (Code 30).

When the remote monitor plug 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

2.10 SAFETY AND PROTECTIVE DEVICES

Unit components are protected from damage by safety and protective devices listed in Table 2-1. These devices monitor the unit operating conditions and open a set of electrical contacts when an unsafe condition occurs.

Open safety switch contacts on either or both of devices IP-CP or HPS will shut down the compressor.

Open safety switch contacts on device IP-CM will shut down the condenser fan motor.

The entire refrigeration unit will shut down if one of the following safety devices open: (a) Circuit Breaker(s); (b) Fuse (F3/10A); or (c) Evaporator Fan Motor Internal Protector(s) – (IP-EM).

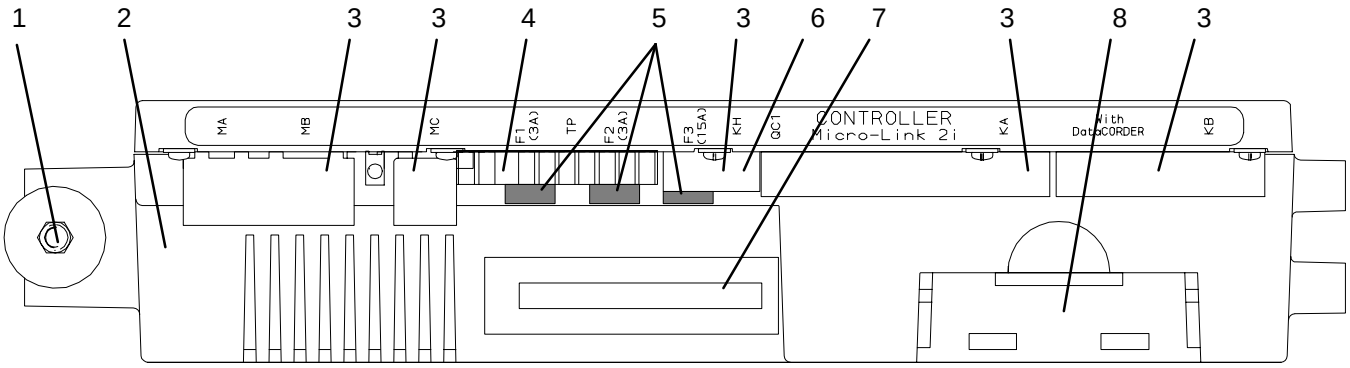
Table 2-1. Safety and Protective Devices

UNSAFE CONDITION	SAFETY DEVICE	DEVICE SETTING
Excessive current draw	Circuit Breaker (CB-1) – Manual Reset	Trips at 29 amps **(460 vac)**
	Circuit Breaker (CB-2, **50** amp) –Manual Reset	Trips at 62.5 amps **(230 vac)**
	Circuit Breaker (CB-2, **70** amp) –Manual Reset	Trips at 87.5 amps **(230 vac)**
Excessive current draw on the control circuit	Fuse (F3)	10 amp rating
Excessive current draw by the Controller/DataCORDER	Fuse (F1 & F2)	5 amp rating
Excessive condenser fan motor winding temperature	Internal Protector (IP-CM) – Automatic Reset	N/A
Excessive compressor motor winding temperature	Internal Protector (IP-CP) – Automatic Reset	N/A
Excessive evaporator fan motor(s) winding temperature	Internal Protector(s) (IP-EM) – Automatic Reset	N/A
Abnormal pressures/temperatures in the high refrigerant side	Rupture Disc – Used on the Water-Cooled Condenser	35 kg/cm@ = (500 psig)
Abnormally high discharge pressure	High Pressure Switch (HPS)	Opens at 25 kg/cm@ (350 psig)

SECTION 3

MICROPROCESSOR

3.1 MICRO-LINK 2i CONTROLLER MODULE



1. Mounting Screw
2. Micro-Link 2i Controller/DataCORDER Module
3. Connectors
4. Test Points (TP)
5. Fuses (F)
6. Control Circuit Power Connection (Location: In back of connector)
7. Battery Pack (Optional)
8. Software Programming Port

Figure 3-1. Micro-Link 2i Controller/DataCORDER Module

3.1.1 Brief Description

WARNING

Do not attempt to service the Controller/DataCORDER module. Breaking the warranty seal will void the warranty.

CAUTION

Remove the Controller/DataCORDER module and unplug all wire harness connectors before performing any arc welding on any part of the container.

Do not remove wire harnesses from module unless you are grounded to the unit frame with a static safe wrist strap.

The Carrier Transicold Micro-Link 2i Controller/DataCORDER is a custom-designed microprocessor-based module which incorporates embedded software to:

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

b. Provide dual independent readouts of set point and supply or return air temperatures.

c. Provide digital readout and ability to select data. Refer to Table 3-3 for Controller Function Codes. For Controller alarm digital display identification refer to Table 3-4.

d. Provide a pre-trip step-by-step checkout of refrigeration unit performance including: proper component operation, electronic and refrigeration control operation, heater operation, probe calibration, pressure limiting and current limiting. Refer to section 3.2.

e. Provide the ability to select or change Codes 27 to 37 and set point without AC power being hooked up. Refer to section 3.1.4.

f. Provide reprogrammability and configuration through a memory card. The memory card automatically downloads new software to the Controller when inserted, and controls output to the display for status information.

g. Provide electronic data storage.

NOTE

For the benefit of the reader the remaining parts of section 3.1 will devote themselves to the temperature controller portion of the module. For the integrated DataCORDER refer to section 3.3.

3.1.2 Controller Programming (Memory) Cards

The programming cards are used for loading software into the Controller. This is the same concept as using a floppy diskette to load software into a personal computer.

The software that can be loaded into the Controller module comes in one of two forms: "Operational Software" or "Configuration Software."

Procedure for loading software:

Refer to section 6.27.1.

Operational Software:

This software operates the Controller module, which turns fans on and off, turns the compressor on and off, etc.

Configuration Software:

This software tells the Operational Software what physical components are built into the container unit. Refer to Table 3-1.

Programming cards with either Operational Software or Configuration Software are available through CTD Replacement Components Group.

The use of a configuration program card in the field should only occur under unusual circumstances. Some of these circumstances may include:

a. A Controller module that has an older version of Operational Software, when the need exists to upgrade to a newer version of the software.

b. A physical component in the container unit is changed to a different component, resulting in a new configuration for the unit.

c. A Controller module was damaged in such a way that the integrity or existence of software within the module is questionable.

Table 3-1. Controller Configuration Variables			
CONFIGURATION NUMBER	**TITLE**	**DEFAULT**	**OPTION**
1	Bypass Valve Enable	In	Out
2	Evaporator Fan Speed	dS (Dual)	SS (Single)
3	Number of Sensor Probes	FOUr	duAL
4	Dehumidification Mode	On	OFF
5	Probe Calibration	nOCAL	CAL
6	Condenser Fan Speed Select	OFF (Single)	On (Variable)
7	Unit Selection, 20FT/ 40FT/45FT	40ft	20ft,45
8	Single Phase/Three Phase Motor	1Ph	3Ph
9	Refrigerant Selection	r134a	r12, r22, bLEnd
10	Compressor Speed	Out (Single)	In (Dual)
11	Defrost “Off” Selection	nOOFF	OFF
12	TXV/Solenoid Quench Valve	Out (TXV)	In (Solenoid)
13	Unloader	Out	In
14	Condenser Pressure Control (CPC)	In	Out
15	Discharge Temperature Sensor	Out	In
16	DataCORDER Option	On (Yes)	OFF (No)
17	Discharge Pressure Sensor	Out (No)	In (Yes)
18	Heater	Old (Low Watt)	nEW (High Watt)
19	Controlled Atmosphere	Out (No)	In (Yes)
20	Pressure Sensor (Suction)	Out (No)	In (Yes)
21	Auto-Transformer	Std	–
22	Economy Mode Option	OFF	Std, Full
23	Defrost Interval Timer Save Option	nOSAv	SAv
24	Advanced Pre-Trip Enhanced Test	OFF	On
25	Pre-Trip Test Points/Results Recording	rSLtS	dAtA
26	Heat Lockout	Set to –10_C	Set to–5_C
27	Suction Temperature Display	Out	In
28	Bulb Mode	NOr	bulb
29	Arctic Mode	Out	In
30	Compressor Size	41 CFM	37 CFM
31	Probe Check Logic	Std	SPEC
32	Single Evaporator Fan Option	2EF0	1EF0
33	Snap Freeze Option	OFF	SnAP
34	Degree Celsius Lockout Option	bOth	_F
35	Humidification Mode	OFF	On
36	Modulation Valve Type	1	2, 3
37	Electronic Partlow	rEtur	SuPPL, bOth
38	Quench Bypass Valve	Out	In
39	Current Limit Range	Out	In
40	Demand Defrost	Out	In

3.1.3 General Layout of the Controller Section

The Micro-Link 2i Controller/DataCORDER consists of a key pad, display module and Controller module. Connectors are used to attach the wiring of the unit to the Controller module. The Controller module is designed to permit ease of installation and removal.

All control functions are accessed by key pad selections and viewed on the display module which are designed for optimum user friendliness and convenience.

The key pad (see Figure 3-2) is mounted on the right-hand side of the control box. The key pad consists of eleven push-energized membrane switches that act as the user's interface with the Controller and the optional DataCORDER. Refer to Table 3-2.

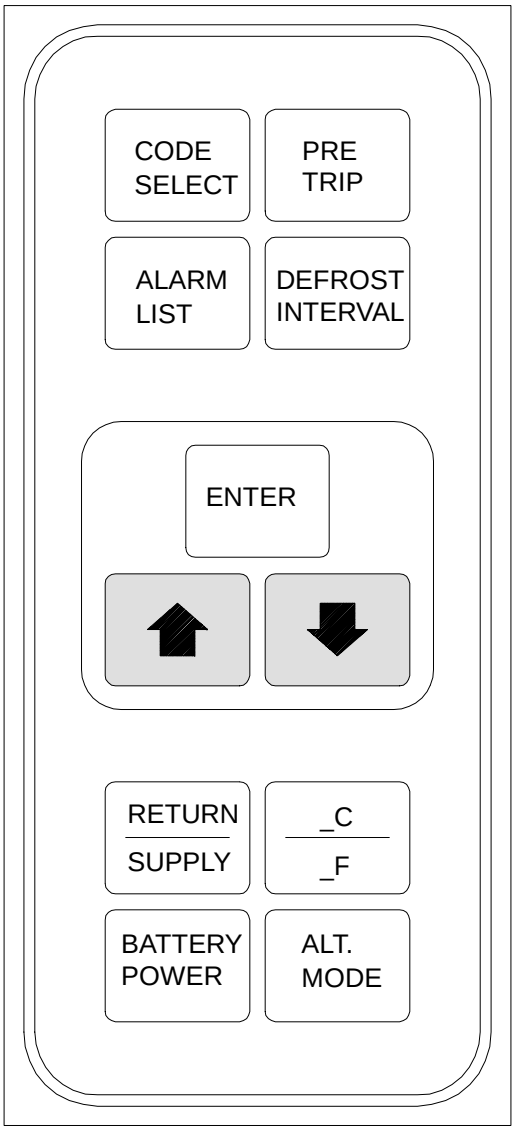


Figure 3-2. Key Pad

Table 3-2. Key Pad Function

KEY	FUNCTION
Arrow Up	Change set point upward. Change codes upward. Scan alarm list upward. Change user selectable features upward. Pre-trip advance forward. Pre-trip test interruption. DataCORDER Function and Alarm Codes are scrolled upward after the ALT. MODE key is depressed.
Arrow Down	Change set point downward. Change codes downward. Scan alarm list downward. Change user selectable features downward. Pre-trip repeat backward. DataCORDER Function and Alarm Codes are scrolled downward after the ALT. MODE key is depressed.
Return/ Supply	Displays non-controlling probe temperature (momentary display).
_C/_F	Displays alternate temperature scale (momentary display).
Alarm List	Displays alarm list and clearing of the alarm queue (when followed by *Enter* key) for the Controller, and also for the DataCORDER after the ALT. MODE key is depressed.
Code Select	Access function codes (see arrow up and arrow down) for the Controller, and also for the DataCORDER after the ALT. MODE key is depressed.
Defrost Interval	Displays selected defrost interval.
Pre–Trip	Displays a pre-trip selection menu. Discontinues pre-trip in progress.
Battery Power	If the unit is equipped with the optional battery pack, initiate the battery backup mode to allow set point and function code selection if no mains power is present.
Enter	Entering a set point change. Extending to 30 seconds the time a chosen data function code is displayed. Entering the value of a user selectable mode. Clearing the alarm list and initiating pre-trip. Also used for various DataCORDER functions after the ALT. MODE key is depressed.
ALT. Mode	Allows access to DataCORDER function codes, alarm codes, DataCORDER configuration and scrollback.

The display module (see Figure 3-3) is mounted at a 20 degree downward tilt to aid in visibility. The display module consists of:

a. Two 25mm (1 inch) high, five digit LCD displays which are easily viewed in direct sunlight and backlighted for superior low-light visibility.

b. Seven Indicators:

- S Cool – White Lamp: Energized when the refrigerant compressor is energized.
- S Heat – Orange LED: Energized when the heaters are on, and the unit is in the heat or defrost mode.
- S Defrost – Orange LED: Energized when the heaters are on, and the unit is in the defrost mode.
- S In-Range – Green LED: Energized when the controlling temperature probe is in range. (Supply air probe will be used for control in the perishable ranges and the return air probe is used for control in the frozen ranges.)
- S Alarm – Red LED: Energized when there is an active or an inactive shutdown alarm (AL20 to AL27) in the alarm queue.
- S Supply – Yellow LED: Energized when supply temperature and set point are displayed. Flashes if dehumidification or humidification is enabled on units so equipped.
- S Return – Yellow LED: Energized when return temperature and set point are displayed.

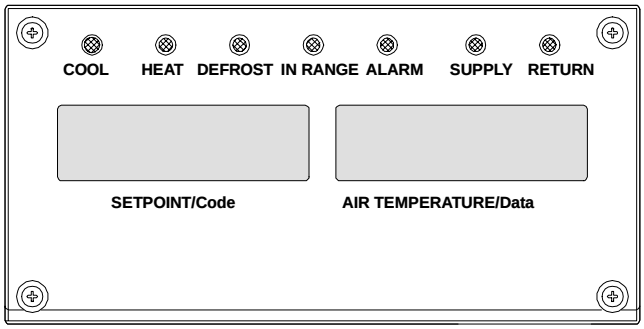


Figure 3-3. Display Module

NOTE

The default display mode will show the set point temperature (on the left display) and controlling probe temperature (on the right display). The controlling probe in the perishable range will be the SUPPLY air probe and the controlling probe in the frozen range will be the RETURN air probe.

3.1.4 Controller Function Codes

There are thirty-nine functions which the operator may access to examine the operating status of the unit. To access these functions, perform the following steps: Press the CODE SELECT key, then press an arrow key until the left window displays the desired code number (see Table 3-3). For the display only function codes, the right window will display the value of this item for five 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. Function codes are explained in Table 3-3.

Table 3-3. Controller Function Code Assignments

Code No.	TITLE	DESCRIPTION
Inapplicable Functions Display -- -- -- --		
Display Only Functions		
Cd01	Modulation Valve Opening (%)	The valve is completely open (right display reads 100%) and is completely closed (right display reads 0%). The stepper motor SMV, on start up of the unit, usually will be at a 21% open position, except for very high ambients.
Cd02	Quench Valve (Open-Closed)	Shows state of the solenoid quench valve, if so equipped (open or closed).
Cd03	Not Applicable	This code is not in use starting with model number 69NT40-511-200 and UP.
Cd04 Cd05 Cd06	Line Current, Phase A Line Current, Phase B Line Current, Phase C	Unit current is monitored by two current sensors. The current measured is used for control and diagnostic purposes.For control processing, the highest of the Phase A and B current values is used for current limiting purposes. The third unmeasured leg is calculated based on a current algorithm. 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. The current draw is then tested to determine if it falls within the expected range of values for the unit. Failure of this test will result in a pre-trip failure or a control alarm indication.
Cd07	Main Power Voltage	The main supply voltage is displayed.
Cd08	Mains Power Frequency	The value of the main power frequency is displayed in Hertz. The frequency displayed will be halved if either fuse F1 or F2 is bad and alarm code AL21 is active.
Cd09	Ambient Temperature	The ambient sensor (AMBS) measures the temperature outside the container.
Cd10	Compressor Suction Temperature (Optional)	Compressor suction temperature is measured just prior to the compressor suction line, and is a display-only temperature.
Cd11	Compressor Discharge Temperature (Optional)	The compressor discharge temperature is measured near the compressor discharge line and is display only.
Cd12	Compressor Suction Pressure (Optional)	Compressor suction pressure is displayed using a pressure transducer. Pressure is displayed in units of psig when code 28 is set to _F and units of bars when code 28 is set to _C. “P” appears after the value to indicate psig, “b” appears after the value to indicate bars and “i” appears after the value for inches of mercury.
Cd13	Condenser Pressure (CPC)	Condenser pressure is displayed using a pressure transducer. Pressure is displayed in units of psig when code 28 is set to _F and units of bars when function code Cd28 is set to _C. “P” is displayed after the value to indicate psig, “b” appears after the value to indicate bars and “i” appears after the value for inches of mercury.

Code No.	TITLE	DESCRIPTION
Inapplicable Functions Display – – – – –		
Cd14	Compressor Discharge Pressure (Optional)	Compressor discharge pressure is displayed using a pressure transducer. Pressure is displayed in units of psig when function code Cd28 is set to _F and units of bars when Cd28 is set to _C. “P” is displayed after the value to indicate psig, “b” appears after the value to indicate bars and “i” appears after the value for inches of mercury.
Cd15	Unloader Valve (On–Off)	The status of the unloader valve (if present) is displayed (on or off).
Cd16	Compressor Motor Hour Meter	Records total hours of compressor run time. Total hours are recorded in increments of 10 hours (i.e., 3000 hours displayed as 300).
Cd17	Relative Humidity (%) (Optional)	This code is only applicable to units with a humidity sensor (HS). This code displays, as a percent value, the relative humidity at that time.
Cd18	Software Revision #	The software revision number is displayed.
Cd19	Battery Check	This code checks the Controller/DataCORDER battery pack. While the test is running, “btest” will flash on the right display, followed by the result. “PASS” will be displayed for battery voltages greater than 7.0 volts and for alkaline batteries with voltages greater than 7.5 volts, “FAIL” will be displayed for battery voltages between 4.5 and 7.0 volts, and “**– – – – – –**” will be displayed for battery voltages less than 4.5 volts. After the result is displayed for four seconds, “btest” will again be displayed, and the user may continue to scroll through the various codes.
Cd20	Config/Model #	This code indicates the dash number of the model for which the Controller is configured (i.e., if the unit is a 69NT40-511-201, the display will show 11201).
Cd21	Future Expansion	This code is for future expansion, and is not in use at this time.
Cd22	Compressor Speed (High–Low–Off)	The status of the compressor is displayed (high, low or off).
Cd23	Evaporator Fan Speed (High–Low–Off)	Displays the current evaporator fan state (high, low or off).
Cd24	Controlled Atmosphere State (On–Off) (Optional)	This code shows the state of Controlled Atmosphere (enabled or disabled), if equipped.
Cd25	Compressor Run Time Remaining Until Defrost	This code displays the time remaining until the unit goes into defrost (in tenths of an hour). This value is based on the actual accumulated compressor running time.
Cd26	Defrost Termination Sensor Temperature	The defrost termination sensor (DTS) is located immediately above the evaporator coil. It is used by the Controller for defrost initiation and termination. (See Figure 2-2.)

Code No.	TITLE	DESCRIPTION
Inapplicable Functions Display – – – – –		
Display/Select Functions **NOTE** Function codes Cd27 through Cd37 are user-selectable functions. The operator can change the value of these functions to meet the operational needs of the container.		
Cd27	Defrost Interval (Hours)	The defrost interval is the time interval between defrost cycles. Five selectable values are available: 3, 6, 9, 12 or 24 hours. The factory default value is 12 hours. The time interval of the first defrost will not begin counting down until defrost termination sensor (DTS) is below 10_C (50_F). The time interval to the next defrost cycle is entered into the Controller at the time DTS is below 10_C (50_F) or at power-up. (See code Cd37 for deviations.) If DTS reaches 25.6_C (78_F) at any time during the timer count down, the interval is reset and the countdown begins over. If DTS has failed (i.e., alarm code AL60 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 sensor temperature rises above 25.6_C. (See section 4.4.6.) *Defrost Interval Timer Value Option:* If the software is configured to "ON" for this option, then the value of the defrost interval timer will be saved at power down and restored at power up. This option prevents short power interruptions from resetting an almost expired defrost interval, and possibly delaying a needed defrost cycle. **NOTE** The defrost interval timer counts only during compressor run time.
Cd28	Temperature Units (_C or _F)	This code determines the temperature units (_C or _F) which will be used for all temperature displays. The user selects _C or _F by selecting function code Cd28 and pushing the ENTER key. The factory default value is Celsius units. **NOTE** This function code will display "– – – – –" if the Controller configuration variable option 34 is set to _F (refer to Table 3-1).
Cd29	Failure Action (Mode)	If all of the control sensors are out of range (alarm code AL26) or there is an alarm code AL27 failure, the unit 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 (stepper motor SMV 100%) B – Partial Cooling (stepper motor SMV 11% open) C – Evaporator Fan Only D – Full System Shutdown – Factory Default
Cd30	In-Range Tolerance	The in-range tolerance will determine the band 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) – Factory Default
Cd31	Stagger Start Offset Time (Seconds)	The stagger start offset time is the amount of time that the unit 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: 0 (Factory Default), 3, 6, 9, 12, 15, 18 or 21 seconds

Code No.	TITLE	DESCRIPTION
Inapplicable Functions Display – – – – –		
Cd32	Current Limit (Amperes)	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 main power and lowers the compressor discharge pressure. When desirable, the limit can be lowered. Note, however, that capacity is also reduced. Depending on the selection made for configuration #39 in Table 3-1, the values for 460vac operation are: Default = 15, 17, 19, 21, 23 (Factory Default) and; Optional = 13.5, 15, 17, 18, 19, 21, 23
Cd33	Dehumidification Control (% RH) (Optional)	This code is only applicable to units with a humidity sensor (HS).Relative humidity set point is available only on units configured for dehumidification. When the mode is activated, the control probe LED flashes on and off every second to alert the user. If not configured, the mode is permanently deactivated and Cd33 will display "– – – – – –." When set point is available, it can be set to "OFF." "TEST," or 65 to 95% relative humidity in increments of 1%. If bulb mode is active (code Cd35) and "Lo" speed evaporator motors are selected (code Cd36) then set point ranges from 60 to 95%. When "TEST" is selected or test set point is entered, the heaters should be turned on, indicating that dehumidification mode is activated. After a period of five minutes has elapsed in this mode, the previously selected mode is reinstated.
Cd34	Economy Mode (On–Off) (Optional)	Economy mode is a user selectable mode of operation provided for power saving purposes. Refer to sections 3.1.7.1 and 3.1.7.2 for a more detailed description of economy mode.
Cd35	Bulb Mode (Normal–Bulb) (Optional)	Bulb mode is a user selectable mode of operation that is an extension of normal dehumidification. If dehumidification is set to "Off," code Cd35 will display "Nor" and the user will be unable to change it. After a dehumidification set point has been selected and entered for code Cd33, the user may then change code Cd35 to "bulb." After bulb has been selected and entered, the user may then utilize function codes Cd36 and Cd37 to make the desired changes.
Cd36	Evaporator Speed Select (Cd35 must be in "Bulb")	This code is enabled only if a dehumidification set point has been selected using function code Cd33 and "bulb" has been selected using function code Cd35. If these conditions are not met, "alt" will be displayed indicating that the evaporator fans will alternate their speed whenever a dehumidification set point is selected. This display cannot be changed by the user. If a dehumidification set point has been selected along with bulb mode then "alt" may be selected for alternating speed, "Lo" for low speed evaporator fan only, or "Hi" for high speed evaporator fan only. If a setting other than "alt" has been selected and bulb mode is deactivated in any manner, then selection reverts back to "alt."
Cd37	Defrost Temperature Sensor Setting (Optional)	This code, as with function code Cd36, is used in conjunction with bulb mode and dehumidification. If bulb mode is active, this code allows the user to change the temperature above which the defrost termination sensor (DTS) temperature must go to terminate defrost. It allows the user to change the setting from 4_C to 25.6_C in 0.1_C (0.2_F) increments. This value is changed using the UP/DOWN ARROW keys, followed by the ENTER key when the desired value is displayed. If bulb mode is deactivated in any manner, the DTS setting above which defrost terminates defaults to the normal 25.6_C (78_F) setting.
NOTE In the unlikely event that AL55 activates, Function Codes Cd38 and Cd39 will display SRS and RRS, respectively.		
Cd38	Secondary Supply Air Temperature (Optional)	This code is only applicable to units without a DataCORDER that are configured to have four probes. If this is true, it will then display the current secondary supply air temperature.If the unit is configured with a DataCORDER, the Controller function code Cd38 will display "– – – – – –." and the display values for SRS will appear on the DataCORDER function code dC1.

Code No.	TITLE	DESCRIPTION
Inapplicable Functions Display – – – – –		
Cd39	Secondary Return Air Temperature (Optional)	This code is only applicable to units without a DataCORDER, that are configured to have four probes. If this is true, it will then display the current secondary return air temperature.If the unit is configured with a DataCORDER, the Controller function code Cd39 will display "– – – – – –," and the display values for RRS will appear on the DataCORDER function code dC2.

3.1.5 Controller 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 that 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 (see Table 3-4) is a low mains voltage, when the voltage drops over 25%, an indication is given on the display, but the unit will continue to run.

An alarm is indicated by flashing an alarm code on the display panel, and for some alarms, by the alarm light illuminating.

When an Alarm Occurs:

- The red alarm light will illuminate for "20 series" alarms only.
- If a detectable problem is found to exist, its alarm code will be alternately displayed with the set point on the left display.
- The user should scroll through the alarm list to determine what alarms exist or have existed. Alarms must be diagnosed and corrected before the Alarm List can be cleared.

To Display Alarm Codes:

While in Set Point Selection or Default Display mode, press the ALARM LIST key. This accesses the Alarm List Display Mode, which displays any alarms archived in the Alarm Queue. The alarm list stores up to 16 alarms in the sequence in which they occurred. The user may scroll through the list by depressing the UP ARROW key. Depressing the DOWN ARROW key allows the user to scroll backward through the list.

The left display will show "AL#," where # is the alarm number sequentially in the queue.

The right display will show:

- "AAXX" for an active alarm, where "XX" is the alarm code. See Table 3-4, Controller Alarm Indications.
- "IAXX" for an inactive alarm.

"END" is displayed to indicate the end of the alarm list if any alarms are active. "CLEAr" is displayed if all alarms are inactive.

- The alarm queue may only be cleared if no alarms are active, other than alarm code AL51, and "CLEAr" is displayed.

To Clear the Alarm List:

If all above conditions have been satisfied, e.g. no alarms are active other than AL51, the alarm queue may be cleared.

- Press the ENTER key. The alarm list will clear and "– – – – – –" will be displayed.

Table 3-4. Controller Alarm Indications		
Code No.	**TITLE**	**DESCRIPTION**
AL20	Control Circuit Fuse Open (24 vac)	Alarm 20 is triggered by fuse (F3) opening and will cause the software shutdown of all control units. This alarm will remain active until the 10 amp fuse is replaced.
AL21	Micro Circuit Fuse Open (18 vac)	Alarm 21 is triggered by one of the fuses (F1/F2) being opened on 18 volts AC power supply to the Controller. The suction modulation valve (SMV) will be opened and current limiting is halted. The compressor will cycle. Temperature control will be maintained by cycling the compressor.
AL22	Evaporator Fan Motor Safety	Alarm 22 is triggered by the opening of the evaporator motor internal protector. This alarm will disable all control units until the motor protector resets.
AL23	KA2–KB10 Jumper Disconnected	Alarm 23 is triggered by a missing jumper wire. The alarm will stay active until the jumper wire is reconnected.
AL24	Compressor Motor Safety	Alarm 24 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. Also, refer to code Cd29.
AL25	Condenser Fan Motor Safety	Alarm 25 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 condensing.
AL26	All Supply and Return Air Control Sensors Failure	Alarm 26 is triggered if the Controller determines that all of the control sensors are out-of-range. This can occur for box temperatures outside the range of –50_C to +70_C (–58_F to +158_F). This alarm triggers the failure action code set by Function Code Cd29.
AL27	Probe Circuit Calibration Failure	The Controller has a built-in Analog to Digital (A-D) converter, used to convert analog readings (i.e. temperature sensors, current sensors, etc.) to digital readings. The Controller continuously performs calibration tests on the A-D converter. If the A-D converter fails to calibrate for 30 consecutive seconds, this alarm is activated.This alarm will be inactivated as soon as the A-D converter calibrates.
AL51	Alarm List Failure	During start-up diagnostics, the EEPROM 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 activated.During control processing, any operation involving alarm list activity that results in an error will cause Alarm 51 to be activated.Alarm 51 is a “display only” alarm and is not written into the alarm list. Pressing the ENTER key when “CLEAr” is displayed will result in an attempt to clear the alarm list. If that action is successful (all alarms are inactive), Alarm 51 will be reset.
AL52	Alarm List Full	Alarm 52 is activated 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.
AL53	NiCad Battery Pack Failure	Alarm 53 is caused by the nicad battery pack being too low of a charge for battery-backed recording. **NOTE** Check for recharging or replacing battery pack.

Code No.	TITLE	DESCRIPTION
AL54	Primary Supply Air Sensor Failure (STS)	Alarm 54 is activated by an invalid primary supply sensor reading that is sensed outside the range of –50 to +70_C (–58_F to +158_F) or if the probe check logic has determined there is a fault with this sensor. If Alarm 54 is activated and the primary supply is the control sensor, the secondary supply sensor will be used for control if the unit is so equipped. If the unit does not have a secondary supply probe, and AL54 is activated, the (primary return sensor, minus 2_C) will be used for control. **NOTE** The P5 Pre-Trip test must be run to inactivate the alarm (refer to section 3.2.1).
AL55	DataCORDER Failure	This alarm has been activated to indicate the DataCORDER has been disabled due to internal failure. To clear this alarm, simply reconfigure the unit to its OEM model number by using the multi-configuration card.
AL56	Primary Return Air Sensor Failure (RTS)	Alarm 56 is activated by an invalid primary return sensor reading that is outside the range of –50 to +70_C (–58_F to +158_F). If Alarm 56 is activated and the primary return is the control sensor, the secondary return sensor will be used for control if the unit is so equipped. If the unit is not equipped with a secondary return sensor or it fails, the primary supply sensor will be used for control. **NOTE** The P5 Pre-Trip test must be run to inactivate the alarm (refer to section 3.2.1).
AL57	Ambient Temperature Sensor Failure (AMBS)	Alarm 57 is triggered by an ambient temperature reading outside the valid range from –50_C (–58_F) to +70_C (+158_F).
AL58	Compressor High Pressure Safety (HPS)	Alarm 58 is triggered when the compressor high discharge pressure safety switch (HPS) remains open for at least one minute. This alarm will remain active until the pressure switch resets, at which time the compressor will restart.
AL59	Heat Termination Thermostat (HTT) Safety	Alarm 59 is triggered by the opening of the heat termination thermostat (HTT) and will result in the disabling of the heater. This alarm will remain active until the thermostat resets.
AL60	Defrost Termination Sensor Failure (DTS)	Alarm 60 is an indication of a probable failure of the defrost termination sensor (DTS). It is triggered by the opening of the heat termination thermostat (HTT) or the failure of the DTS to go above 25.6_C (78_F) within two hours of defrost initiation. After one-half hour with a frozen range set point, or one-half hour of continuous compressor run time, if the return air falls below 7_C (45_F), the Controller checks to ensure defrost termination sensor (DTS) has dropped to 10_C or below. If not, a DTS 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.
AL61	Heaters Failure	Alarm 61 is the heater alarm caused by detection of 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.
AL62	Compressor Circuit Failure	Alarm 62 is triggered by improper current draw increase (or decrease) resulting from compressor turn on (or off). The compressor is expected to draw a minimum of 2 amps; failure to do so will activate the alarm.This is a display alarm with no associated failure action and will be reset by a proper amp draw of the compressor.
AL63	Current Over Limit	Alarm 63 is triggered by 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 a display alarm and is inactivated by power cycling the unit, changing the current limit via the code select Cd32, or if the stepper motor suction modulation valve (SMV) is allowed to open to 100%.

<table>
<tr><th>Code No.</th><th>TITLE</th><th>DESCRIPTION</th></tr>
<tr><td>AL64</td><td>Discharge Temperature Over Limit (CPDT)</td><td>Alarm 64 is triggered if the discharge temperature is sensed greater than 135_C (275_F) for three continuous minutes, if it exceeds 149_C (300_F), or if the sensor is out of range. This is a display alarm and has no associated failure action.</td></tr>
<tr><td>AL65</td><td>Discharge Pressure Transducer Failure (DPT)</td><td>Alarm 65 is triggered by a compressor discharge transducer reading outside the valid range of 73.20 cm Hg (30 in Hg) to 32.34 Kg/cm^2 (460 psig). This is a display alarm and has no associated failure action.</td></tr>
<tr><td>AL66</td><td>Suction Pressure Transducer Failure (SPT)</td><td>Alarm 66 is triggered by a suction pressure transducer reading outside the valid range of 73.20 cm Hg (30 in Hg) to 32.34 Kg/cm^2 (460 psig). This is a display alarm and has no associated failure action.</td></tr>
<tr><td>AL67</td><td>Humidity Sensor Failure</td><td>Alarm 67 is triggered by a humidity sensor reading outside the valid range of 0% to 100% relative humidity. If alarm AL67 is active and the dehumidification mode was previously activated, then the dehumidification mode will be deactivated.</td></tr>
<tr><td>AL68</td><td>Condenser Pressure Transducer Failure (CPT)</td><td>Alarm 68 is triggered by a condenser pressure transducer reading outside the valid range of 73.20 cm Hg (30 in Hg) to 32.34 Kg/cm^2 (460 psig). This is a display alarm and has no associated failure action.</td></tr>
<tr><td>AL69</td><td>Suction Temperature Sensor Failure (CPSS)</td><td>Alarm 69 is triggered by a suction temperature sensor reading outside the valid range of –60_C (–76_F) to 150_C (302_F). This is a display alarm and has no associated failure action.</td></tr>
<tr><td colspan="3">NOTE
If the Controller is configured for four probes without a DataCORDER, the DataCORDER alarms AL70 and AL71 (See Table 3-7) will be processed as Controller alarms AL70 and AL71.</td></tr>
<tr><td rowspan="7">ERR #</td><td rowspan="7">Internal Microprocessor Failure</td><td colspan="2">The Controller performs self-check routines. if an internal failure occurs, an ERR #0–5 will appear on the display. This is an indication the Controller needs to be replaced.</td></tr>
<tr><td>ERROR</td><td>DESCRIPTION</td></tr>
<tr><td>#0 – RAM failure</td><td>Indicates that the Controller working memory has failed.</td></tr>
<tr><td>#1 – Program Memory failure</td><td>Indicates a problem with the Controller program.</td></tr>
<tr><td>#2 – Watchdog time–out</td><td>The Controller program has entered a mode whereby the Controller program has stopped executing.</td></tr>
<tr><td>#3 – On board timer failure</td><td>The on board timers are no longer operational. Timed items such as; defrost, etc. may not work.</td></tr>
<tr><td>#4 – Internal counter failure</td><td>Internal multi-purpose counters have failed. These counters are used for timers and other items.</td></tr>
<tr><td>#5 – A-D failure</td><td>The Controller’s Analog to Digital (A-D) converter has failed.</td></tr>
<tr><td>Entr StPt</td><td>Enter Setpoint (Press Arrow & Enter)</td><td colspan="2">The Controller is prompting the operator to enter a set point.</td></tr>
<tr><td>LO</td><td>Low Mains Voltage (Function Codes Cd27–38 disabled and NO alarm stored.)</td><td colspan="2">This message will be alternately displayed with the set point whenever the mains voltage is less than 75% of its proper voltage.</td></tr>
</table>

3.1.6 Condenser Pressure Control (CPC)

A pressure control system has been incorporated by means of a condenser pressure transducer (CPT) and condenser pressure control (CPC) logic to maintain discharge pressures above 130 psig in low temperatures.

In order for the CPC logic to be enabled, the following conditions must be met:

- S CPC configuration variable set to "In"
- S CPT sensor is valid (alarm code AL68 inactive)
- S AMBS sensor is valid (alarm code AL57 inactive)
- S AMBS is less than or equal to 26.6_C (79.9_F)
- S Voltage/Frequency ratio is less than or equal to 8.38

When condenser pressure control (CPC) is enabled (all of the above conditions are met), either pressures or timers may dictate a change of state from OFF to ON, or ON to OFF. If the condenser fan is OFF, it will be energized if saturation condensing pressure is greater than 200 psig OR if the condenser fan has been OFF for a maximum of sixty seconds depending on the ambient temperature. If the condenser fan is ON, it will de-energize only if the saturation condensing pressure is less than 130 psig and the condenser fan has been running for a minimum of thirty seconds depending on the ambient temperature. As the ambient temperature increases, the amount of time that the condenser fan is energized will correspondingly increase.

If any one of the following conditions occur the CPC logic will be disabled:

- S CPT sensor is invalid (alarm code AL68 activates)
- S AMBS sensor is invalid (alarm code AL57 activates)
- S AMBS is greater than 29.5_C (85.1_F)
- S Voltage/Frequency ratio is greater than 8.42

3.1.7 Controller Temperature Control

There are two control ranges, Frozen and Perishable (chill). The Frozen range is active with set points *at or below –10_C (+14_*F), or –5_C (+23_F) optionally, and the Perishable range is active at set points *above –10_C (+14_*F), or –5_C (+23_F) optionally. See Figure 3-5 and Figure 3-6.

The Controller configuration variable for "Heat Lockout" (refer to Table 3-1) can be changed for set points of either –10_C (+14_F), or –5_C (+23_F) optionally.

NOTES

- S When upward set point changes are made at ambients below 27_C (80_F), the compressor is immediately cycled OFF. The compressor three minute time delay will be overridden, so that as soon as the control temperature is at least 0.2_C (0.4_F) above set point the compressor will turn ON.
- S At each manual power up of the unit, the normally closed stepper motor SMV starts at a 6 to 21% open position, and the unit will run for three minutes to boil off dissolved refrigerant from the compressor oil, depending on ambient conditions.
- S Depending on ambient conditions, the unit may be in a pressure limiting mode which may restrict the maximum SMV position.
- S Depending on the current limiting setting and the environmental conditions, the SMV position may be restricted.

3.1.7.1 Perishable (Chill) Range Above –10_C (+14_F), or –5_C (+23_F) Optionally.

For set points *above* –10_C (+14_F), or –5_C (+23_F) optionally, the Controller maintains SUPPLY air at the set temperature by the following modes of operation:

a. Operation in the conventional mode without dehumidification (Code 33 OFF)

1. At ambients below 27_C (80_F), the condenser fan will cycle on/off depending on condenser pressure and on/off times.

If the condenser pressure is greater than 200 psig OR the condenser fan has been OFF at least 60 seconds, the condenser fan will start.

If the condenser pressure is less than 130 psig AND the condenser fan remains ON for at least 30 seconds, the condenser fan will stop.

2. At ambients above 27_C (80_F), condenser pressure control (CPC) is disabled and the condenser fan runs continuously.

If the unit starts when ambient is below –10_C (+14_F) and condenser pressure is below 200 psig, the condenser fan will not start until pressure reaches 200 psig.

The supply probe is used for control and is so indicated by the "SUPPLY" LED on the display module. The Perishable temperature range demands high accuracy. The unit is capable of maintaining supply air temperature to within ¦ 0.25_C (¦ 0.5_F) of the set point temperature setting. In Perishable range *above -10_C (+14_F),* or -5_C (+23_F) optionally, control is maintained by controlling the position of the stepper motor suction modulation valve (SMV) with the compressor energized.

When pulling down from a control temperature that is more than 5_C (9_F) above set point, the SMV valve will be open to reduce the pulldown time. The pressure and current limit functions may restrict the valve, if the pressure or current is above the selected value.

When the controlling probe temperature enters the in-range temperature tolerance as selected at function code Cd30, the in-range light will energize.

The Controller logic is designed so the SMV will begin to close as the set point is reached. The SMV will close to restrict refrigerant flow until the capacity of the unit and the load are balanced, unless the compressor reliability enhancement logic on the first compressor start prevents closure.

If the temperature drops below the set point, the compressor will remain running for a few minutes. This is to accommodate any initial undershoot which might occur. After this time, and at 0.2_C (0.4_F) or greater below the 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 the set point. The heaters will de-energize when the temperature rises to 0.2_C (0.4_F) below the set point. The compressor will not restart until the temperature rises to 0.2_C (0.4_F) above the set point and a three minute time delay since the last compressor turn off has been satisfied.

b. Operation in the dehumidification mode (Code 33 value selected) - Optional

The dehumidification mode is activated by selecting Code 33, choosing a desired relative humidity value, and pressing the ENTER key. The control probe LED (supply 1) will flash ON and OFF every second to indicate that 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 humidity sensor reading is above the set point and valid (AL67).
2. The pulldown mode is NOT active. (ie., The control temperature is less than 5_C above set point.)
3. The control probe (i.e.; Supply 1) temperature is less than set point, plus 0.25_C.
4. Temperature control set point is greater than *-10_C (+14_F),* or -5_C (+23_F) optionally, in the perishable range, and the compressor is running.
5. The heater debounce timer (three minutes) has timed out.
6. Heat termination thermostat (HTT) is closed.
7. The Controlled Atmosphere (CA) option VENT or Pre-Trip mode is not initiated.
8. Humidity sensor alarm is not active (AL67).
9. High pressure switch (HPS) is not open.

If the above conditions remain true for at least one hour the evaporator fans will switch from high to low speed operation (on units so equipped). The evaporator fan speed will switch every hour thereafter as long as all conditions are met (see Bulb Mode section for different evaporator fan speed options). If any condition except for item (1.) becomes false OR if the relative humidity sensed is 2% below the dehumidification set point, the high speed evaporator fans will be energized.

The dehumidification mode 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 the set point.

Opening the modulating valve reduces the temperature of the evaporator coil surface, which increases the rate at which water is condensed from the air passing through the coil. Removing water from the air reduces the relative humidity. When the relative humidity sensed is 2% below the set point (function code Cd33), the Controller de-energizes the heat relay. The Controller will continue to cycle heating to maintain relative humidity below the selected set point.

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

- Heater debounce timer (three minutes).
- Out-of-range timer (five minutes).

The heater debounce timer is activated whenever the heater contactor status is changed. The heat contactor remains energized (or de-energized) for at least three minutes even if the set point criteria are satisfied. This is

to prevent rapid cycling of the heater contactor when the humidity set point is satisfied. If the mode is terminated by a condition other than the humidity sensor, e.g., an out-of-range or compressor shutdown condition, 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 temperature remains outside of the user selected in-range setting for more than five 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 function code Cd30.

Cooling capacity reduction by modulation is the same as described for the conventional operating mode when any of the above first four conditions (1. thru 4.) are invalid.

With set points below –10_C (+14_F), or –5_C (+23_F) optionally, heating and dehumidification are locked out.

c. Operation in the economy mode (Code 34 set to ON)

The economy mode selection determines the status of the economy mode of operation. There are two values: "ON" and "OFF." A code which represents the status of this function is recorded in the DataCorder memory whenever the value is changed.

Economy mode is a user selectable mode of operation provided for power saving purposes. Economy mode could be utilized in the transportation of temperature tolerant cargo or non-respiration items which do not require high airflow for removing respiration heat.

The economy mode is activated by selecting function code Cd34 to the "ON" status. There is no active display indicator that economy mode has been activated, and a manual display of Cd34 is a way to be sure if the economy mode is or is not active.

In order to achieve economy mode perishable operation, a perishable set point must be selected PRIOR to activating economy mode. When economy mode perishable is active, the evaporator fans will be controlled as follows: At the start of each cooling or heating cycle, the high speed evaporator fans will be run for three minutes. After that initial three minutes, the evaporator fans will be switched to low speed any time the supply air temperature is within ¦ 0.25_C (0.45_F) of the set point and the return air temperature is less than or equal to the supply air temperature + 3_C (5.4_F). When the fans switch to low speed, they will run in low speed for one hour. At the end of the hour, the evaporator fans will switch back to high speed. The evaporator fans will again run in high speed for three minutes and the above mentioned cycle will be repeated, just as it was from the start of the cooling or heating cycle. If the unit is not equipped with dual speed evaporator fans, then economy mode perishable will perform exactly the same as the normal control mode.

d. Operation in bulb mode (Code 35 set to bulb and Code 33 selected)

Bulb mode is an extension of the dehumidification mode. Dehumidification must be enabled by selecting a value (percentage of relative humidity) at function code Cd33 before bulb mode function code Cd35 can be initiated.

To initiate bulb mode, use the ARROW keys to scroll to function code Cd35 and change from "Nor" to "bulb." Once the bulb mode is activated, the user may then change from the normal evaporator fan operation where the fan speed alternates every hour between low or high speed operation. This is done by toggling function code Cd36 from its default of "alt" to "Lo" or "Hi" respectively. If low speed evaporator fan operation is selected, this gives the user the additional capability of selecting dehumidification set points from 60 to 95% (instead of the normal 65 to 95%).

In addition, if bulb mode is active, the user is given the option to change the defrost termination sensor (DTS) temperature, in which defrost is terminated from the normal 25.6_C (78_F) temperature setting to 4_C (39.2_F) in 0.1_C (0.2_F) increments. The temperature set point that the DTS temperature must go below before the defrost interval timer begins counting down also changes from 0_C to 10_C as the desired DTS termination temperature is raised.

Bulb mode is terminated when:

- Code Cd35 is set to "Nor."
- Code Cd33 for dehumidification is set to "Off."
- The user changes the set point to one that is in the frozen range.

When bulb mode is disabled by any of the above means, the evaporator fan operation for dehumidification reverts to "alt" and the DTS termination setting resets to the normal 25.6_C (78_F).

3.1.7.2 Frozen Range Below -10_C (+14_F), or -5_C (+23_F) Optionally

For set points *below* -10_C (+14_F), or -5_C (+23_F) optionally, the Controller maintains RETURN air at the set point temperature using the following modes of operation:

a. Operation in the conventional mode (Code 33 OFF)

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 unit. Temperature control in the Frozen range *at or below -10_C (+14_F),* or -5_C (+23_F) optionally, 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 the set point and the three minute time delay has been met, the compressor will restart. The unit will always operate at full capacity, and the stepper motor suction modulation valve (SMV) will open to 100%, or as allowed by current and pressure limiting.

NOTE

On start up of the unit, SMV will reset to a known open position. This is accomplished by assuming the valve was fully open, driving it fully closed, resetting the percentage open to zero, then opening to a known 21% staging position. This makes the unit ready to start and normal operation will begin.

To prevent on/off cycling of the compressor from occurring, a three minute compressor off time must be satisfied before the compressor will restart. Under a condition of 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.

b. Operation in the economy mode (Code 34 OFF)

The economy mode is deactivated by setting function code Cd34 to the "OFF" status. Economy mode has no active display indicator to show that it is enabled, so a manual display of function code Cd34 must be performed to enable the user to see its current status. A second way to deactivate economy mode is to change the set point. Once economy mode is deactivated, the system will return to normal control mode operations.

In order to achieve economy mode frozen operation, a frozen set point temperature must be selected PRIOR to activating economy mode. When economy mode frozen is active, the system will perform normal frozen mode operations except that the entire refrigeration system, excluding the Controller, will be turned off when the control temperature is less than or equal to the set point - 2_C, (i.e., the set point is set at -11_C and the operator subtracts -2_C, the result will equal -13_C). After an off-cycle period of 60 minutes, the unit will turn on high speed evaporator fans for three minutes, and then check the control temperature. If the control temperature is greater than or equal to the set point + 0.2_C., the unit will restart the refrigeration system and continue to cool until the previously mentioned off-cycle temperature criteria are met. If the control temperature is less than the set point + 0.2_C, the unit will turn off the evaporator fans and restart another 60 minute off-cycle.

c. Operation in the bulb mode (Code 35 OFF)

The unit will not run in bulb mode if a frozen range set point is selected. As described in section 3.1.7.1.d., if a frozen set point is selected, dehumidification is deactivated and the temperature above which DTS must go during defrost resets to 25.6_C (78_F).

3.2 PRE-TRIP DIAGNOSTICS

CAUTION

Pre-trip inspection should not be performed with critical temperature cargoes in the container.

NOTE

When Pre-Trip is initiated, dehumidification and bulb mode will be deactivated. At the completion of Pre-Trip, dehumidification and bulb mode must be turned back on again.

Pre-trip Diagnostics is an independent mode which will suspend the normal Control Mode activities when initiated by the user. With pre-trip diagnostics, either all the pre-trip tests can be executed in a defined sequence (Auto Mode), or one of the pre-trip tests can be selected to be executed (Manual Mode), based on the sequence of key selections made.

a. Starting and Terminating Pre-Trip

NOTE

Prior to starting tests, verify that Controller function codes Cd04, Cd05, Cd06 and Cd07 are operational. Otherwise, tests may fail incorrectly. All alarms must be rectified and cleared.

A Pre-trip selection menu is displayed by pressing the PRE-TRIP key. This accesses a test selection menu. If no selection is made, the pre-trip menu selection process will terminate automatically. Pre-Trip will terminate if the VENT mode is selected on the CA Controller. The user must scroll through the selection by pressing the UP ARROW or DOWN ARROW keys, then pressing the ENTER key when the selection is made. While the tests are being executed, the user can terminate the pre-trip mode by holding the PRE-TRIP key. The unit will then resume normal operation. If the user decides to terminate a test but remain at the test selection menu, the user may press the UP ARROW key. When this is done all machinery outputs will be de-energized and the test selection menu will be displayed.

The pre-trip diagnostics may also be initiated via communication, but when initiated will always attempt to execute the entire battery of tests (auto mode).

b. Current and Pressure Limiting During Pre-Trip

Throughout the duration of any pre-trip mode, the current and pressure limiting processes are active, except for the P-7 tests.

c. Test Codes

A detailed description of the pre-trip test codes is listed in Table 3-5.

3.2.1 Pre-Trip

In this mode, the unit will automatically test unit components using internal measurements and comparison logic, and will provide a "PASS" or "FAIL" display to indicate the results of each test.

If the user depresses the PRE-TRIP key, the unit gives access to a pre-trip selection menu. The contents of the menu are as follows:

PRE-TRIP SELECTION MENU	
Auto or Auto 1	**Auto 2 (Optional)**
P, P1, P2, P3, P4, P5, P6, rSLts	P, P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, rSLts

If the pre-trip was last executed manually after power up, the last menu selection will appear on the left display. If pre-trip was not executed since power up, then the right display will show "Auto" or "Auto 1." The user may scroll through the test selection menu using the arrow keys.

A given test is selected by pressing ENTER while it is displayed. The entire battery of tests may be run by pressing ENTER while "Auto 1" or "Auto 2" is displayed.

During this selection mode, failure to press either an arrow key or ENTER for five seconds will return the unit to its default display, and normal operating mode.

Any test may be interrupted by pressing the UP ARROW key. This will return the user to the test selection mode described above, and all machinery outputs will be de-energized.

While certain tests from "Auto 1" are running, "PX-X" will appear on the left display, where the X's indicate the test number and sub-test. The right display will show a countdown time in minutes and seconds, indicating how much time there is left remaining in the test.

For "Auto 2," the left display will show "PX-X," while the right display will show applicable data.

a. Manual Test Operation

Individually selected tests, other than the LED/Display test, will perform the operations necessary to verify the operation of the component under test. At the conclusion of the selected test, PASS or FAIL will be displayed. Upon failure, the Supply and Return LED's will flash on alternately. This message will remain displayed for up to three minutes, during which time a user may select another test. If the three minute time period expires, the unit will terminate pre-trip and return to control mode operation. Following any individually selected test, all outputs will be de-energized.

b. Auto Test Operation From Keypad

If "Auto," "Auto 1" or "Auto 2" test is initiated, then the unit will execute a series of consecutive tests, each related to an identifiable unit component, without any need for direct user interface. These tests vary in length, depending on the component under test.

When an automatic test fails, it will be repeated once automatically. A repeated test failure will cause "FAIL" to be shown on the right display, with the corresponding test number to the left. The user may then press the DOWN ARROW to repeat the test or the UP ARROW to skip to the next test. The unit will wait

INDEFINITELY, until the user manually enters a command. Holding the PRE-TRIP key will terminate the pre-trip mode operation.

When "Auto" or "Auto 1" is allowed to run to completion without being interrupted, the unit will exit the pre-trip mode, and return to normal control operation.

CAUTION

When "Auto 2" is allowed to run to completion without being interrupted, the unit will terminate pre-trip and display "Auto 2" "end." The unit WILL REMAIN SUSPENDED in this mode until the user depresses the ENTER key!

c. Auto Test Operation From Serial Communications

Pre-trip may also be initiated via communications. The operation is the same as for the Auto Test mode described above except that should a test fail, the pre-trip mode will automatically terminate. When initiated via communications, a test may not be interrupted with an arrow key, but the pre-trip mode can be terminated with the PRE-TRIP key.

d. Pre-Trip Test Results

At the end of the pre-trip test selection menu, the message "P," "rSLts" will be displayed. Pressing the ENTER key will allow the user to see the results for all subtests (i.e., 1-0, 1-1, etc). The results will be displayed as "PASS" or "FAIL" for all the tests run to completion since power up. If a test has not been run since power up, "**-- -- -- -- --**" will be displayed.

3.2.2 Pre-Trip Mode

Table 3-5. Pre-Trip Test Codes

Code No.	TITLE	DESCRIPTION
NOTE "Auto" or "Auto1" menu includes the following: P, P1, P2, P3, P4, P5, P6 and rSLts. "Auto2' (Optional) menu includes the following: P, P1, P2, P3, P4, P5, P6,P7, P8, P9, P10 and rSLts. (Refer to section 3.2.1.)		
P	Pre-Trip Initiated	All lights and display segments will be energized for five seconds at the start of the pre-trip. Since the unit cannot recognize lights and display failures, there are no test codes or results associated with this phase of pre-trip.
P1-0	Heaters Turned On	**Setup:** Heater must start in the OFF condition, and then be turned on. A current draw test is done after 15 seconds. **Pass/Fail Criteria:** Passes if change in current draw is within the range specified.
P1-1	Heaters Turned Off	**Setup:** Heater must start in the ON condition, and then be turned off. A current draw test is done after 10 seconds. **Pass/Fail Criteria:** Passes if change in current draw is within the range specified.
P2-0	Condenser Fan On	**Requirements:** Water pressure switch (WP) input must be closed. **Setup:** Condenser fan is turned ON, a current draw test is done after 15 seconds. **Pass/Fail Criteria:** Passes if change in current draw test is within the range specified.
P2-1	Condenser Fan Off	**Setup:** Condenser fan is turned OFF, a current draw test is done after 10 seconds. **Pass/Fail Criteria:** Passes if change in current draw test is within the range specified.
P3	Low Speed Evaporator Fans	**Requirements:** The unit must be equipped with a low speed evaporator fan, as determined by the Evaporator Fan speed select configuration variable. **NOTE** If the unit is configured for single evaporator fan operation, Pre-Trip tests P3-0, P3-1, P4-0 and P4-1 will fail immediately if Controller alarm codes AL11 or AL12 are active at the start of testing.

<table>
<tr><th>Code No.</th><th>TITLE</th><th>DESCRIPTION</th></tr>
<tr><td>P3-0</td><td>Low Speed Evaporator Fan Motors On</td><td>Setup: The high speed evaporator fans will be turned on for 10 seconds, then off for two seconds, then the low speed evaporator fans are turned on. A current draw test is done after 60 seconds.
Pass/Fail Criteria: Passes if change in current draw is within the range specified. Fails if AL11 or AL12 activates during test.</td></tr>
<tr><td>P3-1</td><td>Low Speed Evaporator Fan Motors Off</td><td>Setup: The low speed Evaporator Fan is turned off, a current draw test is done after 10 seconds.
Pass/Fail Criteria: Passes if change in current draw is within the range specified. Fails if AL11 or AL12 activates during test.</td></tr>
<tr><td>P4-0</td><td>High Speed Evaporator Fan Motors On</td><td>Setup: The high speed Evaporator Fan is turned on, a current draw test is done after 60 seconds.
Pass/Fail Criteria: Passes if change in current draw is within the range specified. Fails if AL11 or AL12 activates during test.</td></tr>
<tr><td>P4-1</td><td>High Speed Evaporator Fan Motors Off</td><td>Setup: The high speed Evaporator Fan is turned off, a current draw test is done after 10 seconds.
Pass/Fail Criteria: Passes if change in current draw is within the range specified. Fails if AL11 or AL12 activates during test.</td></tr>
<tr><td>P5-0</td><td>Supply/Return Probe Test</td><td>Setup: The High Speed Evaporator Fan is turned on and run for eight minutes, with all other outputs de-energized.
Pass/Fail Criteria: A temperature comparison is made between the return and supply probes.
NOTE
If this test fails, “P5-0” and “FAIL” will be displayed. If both Probe tests (this test and the PRIMARY/ SECONDARY) pass, the display will read “P5” “PASS.”</td></tr>
<tr><td>P5-1</td><td>Supply Probe Test</td><td>Requirements: For units equipped with secondary supply probe only.
Pass/Fail Criteria: The temperature difference between primary and secondary probe (supply) is compared.
NOTE
If this test fails, “P5-1” and FAIL will be displayed. If both Probe tests (this and the SUPPLY/ RETURN TEST) pass, because of the multiple tests, the display will read ’P 5’ ’PASS’.</td></tr>
<tr><td>P5-2</td><td>Return Probe Test</td><td>Requirements: For units equipped with secondary return probe only.
Pass/Fail Criteria: The temperature difference between primary and secondary probe (return) is compared.
NOTES
S If this test fails, “P5-2” and “FAIL” will be displayed. If both Probe tests (this test and the SUPPLY/ RETURN) pass, because of the multiple tests, the display will read “P 5,” “PASS.”
S The results of Pre-Trip tests 5-0, 5-1 and 5-2 will be used to activate or clear control probe alarms.</td></tr>
<tr><td rowspan="2">P6-0</td><td rowspan="2">Compressor On</td><td>Setup: A current draw test is performed before the compressor is started. The compressor is started. SMV is opened to 30%, and another current draw test is performed. If it is the first compressor start, the compressor reliability enhancement logic (CREL) is executed, running a current draw test on the additional output of the following state:
<table>
<tr><th>Component</th><th>Normal Logic (10 seconds)</th><th>CREL (3 minutes)</th></tr>
<tr><td>SMV</td><td>30%</td><td>100% (for 3 minutes) then 30%</td></tr>
</table></td></tr>
<tr><td>P-6</td><td>Not Applicable</td><td>This test is not in use starting with model number 69NT40-511-200 and UP.</td></tr>
</table>

Code No.	TITLE	DESCRIPTION
P6-H	Not Applicable	This test is not in use starting with model number 69NT40-511-200 and UP.
P6-L	Not Applicable	This test is not in use starting with model number 69NT40-511-200 and UP.
P6-2	Suction Modulation Valve (Open and Closed)	**Setup:** The compressor and fans continue to run from the previous test. The quench valve (if configured) will operate as in normal control mode. The test validates a current draw over a specified range of SMV (0 to 50% open). **Pass/Fail Criteria:** This test will fail if any "one" of the following conditions is true: Pressure limiting is active and condenser pressure is greater than or equal to 300 psi; Current limiting is active and any one of the three phases are greater than the user limit; the high pressure switch opened when SMV was 0% open. Passes if all of the above are false.
P6-3	Quench Valve Test	This test is not in use starting with model number 69NT40-511-200 and UP.
P6-4	Not Applicable	This test is not in use starting with model number 69NT40-511-200 and UP.
P6-5	Not Applicable	This test is not in use starting with model number 69NT40-511-200 and UP.
NOTE Starting with test P7-0 through test P10, these tests are only included with the "Auto2" (Optional) selection menu. (Refer to section 3.2.1.)		
P7-0	High Pressure Switch Closed	**Setup:** When the unit is running, the condenser fan is de-energized, and a 15 minute timer is started. The right display shows discharge pressure if equipped with the discharge pressure transducer (DPT), or condenser pressure if equipped with a condenser pressure transducer (CPT), or discharge pressure if equipped with either a discharge pressure transducer (DPT) or a condenser pressure transducer (CPT). **Pass/Fail Criteria:** The test fails if high pressure switch fails to open in 900 seconds.
		Note, this test is skipped if the unit does NOT have: S A compressor discharge sensor (CPDS). S A discharge pressure transducer (DPT). S Condenser pressure transducer (CPT).
		In addition, this test is skipped if: S The sensed ambient temperature is less than 7_C (45_F). S The return air temperature is less than –17.8_C (0_F). S The water pressure switch (WP) is open, indicating that the unit is operating with a water-cooled condenser.
		Pass/Fail Criteria: Under conditions of the above NOTE; the test immediately fails if the following inputs are sensed to be invalid: S Compressor discharge sensor (CPDS). S Discharge pressure transducer (DPT). S Condenser pressure transducer (CPT). **OR** if any one of the following inputs are sensed to be invalid: S Return temperature sensor (RTS). S Ambient sensor (AMBS).
		In addition, the test will fail if: S The high pressure switch (HPS) fails to open within 15 minutes. S The discharge temperature exceeds 138_C (280_F). S The discharge temperature is less than or equal to ambient temperature plus 5_C (9_F). S The condenser pressure transducer (CPT) or discharge pressure transducer (DPT) pressure exceeds 27.42 kg/cm_2 (390 psig).
P7-1	High Pressure Switch Open	**Requirements:** Test P7-0 must pass for this test to execute. Setup: The condenser fan is started and a 60 second timer is started. **Pass/Fail Criteria:** Passes the test if the high pressure switch (HPS) closes within the 60 second time limit, otherwise, it fails.

Code No.	TITLE	DESCRIPTION
P8-0	Perishable Mode Heat Test	**Setup:** If the container temperature is below 60_F, the set point is changed to 60_F, and a 60 minute timer is started. The left display will read “P8-0.” The control will then heat the container until 60_F is reached. If the container temperature is above 60_F at the start of the test, then the test proceeds immediately to test P8-1 and the left display will change to “P8-1.” **Pass/Fail Criteria:** The test fails if the 180 minute timer expires before the control temperature reaches set point. The display will read “P8-0,” “FAIL.”
P8-1	Perishable Mode Pull Down Test	**Requirements:** Control temperature must be at least 60_F. **Setup:** The set point is changed to 32_F, and a 180 minute timer is started. The left display will read “P8-1,” the right display will show the supply air temperature. The unit will then start to pull down the container temperature to the 32_F set point. **Pass/Fail Criteria:** The test passes if the container temperature reaches set point before the 180 minute timer expires.
P8-2	Perishable Mode Maintain Temperature Test	**Requirements:** Test P8-1 must pass for this test to execute. **Setup:** The left display will read “P8-2,” and the right display will show the supply air temperature. A 60 minute timer is started. The unit will be required to maintain the 32_F temperature to within + or – 0.5_C (0.9_F) of set point until a DataCORDER recording is executed. The recorder supply probe temperature running total (and its associated readings counter) will be zeroed out for the remainder of the recording period at the start of this test, so that the actual value recorded in the DataCORDER will be an average of only this test’s results. Once a recording interval is complete, the average recorder supply temperature will be recorded in the DataCORDER, as well as stored in memory for use in applying the test pass/fail criteria. **Pass/Fail Criteria:** If the recorded temperature is within +/– 0.5_C. of set point from test start to DataCORDER recording, the test passes. If the average temperature is outside of the tolerance range at the DataCORDER recording, the test fails.
P9-0	Defrost Test	**Setup:** The defrost temperature sensor (DTS) temperature will be displayed on the left display. The right display will show the supply air temperature. The unit will run FULL COOL for 30 minutes maximum while the DTS sensor temperature is above 10_C. Once the DTS is below 10_C, the unit simulates defrost by running the heaters for up to two hours, or until the DTS senses the temperature above 25.6_C. **Pass/Fail Criteria:** The test passes if DTS is sensed above 25.6_C before a two hour timer times out. The test fails if DTS does not go below 10_C after 30 minutes of full cooling, and/or the heat termination thermostat (HTT) is open when the DTS is below 10_C. The test also fails if the HTT opens anytime during the defrost cycle and/or the return air temperature exceeds 120_F anytime during the heat cycle.
P10-0	Frozen Mode (Setup) Test	**Setup:** After completion of the DTS test, the set point will be set to 7_C (45_F). The left display will read “P100,” and if the container temperature is below 45_F, will continue this display until the container temperature is raised to set point. The left display will change to “P101” and execute the frozen pull down test when the container temperature reaches set point, or if the container temperature initially was greater than or equal to set point. The maximum time allowed in heat mode is one hour. **Pass/Fail Criteria:** If this time limit is exceeded, the test fails. There will be no pass indication for this test. However, if the test fails the display will read “P100,” “FAIL.”

Code No.	TITLE	DESCRIPTION
P10-1	Frozen Mode (Pull Down) Test	**Setup:** When the container temperature is greater than or equal to the 45_F. set point which was set in the frozen mode heat test, the left display will read “P101” and the right display will show the return air temperature. The set point will then be changed to –17.7_C (0_F). The unit will then have a maximum of three hours to pull the container temperature down to the 0_F set point. **Pass/Fail Criteria:** If this occurs within the three hour time limit, the test passes. If pulldown is not completed within the three hour time limit, the test fails.
P10-2	Frozen Mode Maintain Temperature Test	**Setup:** After the unit has successfully completed the frozen pulldown test, the left display will read “P102” and the right display will show the return air temperature. The unit will then be required to maintain the 0_F temperature within + or – 0.5_C (0.9_F) of set point until a DataCORDER recording is executed. The recorder return probe temperature running total (and its associated readings counter) will be zeroed out for the remainder of the recording period at the start of this test, so that the actual value recorded in the DataCORDER will be an average of only this test’s results. Once the recording interval is complete, the average recorder return temperature will be recorded in the DataCORDER, as well as stored in memory for use in applying the test pass/fail criteria. **Pass/Fail Criteria:** If the recorded temperature is within +/– 0.5_C of set point from test start to DataCORDER recording, the test passes. If temperature is outside of the tolerance range at the DataCORDER recording, the test fails.

3.3 INTEGRATED DATACORDER (Optional)

3.3.1 Brief Description

Carrier Transicold has developed a recorder, which we have termed the “DataCORDER,” and is integrated into a module with the Controller. For reader simplicity and understanding this section has been separated to explain the DataCORDER side of the module. The DataCORDER consists of:

- Microprocessor
- Program memory
- Data memory
- Internally battery backed real time clock
- Six thermistor inputs
- Two communication ports
- Power supply (optional battery pack).

This recorder eliminates the mechanical recorder and paper chart, and replaces it with a custom-designed module (see Figure 3-1) that interfaces with the Interrogator and operates in the following ways:

a. Logs data at 15, 30, 60 or 120 minute intervals.

b. Records and displays alarms through the digital display module. (Refer to Table 3-7.)

c. Stores at least two years’ worth of data based on typical one hour intervals.

d. Records DataCORDER/Network generated data and events as follows:

- Container ID Change
- S/W Upgrade
- Controller configuration change
- Alarm Activity
- Battery Low (Battery Pack)
- Data Retrieval
- Defrost Start
- Defrost End
- Dehumidification Start
- Dehumidification End
- Power Loss (w/wo battery backup)
- Power Up (w/wo battery backup)
- “Auto 1” Pre-Trip Start
- “Auto 1” Pre-Trip End
- Remote Probe Temperatures in the Container (USDA Cold treatment and Cargo probe recording)
- Return Air Temperature
- Set Point Change
- Supply Air Temperature
- Real Time Clock (RTC) Battery (Internal Battery) Replaced

- Real Time Clock (RTC) Modification
- Pre-Trip result & data
- Trip Start
- ISO Trip Header (Must be entered first via Interrogation program)
- Economy Mode Start
- Economy Mode End
- "Auto 2" Pre-Trip Start
- "Auto 2" Pre-Trip End
- Bulb Mode Start
- Bulb Mode changes
- Bulb Mode End
- USDA Trip Comment
- CTD Controlled Atmosphere Information
- Humidification Start
- Humidification End
- USDA Probe Calibration

3.3.2 DataCORDER Configuration

NOTE

The DataCORDER software is integrated with the Controller software.

Configuration to factory installed default configuration is achieved via a common configuration card used for controller functions, see section 3.1.2.

Changes to the factory default configuration must be made with the Interrogation device.

Configuration:

Tells the operational software what physical components are built into the container unit, how many sensors to record, what recording interval should be used, etc..

Configuration cards are available thru CTD Replacement Components Group.

The use of a programming card in the field should only occur under unusual circumstances, such as a physical component in the container unit is changed to a different component, resulting in a new configuration for the unit.

ITEM	SETTING	FACTORY DEFAULT
Sensor Logging (Network)	Average or Snapshot	Average
Sensor Logging (Thermistor)	Average, Snap-shot or USDA	Average
Sensor Format	1 or 2 byte	1 byte
Sensor Configuration	Refer to section 3.3.5.f.	2 sensors
Logging Interval	15, 30, 60 or 120 minutes	60 minutes

3.3.3 DataCORDER Function Codes

There are 35 functions which the operator may access to examine the operating status of the unit. To access these functions, perform the following: Press the ALT. MODE & CODE SELECT keys, press an arrow key until the left window displays the desired code number (see Table 3-6). The right window will display the value of this item for five 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.

Table 3-6. DataCORDER Function Code Assignments		
NOTE Inapplicable Functions Display "– – – – –"		
To Access: Press ALT. MODE key		
Code No.	**TITLE**	**DESCRIPTION**
dC1	Recorder Supply Temperature	Current recorder supply air temperature.
dC2	Recorder Return Temperature	Current recorder return air temperature.
dC3-5	USDA 1,2,3 Temperatures	Current temperatures of the three USDA probes.
dC6-13	Network Sensors 1-8	Current values of the network sensors (as configured). Network sensor 1 (Code 6) is generally the humidity sensor and its value is obtained from the Controller once every minute.
dC14	Cargo Probe 4 Temperature	Current temperature of the cargo probe #4.
dC15-19	Future Expansion	These codes are for future expansion, and are not in use at this time.
dC20-24	Temperature Sensors 1-5 Calibration	Current calibration offset values for each of the five probes: supply, return, USDA #1, #2, and #3. These values are entered via the interrogation program.
dC25	Future Expansion	This code is for future expansion, and is not in use at this time..
dC26,27	S/N, Left 4, Right 4	The DataCORDER serial number consists of eight characters. Function code dC26 contains the first four characters. Function code dC27 contains the last four characters. (This serial number is the same as the Controller serial number.)
dC28	Minimum Days Left	An approximation of the number of logging days remaining until the DataCORDER starts to overwrite the existing data.
dC29	Days Stored	Number of days of data that are currently stored in the DataCORDER.
dC30	Date of last Trip start	The date when a Trip Start was initiated by the user. In addition, if the system goes without power for seven continuous days or longer, a trip start will automatically be generated on the next AC power up.
dC31	Battery Test	Shows the current status of the optional battery pack. **PASS**: Battery pack is fully charged. **FAIL**: Battery pack voltage is low.
dC32	Time: Hour, Minute	Current time on the real time clock (RTC) in the DataCORDER.
dC33	Date: Month, Day	Current date (month and day) on the RTC in the DataCORDER.
dC34	Date: Year	Current year on the RTC in the DataCORDER.
dC35	Cargo Probe 4 Calibration	Current calibration value for the Cargo Probe. This value is an input via the interrogation program.

3.3.4 DataCORDER Alarms

To Display Alarm Codes:

While in Set Point Selection or Default Display mode, press the ALT. MODE & ALARM LIST keys. This accesses the Alarm List Display Mode, which displays any alarms stored in the Alarm Queue. The user may scroll to the end of the alarm list by pressing the UP ARROW key after the ALARM LIST key is depressed. Depressing the DOWN ARROW key allows the user to scroll backward in the alarm list.

The left display will show "AL#" where # is the alarms number in the queue.

The right display will show:

- "AAXX," if the alarm is active, where XX is the alarm number. See Table 3-7, DataCORDER Alarm Indications.
- "IAXX," if the alarm is inactive

"END" is displayed to indicate the end of the alarm list if any alarms are active. "CLEAr" is displayed if all the alarms in the list are inactive.

- The exception to this rule is the DataCORDER Alarm Queue Full AL91 alarm, which does not have to be inactive in order to clear the alarm list.

To Clear the Alarm List:

If no alarms are active, the Alarm Queue may be cleared.

- Press the ALT. MODE & ALARM LIST keys.
- Press the UP/DOWN ARROW key until "CLEAr" is displayed.
- Press the ENTER key. The alarm list will clear and "------" will be displayed.
- Press the ALARM LIST key. "AL" will show on the left display and "------" on the right display when there are no alarms in the list.
- Upon clearing of the Alarm Queue, the Alarm light will be turned off.

Table 3-7. DataCORDER Alarm Indications		
To Access: Press ALT. MODE key		
Code No.	**TITLE**	**DESCRIPTION**
AL70	Recorder Supply Temperature Out of Range	The recorder supply air temperature is sensed outside of the range of –50_C to 70_C (–58_F to +158_F) or if the probe check logic has determined there is a fault with this sensor. **NOTE** The P5 Pre-Trip test must be run to inactivate the alarm (refer to section 3.2.1).
AL71	Recorder Return Temperature Out of Range	The recorder return air temperature is sensed outside of the range of –50_C to 70_C (–58_F to +158_F) or if the probe check logic has determined there is a fault with this sensor. **NOTE** The P5 Pre-Trip test must be run to inactivate the alarm (refer to section 3.2.1).
AL72-74	USDA Temperatures 1, 2, 3 Out of Range	The USDA probe temperature reading is sensed outside of range.
AL75	Cargo Probe 4 Out of Range	The cargo probe temperature reading is sensed outside of range.
AL76, 77	Future Expansion	These alarms are for future expansion, and are not in use at this time.
AL78-85	Network Sensors 1 – 8 Out of Range	The network sensor is outside of its specified range. See NOTE below.
NOTE While the DataCORDER is normally setup to record only supply and return recorder sensors, the DataCORDER has the capability to record the data of eight additional sensors. Any sensor installed on the unit may be recorded, and are identifiable as Network Sensors AL 78 to AL85. Which alarm (AL78 to AL 85) is associated with the physical sensor, depends on how the DataCORDER was configured. To identify which sensor is at fault, the unit must be interrogated to locate the sensor being recorded. Generally, the humidity sensor is AL78, as it is the only network sensor recorded.		
AL86	RTC Battery Low	The Real Time Clock (RTC) backup battery is too low to adequately maintain the RTC reading.
AL87	RTC Failure	An invalid date or time has been detected. This situation may be corrected by changing the Real Time Clock (RTC) to a valid value using the DataView.
AL88	DataCORDER EEPROM Failure	A write of critical DataCORDER information to the EEPROM has failed.
AL89	Flash Memory Error	An error has been detected in the process of writing daily data to the non-volatile FLASH memory.
AL90	Future Expansion	This alarm is for future expansion, and is not in use at this time.
AL91	Alarm List Full	The DataCORDER alarm queue is determined to be full (eight alarms).

The DataCORDER alarms for the USDA and cargo probes are configurable using the interrogation program or via a configuration card. There are four configuration variables for the DataCORDER, which are listed in Table 3-8 with their descriptions and selection values.

Table 3-8. DataCORDER Alarm Configurations

Configuration Variable	Description	Selection Values
dCF07	USDA (PR1)	Auto,On,Off
dCF08	USDA (PR2)	Auto,On,Off
dCF09	USDA (PR3)	Auto,On,Off
dCF10	Cargo Probe (PR4)	Auto,On,Off

The default configuration for the four probes is "Auto." If the alarms are configured as "Auto," and all the probes are missing (i.e., appear open-circuited to the DataCORDER), no alarms are activated. As soon as one of the probes is installed (plugged into the receptacle), then all of the alarms are enabled and the remaining probes that are not installed will give active alarm indications. This function is designed to assist those users who wish to keep their DataCORDER configured for USDA recording, and do not wish to install the probes for every trip.

If a probe alarm is configured to be "On," then the associated alarm is always enabled. As long as the probe remains in-circuit (plugged in), the alarm will not be activated. Probes with this configuration have alarms that act like the alarms for the supply and return recorder sensors. It is presumed that normal operation includes the probe in question.

If a probe alarm is configured to be "Off," then the alarm for this probe is always disabled. It is not possible to activate the respective alarm for this probe no matter what the circumstance.

3.3.5 Access to DataCORDER Functions

To access the DataCORDER functions codes, alarm codes, configuration and scrollback, the user must first press the ALT. MODE key, then press the applicable key for functions (CODE SELECT) or alarms (ALARM LIST).

a. Keypad/Display Interface

The DataCORDER uses the Controller display and keypad. The DataCORDER contains four types of display parameters. They are: functions codes, alarm codes, configuration and scrollback.

b. DataCORDER Power-Up

The DataCORDER may be powered up in several ways:

1. *Normal AC power:* The DataCORDER is powered up when the unit is turned on via the stop-start switch (ST).

2. *Normal DC power:* If a rechargeable battery pack is installed (fully charged), the user may plug the interrogation cable into the front interrogation receptacle and the DataCORDER will power up for communications.

On every DataCORDER wake-up, while using battery-pack power, the Controller will first perform a hardware voltage check on the battery. If the hardware check passes, the Controller will energize the appropriate circuitry and perform a software battery voltage check before DataCORDER logging. If either the hardware or software battery test fails, the real time clock (RTC) battery-backed wake-up will be disabled until the next AC power cycle. Further DataCORDER temperature logging will be prohibited until that time.

A 12 volt VCR battery pack may also be plugged into the back of the interrogation cable, which is then plugged into either interrogation port. No rechargeable battery pack is required with this method. The user may now interrogate the DataCORDER.

3. *Real Time Clock (RTC) because a logging interval has expired:* If the DataCORDER is equipped with a charged battery pack and AC power is not present, the DataCORDER will power up when the RTC indicates that a data recording should take place. When the DataCORDER is finished recording, it will power down.

c. DataCORDER Battery Pack Test

If the DataCORDER has the optional battery pack, then the battery voltage will be tested once every five minutes. An alarm will be generated when the battery voltage transitions from good to bad indicating that the battery pack needs recharging. If the alarm condition persists for more than 24 hours on continuous AC power, the battery pack probably needs replacement.

d. Trip Start Processing

To initiate Trip Start:

- Press the ALT. MODE key
- Select function code dC30
- Depress the ENTER key for five seconds

Trip Start will flash for five seconds, turn solid, then the date will appear to indicate that a Trip Start is registered.

Trip Start may also be initiated via communications using the interrogation program.

e. Display vs. Configuration Codes

The DataCORDER contains two types of display codes; Display and Configuration. Display codes will display parameter values, but will not let them be modified. Configuration codes can be modified via the interrogator or with the insertion of the common configuration software card.

f. Data Recording Mode

The DataCORDER recording mode is labeled as Standard. To see an example of a report using a standard configuration, see Figure 3-4.

Generic Mode:

The generic recording mode is used for special data recordings. The user may select up to eight different sensor readings. The sensors available for this type of recording are listed below. (Also, refer to network sensor Note in Table 3-7) Changing the configuration to generic and selecting which sensors to record may be done via the Interrogation program.

Configurable Generic Recording Options:

- Control mode
- Control temperature
- Frequency
- Humidity (Standard configuration: 6 or 64)
- Phase A current
- Phase B current
- Phase C current
- Mains voltage
- Stepper motor suction modulation valve (SMV) percentage
- Discrete outputs (Bit mapped – require special handling if used)
- Discrete inputs (Bit mapped – require special handling if used)
- Ambient sensor (AMBS)
- Compressor suction sensor (CPSS)
- Compressor discharge sensor (CPDS)
- Return temperature sensor (RTS)
- Supply temperature sensor (STS)
- Defrost termination sensor (DTS)
- Discharge pressure transducer (DPT)
- Suction pressure transducer (SPT)
- Condenser pressure transducer (CPT)

Standard Mode:

The standard recording mode allows the user to configure the DataCORDER to monitor data using one of seven standard configurations. The seven standard configuration variables, with their descriptions, are listed in Table 3-9.

The six thermistor inputs (supply, return, USDA #1, #2, #3 and cargo probe) and the humidity sensor will be DataCorder inputs. The three inputs will be read over a network from the Controlled Atmosphere module.

In addition, if NO Controller alarms are active, the most recent active DataCORDER alarm will be displayed on the Display Module alternately with set point.

Table 3-9. DataCorder Standard Configuration

Standard Config.	Description
2 sensors (dCF02 = 2)	2 thermistor inputs(supply & return)
5 sensors (dCF02 = 5)	2 thermistor inputs(supply & return) 3 USDA thermistor inputs
6 sensors (dCF02 = 6)	2 thermistor inputs(supply & return) 3 USDA thermistor inputs 1 humidity input
9 sensors (dCF02 = 9)	2 thermistor inputs(supply & return) 3 USDA thermistor inputs * 3 Controlled Atmosphere inputs 1 humidity input
6 sensors (dCF02 = 54)	2 thermistor inputs(supply & return) 3 USDA thermistor inputs 1 cargo probe (thermistor input)
7 sensors (dCF02 = 64)	2 thermistor inputs(supply & return) 3 USDA thermistor inputs 1 humidity input 1 cargo probe (thermistor input)
10 sensors (dCF02 = 94)	2 thermistor inputs(supply & return) 3 USDA thermistor inputs * 3 Controlled Atmosphere inputs 1 humidity input 1 cargo probe (thermistor input)
* Not Available on model 69NT40-511.	

g. DataCORDER Alarm History List

The DataCORDER contains a buffer of up to eight alarms. The list may be displayed by pressing the ALARM LIST key. The alarm history keypad and display processing will be the same as the Controller module. The format of an alarm history display entry is as follows:

Left Display:	"dALnn" where nn = the alarm history entry 01-08
Right Display:	"xA nn" where x = "I" (inactive) or "A" (active)
Or:	"– – – – – –" if no alarms are currently in the alarm history list

h. Alarm Processing

The DataCORDER contains an eight alarm history queue which will contain the first eight alarms detected by the DataCORDER. The alarms and their corresponding alarm codes are specified in Table 3-7. The alarm queue will be located in the Battery Backed RAM (BRAM). The queue will also have a corresponding status which will indicate whether each alarm is currently active or inactive. If multiple consecutive occurrences of an alarm are generated, only the first will be stored. The queue may be cleared by using the keypad. (If more than eight alarms occur before the queue is cleared, later alarms will be ignored.) In addition, AL91 alarm code will appear if the DataCORDER queue is full.

The out of range value is as follows:

Thermistor Inputs:	Low limit = –50.0 degC High limit = 70.0 degC

3.3.6 USDA/ Message Trip Comment

A special case event is supported for allowing the user to enter comments for a (USDA or any message) trip recording. The comments will be received from the interrogator and have a maximum length of 78 characters. Only one comment will be recorded per day. In the event that multiple comments occur, then only the last is saved.

3.3.7 USDA Recording

A special type of recording is provided for USDA cold treatment purposes. Cold treatment recording requires three remote temperature probes to be placed at various locations of the cargo. Provision is made to connect these probes to the DataCORDER via receptacles located at the rear left-hand side of the unit. Four (five, on some units) receptacles are provided. Four (three-pin) receptacles are for the probes and one (five pin) receptacle is provided for the Interrogator. All receptacles are sized to accept a Deutsch HD16-5-16S size plug with a tricam coupling locking device. The DataCORDER inputs are designed to accept a two wire thermistor probe.

A label on the back panel of the unit shows which receptacle is used for each probe. The USDA #1, #2 and #3 probes (and possibly the optional Cargo probe) are installed in their receptacles.

The DataCORDER records up to six probe temperatures (supply, return, USDA #1, #2, #3 and an optional cargo probe #4), at the logging interval.

The standard DataCORDER report displays the supply and return air temperatures. The cold treatment report displays USDA #1, #2, #3 and the supply and return air temperatures. Cold treatment recording is backed up by a battery so recording can continue if AC power is lost.

When the Relative Humidity Set Point mode is activated or de-activated (ie., Controller function code Cd33), this status is stored in the DataCORDER memory and reported at the next recording, as are like events such as economy mode and bulb mode.

3.3.8 Pre-Trip Data Recording

The unit is equipped with the ability to record pass/fail information along with unit data resulting from the initiation of pre-trip (see section 3.2.2). The data is time-stamped and may be extracted via interrogation using CTD's interrogation program. See Table 3-10 for a description of the data stored in the DataCORDER for each corresponding Pre-Trip test.

3.3.9 DataCORDER Communications

a. DataCORDER Retrieval – Interrogation

Data retrieval from the DataCORDER can be accomplished with three devices: a CTD DataReader and DataView software, a stand-alone DOS-base portable computer with appropriate cable and DataView software, or a Remote Monitoring Unit (RMU).

NOTE

The RMU designation is used in the industry. Be aware that CTD uses the designation CI (Communications Interface Module) on its schematics.

The optional interrogation software for a portable computer is supplied on a 3.5 and 5.25 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.

NOTE

Refer to Interrogation manual 62-02575 for a more detailed explanation of the interrogation software.

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.

3.3.10 DataCORDER Scrollback

The DataCORDER will display probe values for the six DataCORDER probes up to 99 hours back from the current hour. The probe values may be displayed by depressing the ALT. MODE key and then depressing the UP or DOWN ARROW keys until "dCdSP" is shown in the left display window and then depressing the ENTER key. The sensor to display can then be chosen by depressing the UP or DOWN ARROW key until the desired sensor (S for supply, r for return, P1, P2, P3 and C4 for USDA and Cargo probes) is shown in the left display window and then depressing the ENTER key. A temperature value will appear in the right display window and 1 (with sensor designation) will appear in the left display window to signify the temperature displayed is the most recent reading. Each press of the DOWN ARROW key displays the temperature one hour earlier. Use the ENTER key to alternate between sensors and times/temperatures. Use the ARROW keys for scrolling. The display will return to normal if 15 seconds lapse without a key being pressed.

3.4 USDA COLD TREATMENT PROCEDURE

Sustained cold temperature has been employed as an effective postharvest method for the control of 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 DataCORDER. These units have the ability to maintain supply air temperature within one-quarter degree Celsius of setpoint and record minute changes in product temperature within the DataCORDER memory, thus meeting USDA criteria
(refer to section 3.3.7).

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. Pre-cool to treatment temperature.

c. Install the DataCORDER module battery pack (if not already installed).

d. Calibrate the three USDA probes by ice bathing the probes and performing the calibration function with the hand held DataReader or a DOS-based portable computer. This calibration procedure determines the probe offsets and stores them in the Controller for use in generating the cold treatment report. Refer to the Interrogation manual 62-02575 for more details.

e. Place the three probes required for a USDA cold treatment procedure. The probes are placed into the pulp or the fruit at the locations defined below as the product is loaded.

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 foot containers, and three feet from the end of the load for 20 foot containers. This probe should be placed in a center carton at one-half the height of the load.
Sensor 3	Place in pulp of product five feet from the end of the load for 40 foot containers and three feet from the end of the load for 20 foot containers. This probe should be placed in a carton at a side wall at one-half the height of the load.

f. To initiate USDA Recording begin the cold treatment recording, connect the Interrogator and perform the configuration as follows:

- Trip Start
- Trip Comment
- Configure for five probes
- One hour logging interval
- USDA temperature log in
- Two byte memory storage format
- Probe calibration

g. Retrieval of trip data from the DataCORDER memory can be accomplished with a DataReader and DataView software or DataView software and a DOS-based portable computer. Contact a Carrier Transicold Service Parts representative for details.

Table 3-10. DataCORDER Pre-Trip Data		
Test No.	**TITLE**	**DATA**
NOTE "Auto" or "Auto1" menu includes the following: P, P1, P2, P3, P4, P5, P6 and rSLts. "Auto2' (Optional) menu includes the following: P, P1, P2, P3, P4, P5, P6,P7, P8, P9, P10 and rSLts. (Refer to section 3.2.1.)		
1-0	Heater On	Pass/Fail/Skip Result, Change in current for Phase A, B and C
1-1	Heater Off	Pass/Fail/Skip Result, Change in currents for Phase A, B and C
2-0	Condenser Fan On	Pass/Fail/Skip Result, Water pressure switch (WPS) – Open/Closed, Change in currents for Phase A, B and C
2-1	Condenser Fan Off	Pass/Fail/Skip Result, Change in currents for Phase A, B and C
3-0	Low Speed Evaporator Fan On	Pass/Fail/Skip Result, Change in currents for Phase A, B and C
3-1	Low Speed Evaporator Fan On	Pass/Fail/Skip Result, Change in currents for Phase A, B and C
4-0	High Speed Evaporator Fan On	Pass/Fail/Skip Result, Change in currents for Phase A, B and C
4-1	High Speed Evaporator Fan On	Pass/Fail/Skip Result, Change in currents for Phase A, B and C
5-0	Supply/Return Probe Test	Pass/Fail/Skip Result, STS, RTS, SRS and RRS
5-1	Secondary Supply Probe Test	Pass/Fail/Skip Result
5-2	Secondary Return Probe Test	Pass/Fail/Skip Result
6-0	Compressor On	Pass/Fail/Skip Result, Change in currents for Phase A, B and C
6-1	Not Applicable	This test is not in use starting with model number 69NT40-511-200 and UP.
6-2	Suction Modulation Valve Open and Closed	Pass/Fail/Skip Result, Is current or pressure limit in effect? (Y,N)?
6-4	Not Applicable	This test is not in use starting with model number 69NT40-511-200 and UP.
6-5	Not Applicable	This test is not in use starting with model number 69NT40-511-200 and UP.
7-0	High Pressure Switch Closed	Pass/Fail/Skip Result, AMBS, DPT or CPT (if equipped) Input values that component opens?
7-1	High Pressure Switch Open	Pass/Fail/Skip Result, STS, DPT or CPT (if equipped) Input values that component closes?
8-0	Perishable Heat	Pass/Fail/Skip Result, STS, time it takes to heat to 16_C (60_F)?
8-1	Perishable Pull Down	Pass/Fail/Skip Result, STS, time it takes to pull down to 0_C (32_F)?
8-2	Perishable Maintain	Pass/Fail/Skip Result, Averaged DataCORDER supply temperature (SRS) over last recording interval.
9-0	Defrost Test	Pass/Fail/Skip Result, DTS temperature at end of test, line voltage, line frequency, time in defrost.
10-0	Frozen Mode Set-up	Pass/Fail/Skip Result, STS, time unit is in heat.
10-1	Frozen Mode Pull Down	Pass/Fail/Skip Result, STS, time to pull down unit to –17.8 (0_F).
10-2	Frozen Mode Maintain	Pass/Fail/Skip Result, Averaged DataCORDER return temperature (RRS) over last recording interval.

CONTAINER ABCDXXXXXXX ON 08Jul 94 FROM 15Apr94 TO 17Apr94 (DEGREES C) PAGE: 1

HEADER INFORMATION

DataCorder SN: XXXXXXXX

ALARMS REPORT

ALARM NUM	FIRST ACTIVE	LAST ACTIVE
CONTROLLER ALARMS:		
60	17Apr94 03:28	17Apr94 16:13
DATACORDER ALARMS		
No Alarms Reported		

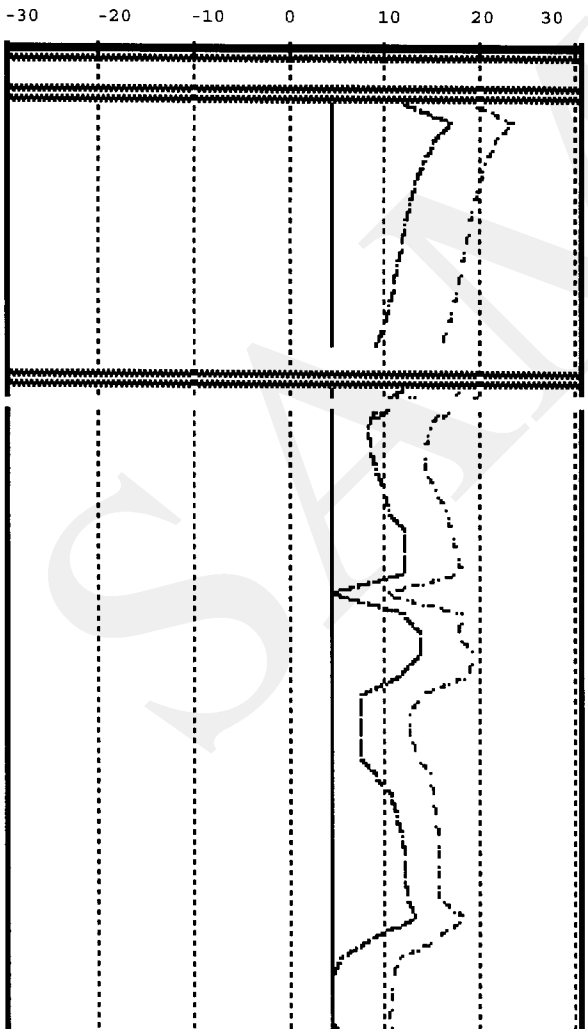
USDA SUMMARY

DATE: 15Apr94 23:49 Trip Start

LEGEND

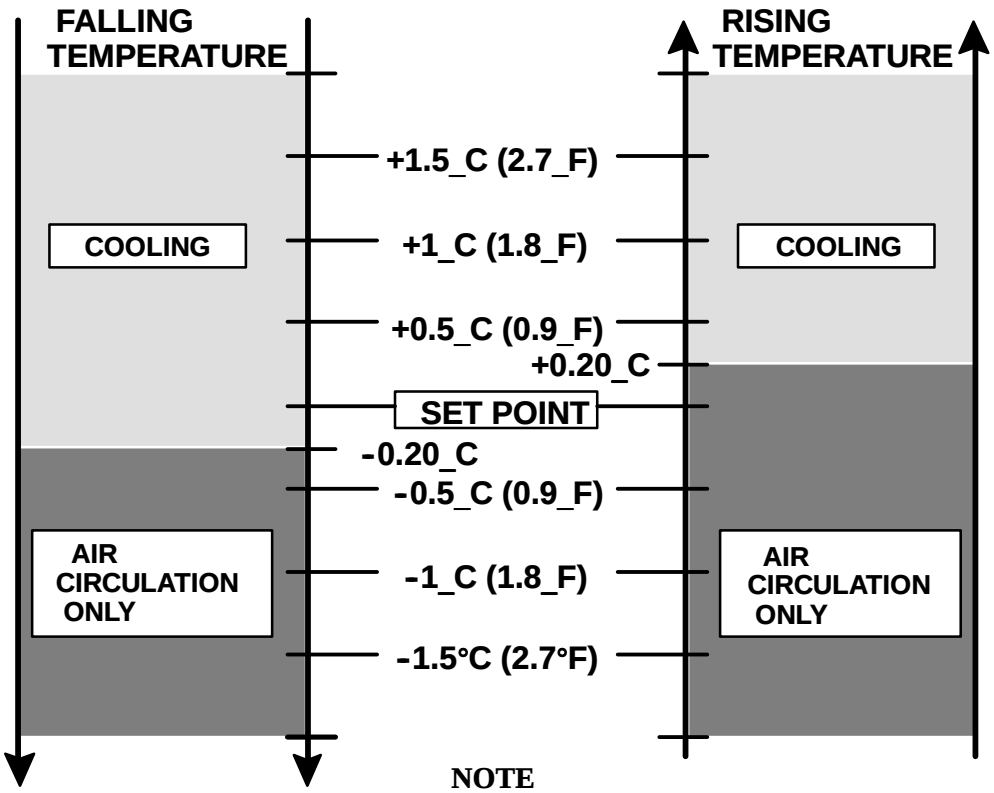
SP	Setpoint Change	DS	Defrost Start		
PS, PE	Pretrip Start/End	DHS, DHE	Dehumid Start/End		
NEW SN	Controller Rep.	NEW ID	Container ID	DE	Defrost End
dal	Datacorder Alm	OFF	Power Loss	AL	Alarm Activity
NEW SW	Software Upgrade	COMM	NetWork Off	TS	Trip Start
				BATT	Power Loss

Setp
SupAir
RetAir



DATE	TIME	Setp	SupAir	RetAir	TEXT
15Apr94	00:00	4.00	20.75	26.50	SP=4.00 C, TS
16Apr94	00:00	4.00	11.00	18.25	
16Apr94	01:00	4.00	16.25	22.75	
16Apr94	02:00	4.00	14.25	20.75	COMM OFF, OFF
16Apr94	03:00	4.00	13.25	19.75	
16Apr94	04:00	4.00	12.50	19.25	
16Apr94	05:00	4.00	12.00	18.50	
16Apr94	06:00	4.00	11.25	18.00	
16Apr94	07:00	4.00	11.00	17.75	
16Apr94	08:00	4.00	10.50	17.25	OFF, COMM OFF
16Apr94	09:00	4.00	10.25	17.00	OFF
16Apr94	10:00	4.00	9.75	16.50	OFF, COMM OFF
16Apr94	11:00	4.00	9.25	16.00	
16Apr94	12:00	4.00	8.50	15.25	
16Apr94	14:00	4.00	11.25	17.50	OFF
16Apr94	15:00	4.00	8.50	15.00	
16Apr94	16:00	4.00	7.75	14.00	
16Apr94	17:00	4.00	8.00	13.50	
16Apr94	18:00	4.00	8.50	13.50	
16Apr94	19:00	4.00	9.25	14.50	
16Apr94	20:00	4.00	9.75	15.75	
16Apr94	21:00	4.00	11.25	16.25	
16Apr94	22:00	4.00	11.50	16.75	
16Apr94	23:00	4.00	11.50	17.25	OFF
17Apr94	00:00	4.00	3.75	9.25	
17Apr94	01:00	4.00	11.50	17.25	
17Apr94	02:00	4.00	13.00	17.00	
17Apr94	03:00	4.00	13.00	18.25	DS
17Apr94	04:00	4.00	11.00	18.00	DE=60min, AL60, AL60
17Apr94	05:00	4.00	6.75	13.00	AL60
17Apr94	06:00	4.00	6.75	12.00	AL60
17Apr94	07:00	4.00	6.75	12.00	AL60
17Apr94	08:00	4.00	6.75	12.75	AL60
17Apr94	09:00	4.00	8.50	14.00	AL60
17Apr94	10:00	4.00	10.00	14.25	AL60
17Apr94	11:00	4.00	10.50	14.50	AL60
17Apr94	12:00	4.00	11.00	14.75	AL60
17Apr94	13:00	4.00	11.50	14.75	AL60 in this hr.
17Apr94	14:00	4.00	11.50	14.75	AL60
17Apr94	15:00	4.00	11.75	14.75	AL60
17Apr94	16:00	4.00	12.50	17.50	OFF, DS
17Apr94	17:00	4.00	8.00	14.50	AL60, DE=60min, OFF
17Apr94	18:00	4.00	4.75	10.75	
17Apr94	19:00	4.00	3.75	10.00	
17Apr94	20:00	4.00	3.75	10.00	SP=4.00 C
17Apr94	21:00	4.00	3.75	9.75	

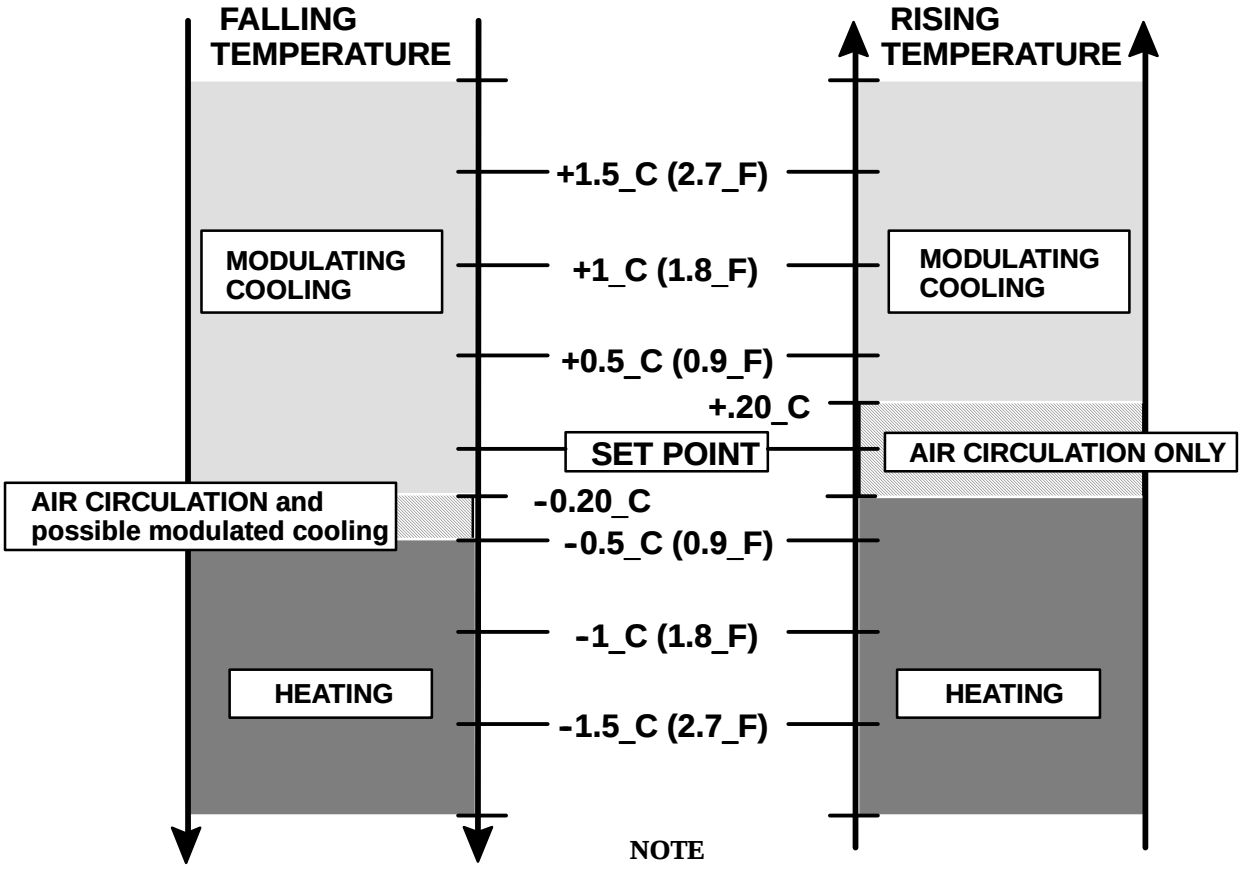
Figure 3-4. Standard Configuration Report Sample



NOTE

For In-range Tolerance, Refer to section 3.1.4 Code 30..

Figure 3-5. Controller Set Point BELOW -10_C (+14_F), or -5_C (+23_F) optionally



NOTE

For In-range Tolerance, Refer to section 3.1.4 Code 30..

Figure 3-6. Controller Set Point ABOVE -10_C (+14_F), or -5_C (+23_F) optionally

SECTION 4

OPERATION

4.1 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 assembly clamp bolts for proper securement (refer to section 6.16).
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 6.14.)
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 6.18.)

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 control box door. Check for loose electrical connections or hardware.

e. Check color of moisture-liquid indicator.

f. Check oil level in compressor sight glass.

g. Start refrigeration unit. (Refer to section 4.3.)

4.2 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

NOTE

The evaporator fans will always start in high speed regardless of set point and will switch to low speed after approximately 20 to 30 seconds if the set point is below -10_C (+14_F), or -5_C (+23_F) optionally.

1. Refer to Pre-Trip Inspection, section 4.1.
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 to ON (position "1").
4. *Units equipped with the integrated DataCORDER:*

   Trip start is initiated by depressing the ALT. MODE key and selecting Code dc30, then depressing the *ENTER* key for five seconds.
5. Refer to section 4.3 after unit is running.

b. Stopping the Unit

Turn the start-stop switch (ST) to position "0" (OFF position).

4.3 AFTER STARTING INSPECTION

a. Check rotation of condenser and evaporator fans.

b. Check compressor oil level. (Refer to section 6.11.)

c. Run unit at least five minutes to stabilize. Start controller Pre-Trip diagnostics. (Refer to section 3.2.)

4.4 UNIT OPERATION

4.4.1 Crankcase Heater (CCH)– Optional

When the crankcase heater is installed, it will be operational whenever the compressor is off and there is power to the unit. The heater is connected to a set of normally closed auxiliary contacts on the compressor contactor (CH).

4.4.2 Probe Check Initiation (Optional)

Whenever the unit is in normal control mode, that is, not in pre-trip, defrost or shutdown modes and there are NO active probe alarms, and alarm codes AL11 and AL12 are inactive (for units so equipped), the following probe diagnostic functions are performed by the controller.

The following is based on current ML2i operational software logic, version 5103. Older versions of software will have differences.

a. Probe Diagnostic Logic

If the unit is configured for standard (Std) "Probe Check Logic," the criteria used for comparison between the primary and secondary **control** probes is:

- 1_C (1.8_F) for **perishable** set points, above –10_C (+14_F), or –5_C (+23_F) optionally.
- 2_C (3.6_F) for **frozen** set points, below above range.
- If 25 or more of 30 readings taken within a 30 minute period are out-of-range per the above criteria, then a defrost* is initiated and a probe check is performed.

b. Special

If the unit is configured for special (SPEC) "Probe Check Logic," the above criteria is identical except for the diagnostic readings which are:

- If 25 or more of 30 readings taken within a 30 minute period **OR** any 10 consecutive readings at any time are out-of-range per the above criteria, then a defrost* is initiated and a probe check is performed.

* The only time defrost will not be initiated is if the defrost termination sensor (DTS) is greater than 25.56_C (78_F).

The 30 minute timer will be reset for each of the following conditions:

- At every power up.
- At the end of every defrost.
- After every diagnostic check that does not fall outside of the limits as described under "standard or special" as outlined above.

If AL55 is active, meaning that the DataCORDER (DC) functionality is no longer active (DC configuration variable off), the Controller will act as a four probe configured system during probe checks. The only differences will be that the Controller Function Codes Cd38 and Cd39 will become enabled thus allowing access to the secondary probe readings since the DC functions, codes and alarms have become deactivated. Controller alarms AL70 and AL71 will replace DC alarms AL70 and AL71 respectively for the secondary probes.

If the unit is configured for standard (Std) "Probe Check Logic," a probe check will be run as a part of **every** normal defrost.

If the unit is configured for special (SPEC) "Probe Check Logic," a probe check will **not** be run as a part of a normal defrost, but **only** as a part of a defrost initiated due to a diagnostic reading outside of the limits as outlined above under "special."

c. Probe Check

During a defrost cycle that includes a probe check, after the heaters turn off, the evaporator motors will be energized for an additional eight minutes after which all the primary/secondary probes will be compared to a set of predetermined limits.

The defrost indicator will remain on throughout this period.

Any probe(s) determined to be outside the limits will cause the appropriate alarm code(s) to be displayed to identify which probe(s) needs to be replaced.

The limits used during a probe check are tighter than those used for the diagnostic criteria to ensure accurate detection of a faulty probe(s).

NOTES

- Be aware that probe check and probe diagnostics are two separate functions. The function of the diagnostic logic is to alert the microprocessor of a discrepancy with the control probe(s). The function of the probe check is to determine what probe(s) is in error.
- The P5 Pre-Trip test must be run to inactivate alarms (refer to section 3.2.1).

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4.4.3 Cooling – Controller Set BELOW –10_C (+14_F), or –5_C (+23_F) optionally

NOTES

- The stepper motor suction modulation valve (SMV) may be up to 100% open depending on the current and pressure limiting controls.
- The evaporator motors run in low speed.
- The compressor runs in high speed.

When the return air temperature decreases to 0.2_C (0.4_F) below set point, relays TD and TN de-energize. 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 TD and TN energize to restart the compressor and condenser fan motor. Also at this time, the cool light is illuminated.

4.4.4 Controller Set ABOVE –10_C (+14_F), or –5_C (+23_F) optionally

a. Cooling Mode (See Figure 4-1.)

NOTES

- Evaporator fan motors will run in high speed. (Contactor EF energized)
- A pressure control system has been incorporated by means of a condenser pressure transducer (CPT) and condenser pressure control (CPC) logic to maintain discharge pressures above 130 psig in low ambients.
- The condenser fan will cycle off if the condenser pressure is below 130 psig. If the condenser pressure goes above 200 psig, the condenser fan will cycle on.

With supply air temperature decreasing, 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 predetermined tolerance above set point, relay TI energizes and the in-range light is illuminated. (Refer to section 3.1.4, Code 30.)

If the air temperature continues to fall, modulating cooling starts at approximately 2.5_C (4.5_F) above set point.

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 greater the negative differential in the running sum.

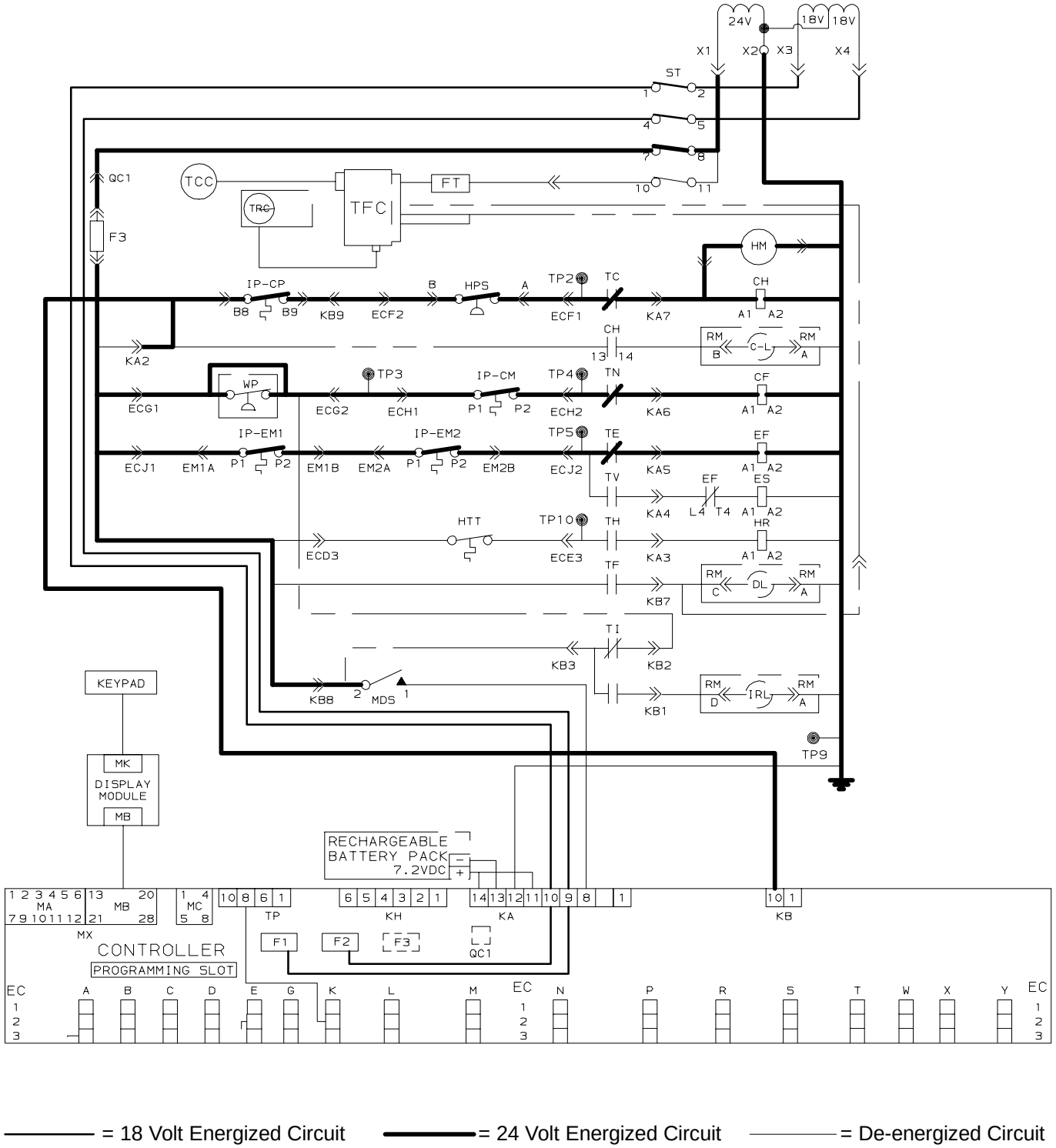
When the supply air temperature decreases to 0.2_C or more below set point and the running sum is greater than or equal to –250 degrees Celsius seconds, relays TN and TC de-energize shutting off the condenser fan and compressor motors. Also, the cool light is de-energized.

NOTE

For example: If the temperature in the container box falls 1_C below set point for 250 seconds, or any combination of temperature and time that equals 250 degrees Celsius seconds, the unit will shut off. (Formula: X_C times TIME in seconds. Where X is the amount of degrees in Celsius, i.e., 1_C times 250 seconds = 250 degrees Celsius seconds.)

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, and the 15 minute override is met.

If the unit is in the holding mode (neither heating nor cooling) and the supply air temperature increases to 0.2_C (0.4_F) above set point, and providing a six 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.



——— = 18 Volt Energized Circuit ——— = 24 Volt Energized Circuit ——— = De-energized Circuit

Figure 4-1. Cooling Mode

4.4.5 Heating Mode

The unit *will heat only* when the controller set point is above –10_C (+14_F), or –5_C (+23_F) optionally, as relay TH is electronically locked out to prevent heating when the controller set point is *below* –10_C (+14_F), or –5_C (+23_F) optionally.

If the air temperature decreases 0.5_C (0.9_F) below controller set point, TH closes (see Figure 4-2) 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 heater contactor (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 a 15 minute time delay) and will remain de-energized until the supply air increases to a tolerance below set point.
(Refer to section 3.1.4, Code 30.)

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 CH and CF remain de-energized. The evaporator fans continue to run to circulate air throughout the container.

A safety heat 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.

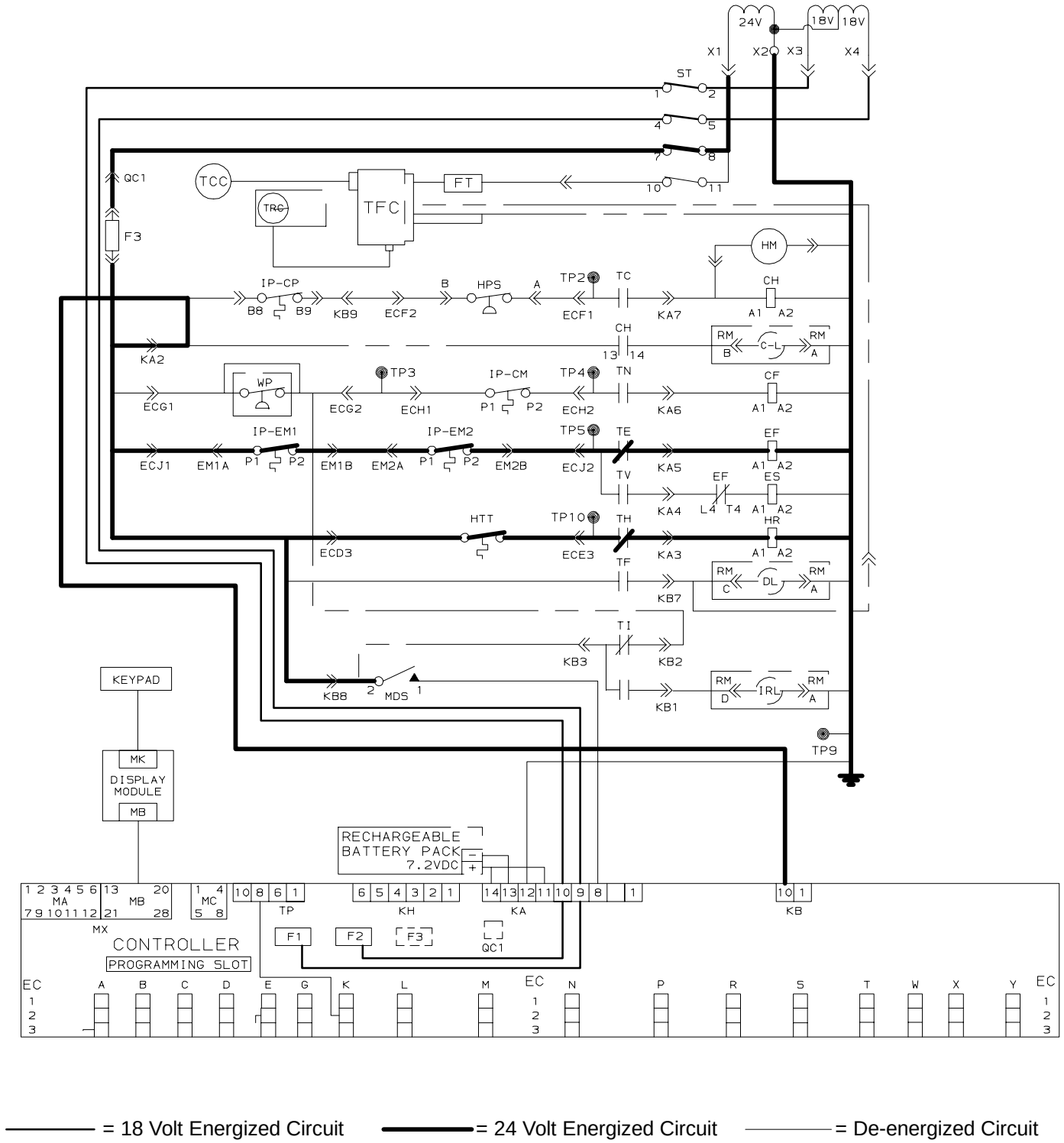


Figure 4-2. Heating Mode

4.4.6 Defrost Mode

Refer to section 3.1.4 (Code 27) for description of the defrost interval selector and automatic defrost initiation.

The defrost cycle consists of two distinct sub-cycles. The first sub-cycle is the de-ice cycle, the second is a probe check cycle.

NOTE

A reset of the stepper motor suction modulation valve (SMV) is performed at the beginning of the de-ice cycle.

Defrost may take place any time the DTS allows, and no shutdown alarms are active. With these conditions satisfied, defrost is initiated when one of the following conditions becomes true:

a. The manual defrost switch (MDS) is closed by the user. Refer to Figure 2-6 for location. The MDS is ignored during Pre-Trip.

b. The defrost interval timer reaches or exceeds the defrost interval selected and set by the user.

c. During Pre-Trip (auto, not manual) defrost can occur during the advanced Pre-Trip tests P-8 and P-10. Defrost is forced during advanced Pre-Trip test P-9.

d. When the probe diagnostic logic determines that a probe check is necessary based on the temperature values currently reported by the supply and return probes.

e. When bulb mode is active, and the defrost termination sensor (DTS) is between 0_C and 10_C (32_F and 50_F).

When the defrost mode is initiated (see Figure 4-3), the controller relay contacts (TH) close to supply power to the heat contactor (HR) and in turn, energize the defrost heaters. The defrost light is illuminated.

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

Relay TE and TV open to stop the evaporator fan motors.

The in-range light remains illuminated during defrost.

When the coil tube sheet temperature reaches 25.6_C (78_F), *[4_C and 25.6_C (39.2_F and 78_F) if configured for and operating in bulb mode],* the defrost termination sensor (DTS) causes the controller to end the defrost cycle and the unit returns to its normal function. Under certain circumstances, defrost may also be forced to terminate through special communication commands.

Upon completion of the de-ice phase of defrost, the controller will perform a probe check cycle. The purpose of the probe check cycle is to perform a periodic check of the controller sensors to detect malfunctions or drift in the sensed temperature that is too small to be detected by the normal sensor out of range tests. The system will run for eight minutes in this condition. At the end of the eight minutes, the primary supply, primary return and DataCORDER sensor temperatures will be compared. The controller probe alarms will be set or cleared based on the conditions seen.

The 54.5_C (130_F) heat termination thermostat (HTT) will open the circuit if the defrost mode does not terminate at 25.6_C (78_F). If termination does not occur within 2.0 hours, the controller will terminate defrost. An alarm will be given of a possible DTS failure.

When the return air falls to 7_C (45_F), the controller checks to ensure the defrost termination sensor (DTS) has dropped to 10_C or below. If it has not, a DTS failure alarm is given and the defrost mode is operated by the return temperature sensor (RTS).

Snap Freeze Option:

NOTE

Controller configuration variable 33 must be set to SnAP to activate this option, refer to Table 3-1.

If the probe check portion of defrost is required (depending on the configuration of probe check), snap freeze will run after the probe check cycle. Otherwise, snap freeze will run immediately following the de-ice portion of defrost.

The snap freeze cycle consists of running the compressor without the evaporator fans running for a period of four minutes with the stepper motor suction modulation valve (SMV) fully open.

If current limiting (see section 3.1.4, Cd32) or pressure limiting activates during snap freeze, the state of the SMV valve may change. When the snap freeze cycle is completed, defrost is formally terminated.

4.4.7 Arctic Mode

With arctic mode enabled, if the ambient is colder than –10.0_C there is a 30 minute time delay at startup for any of the components in the system, except for the controller and the compressor crankcase heater (CCH),

which should be active at this point. In arctic mode, the CCH is energized for 30 minutes to warm the oil in the compressor, and boil off any liquid refrigerant that may be present in the crankcase.

If Pre-Trip is initiated during the 30 minute time period, Pre-Trip will be allowed to run normally. Once Pre-Trip is over, the controller will revert to its normal control mode logic.

If ambient is warmer than –10.0_C, the system will run its normal startup logic.

Arctic mode is configurable by using the configuration variable #29, refer to Table 3-1.

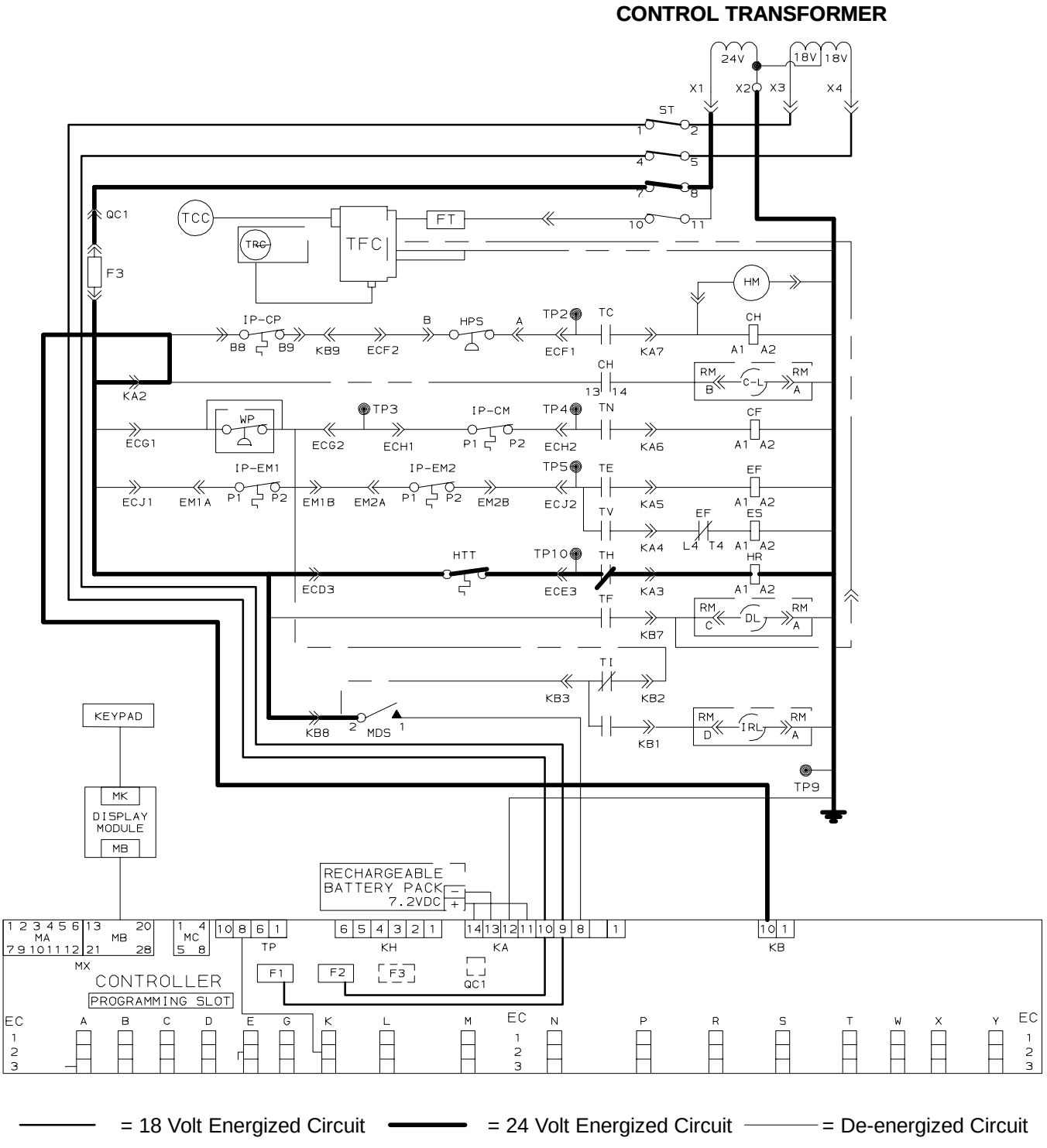


Figure 4-3. Defrost Mode

Table 4-1. Electrical Control Positions – BELOW –10_C (+14_F), or –5_C (+23_F) optionally					
CONTROL CIRCUIT	**COOLING**	**Holding Zone**	****Dehumidification**	**HEATING**	**DEFROST**
Compressor Contactor (CH)	Energized	De-energized	**	**	De-energized [1]
Condenser Fan Contactor (CF)	Energized	De-energized	**	**	De-energized
High Speed Evaporator Contactor (EF)	De-energized	De-energized	Refer to section 3.1.7.a.2	Refer to section 3.1.7.a.2	De-energized [2]
Low Speed Evaporator Contactor (ES)	Energized	Energized	Refer to section 3.1.7.a.2	Refer to section 3.1.7.a.2	De-energized
Heater Contactor (HR)	De-energized	De-energized	**	**	Energized
INDICATING LIGHTS					
Cool	ON	OFF	**	**	OFF
Defrost	OFF	OFF	**	**	ON
In-Range	On – If In-Range (Refer to paragraph 3.1.4, Code 30) →				
Heat	OFF	OFF	**	**	ON
POWER CIRCUIT					
Compressor	Energized	De-energized	**	**	De-energized
Condenser Fan Motor	Energized	De-energized	**	**	De-energized
Heaters	De-energized	De-energized	**	**	Energized
Evaporator Fan Motors	Energized	Energized	**	**	De-energized

** Dehumidification and heating modes do not operate at set points below –10_C (14_F), or –5_C (23_F) optionally

[1] – May be energized in defrost if snap freeze portion of defrost is run.

[2] – May be energized in defrost if probe check portion of defrost is run.

Table 4-2. Electrical Control Positions – ABOVE –10_C (+14_F), or –5_C (+23_F) optionally					
CONTROL CIRCUIT	**COOLING**	**Holding Zone**	*** Dehumidification**	**HEATING**	**DEFROST**
Compressor Contactor (CH)	Energized	De-energized	**	**	De-energized [1]
Condenser Fan Contactor (CF)	Energized	De-energized	Energized	De-energized	De-energized
High Speed Evaporator Contactor (EF)	Energized	Energized	Refer to section 3.1.7.a.2	Refer to section 3.1.7.a.2	De-energized [2]
Low Speed Evaporator Contactor (ES)	De-energized	De-energized	Refer to section 3.1.7.a.2	Refer to section 3.1.7.a.2	De-energized
Heater Contactor (HR)	De-energized	De-energized	Energized	Energized	Energized
INDICATING LIGHTS					
Cool	ON	OFF	ON	OFF	OFF
Defrost	OFF	OFF	OFF	OFF	ON
In-Range	On – If In-Range (Refer to paragraph 3.1.4, Code 30) →				
Heat	OFF	OFF	ON	ON	ON
POWER CIRCUIT					
Compressor	Energized	De-energized	Energized	De-energized	De-energized
Condenser Fan Motor	Energized	De-energized	Energized	De-energized	De-energized
Heaters	De-energized	De-energized	Energized	Energized	Energized
Evaporator Fan Motors	Energized	Energized	Energized	Energized	De-energized

* Unit with optional Humidity sensor

** Dehumidification and heating modes do not operate at set points below –10_C (14_F), or –5_C (23_F) optionally

[1] – May be energized in defrost if snap freeze portion of defrost is run.

[2] – May be energized in defrost if probe check portion of defrost is run.

SECTION 5

TROUBLESHOOTING

CONDITION	POSSIBLE CAUSE	REMEDY/ REFERENCE SECTION
5.1 UNIT WILL NOT START OR STARTS THEN STOPS		
No power to unit	External power source OFF	Turn on
	Start-Stop switch (ST) OFF or defective	Check
	Circuit breaker (CB) tripped or OFF	Check
	Modular transformer (TRANS) not connected	6.21
Loss of control power	Circuit breaker (CB) OFF or defective	Check
	Control transformer (TR) defective	Replace
	Fuse (F3) blown	Check
	Start-Stop switch (ST) OFF or defective	Check
Loss of control power in respective branch of control circuit only	Evaporator fan motor internal protector (IP) open	6.16
	Condenser fan motor internal protector (IP) open	6.19
	Compressor internal protector (IP) open	6.8
	High pressure switch (HPS) open	5.7
	Heat termination thermostat (HTT) open	Replace
Compressor hums, but does not start	Low line voltage	Check
	Single phasing	Check
	Shorted or grounded motor windings	6.8
	Compressor seized	6.8
5.2 UNIT RUNS BUT HAS INSUFFICIENT COOLING		
Compressor	Compressor valves defective	6.8
Refrigeration System	Abnormal pressures	5.7
	Temperature controller malfunction	5.9
	Evaporator fan or motor (EM) defective	6.16
	Stepper motor suction modulation valve (SMV) malfunction	6.24
	Condenser Pressure Transducer (CPT) defective	Check
	Shortage of refrigerant	6.7
5.3 UNIT OPERATES LONG OR CONTINUOUSLY IN COOLING		
Container	Hot load	Normal
	Defective box insulation or air leak	Repair
Refrigeration System	Shortage of refrigerant	6.5/6.7
	Evaporator coil covered with ice	5.6
	Evaporator coil plugged with debris	6.14
	Evaporator fan(s) rotating backwards	6.16/6.17
	Defective evaporator fan motor/capacitor	6.16/6.17
	Air bypass around evaporator coil	Check
	Controller set too low	Reset
	Dirty condenser	6.18
	Compressor worn	6.8
	Current limit (Code 32) set to wrong value	3.1.4
	Stepper motor suction modulation valve (SMV) malfunction	6.24

CONDITION	POSSIBLE CAUSE	REMEDY/ REFERENCE SECTION
5.4 UNIT WILL NOT HEAT OR HAS INSUFFICIENT HEATING		
No power to unit	Start-Stop switch (ST) OFF or defective	Check
	Circuit breaker (CB) OFF or defective	Check
	External power source OFF	Turn on
No control power	Circuit breaker (CB) or fuse (F) defective	Replace
	Transformer defective (TR)	Replace
	Evaporator fan internal motor protector (IP) open	6.16
	Heat relay (TH) defective	Check
	Heater termination thermostat (HTT) open	6.14
Unit will not heat or has insufficient heat	Heater(s) (DHBL, DHBR, DHTL, DHTR) defective	6.15
	Heater contactor (HR) or coil defective	Replace
	Evaporator fan motor(s) defective or rotating backwards	6.16/6.17
	Evaporator fan motor contactor (EF or ES) defective	Replace
	Temperature controller malfunction	5.9
	Defective wiring	Replace
	Loose terminal connections	Tighten
	Low line voltage	2.4
5.5 UNIT WILL NOT TERMINATE HEATING		
Unit fails to stop heating	Temperature controller improperly set	Reset
	Temperature controller malfunction	5.9
	Heater termination thermostat (HTT) remains closed along with the heat relay (TH)	6.14
5.6 UNIT WILL NOT DEFROST PROPERLY		
Will not initiate defrost automatically	Defrost timer malfunction	3.1.4
	Loose terminal connections	Tighten
	Defective wiring	Replace
	Defrost termination sensor (DTS) defective or heat termination thermostat (HTT)open	Replace
	Heater contactor (HR) or coil defective	Replace
Will not initiate defrost manually	Manual defrost switch (MDS) defective	Replace
	Defrost termination sensor (DTS) open	4.4.6
Initiates but relay (DR) drops out	Low line voltage	2.4
Initiates but does not defrost	Heater contactor (HR) or coil defective	Replace
	Heater(s) (DHBL, DHBR, DHTL, DHTR) burned out	6.15
Frequent defrost	Wet load	Normal

CONDITION	POSSIBLE CAUSE	REMEDY/ REFERENCE SECTION
5.7 ABNORMAL PRESSURES (COOLING)		
High discharge pressure	Condenser coil dirty	6.18
	Condenser fan rotating backwards	6.19
	Condenser fan inoperative	6.19
	Refrigerant overcharge or noncondensibles	6.7
	Discharge pressure regulator valve defective	Replace
	Perishable set point	Normal
	Stepper motor suction modulation valve (SMV) malfunction	6.24
Low suction pressure	Filter-drier partially plugged	6.12
	Low refrigerant charge	6.5/6.7
	Expansion valve defective	6.25
	No evaporator air flow or restricted air flow	5.10
	Excessive frost on evaporator coil	6.15/6.17
	Evaporator fan(s) rotating backwards	6.15/6.17
	Discharge pressure regulator valve defective	Replace
	Stepper motor suction modulation valve (SMV) malfunction	6.24
Suction and discharge pressures tend to equalize when unit is operating	Heat exchanger defective	Replace
	Compressor valves defective	6.9
	Compressor cycling/stopped	Check
5.8 ABNORMAL NOISE OR VIBRATIONS		
Compressor	Loose mounting bolts	Tighten
	Worn bearings	6.8
	Worn or broken valves	6.8
	Liquid slugging	5.11
Condenser or Evaporator Fan	Bent, loose or striking venturi	Check
	Worn motor bearings	6.16/6.19
	Bent motor shaft	6.16/6.19
5.9 TEMPERATURE CONTROLLER MALFUNCTION		
Will not control	Defective Sensor	6.23
	Defective wiring	Check
	Fuse (F1, F2) blown	Replace
	Stepper motor suction modulation valve (SMV) circuit malfunction	6.24
5.10 NO EVAPORATOR AIR FLOW OR RESTRICTED AIR FLOW		
Evaporator coil blocked	Frost on coil	5.6
	Dirty coil	6.14
No or partial evaporator air flow	Evaporator fan motor internal protector (IP) open	6.16
	Evaporator fan motor(s) (EM) defective	6.16/6.17
	Evaporator fan(s) loose or defective	6.16
	Evaporator fan contactor (EF or ES) defective	Replace

CONDITION	POSSIBLE CAUSE	REMEDY/ REFERENCE SECTION
5.11 THERMOSTATIC EXPANSION VALVE MALFUNCTION		
Low suction pressure with high superheat	Low refrigerant charge	6.5/6.7
	External equalizer line plugged	Open
	Wax, oil or dirt plugging valve or orifice Ice formation at valve seat	6.25
	Superheat too high	6.5/6.7
	Power assembly failure	6.25
	Loss of element/bulb charge	6.25
	Broken capillary	6.25
	Foreign material in valve	6.25
High suction pressure with low superheat	Superheat setting too low	6.25
	External equalizer line plugged Ice holding valve open	Open
	Foreign material in valve	6.5/6.6
Liquid slugging in compressor	Pin and seat of expansion valve eroded or held open by foreign material	6.25
Fluctuating suction pressure	Improper bulb location or installation	6.25
	Low superheat setting	6.25
5.12 POWER AUTOTRANSFORMER MALFUNCTION		
Unit will not start	Circuit breaker (CB-1 or CB-2) tripped	Check
	Power transformer (TRANS) defective	6.21
	Power source not turned ON	Check
	460 VAC power plug is not inserted into the receptacle	2.4
5.13 WATER-COOLED CONDENSER OR WATER PRESSURE SWITCH		
High discharge pressure	Dirty coil	6.28
	Noncondensibles	6.28
Condenser fan starts and stops	Water pressure switch (WP) malfunction	Check
	Water supply interruption	Check

SECTION 6

SERVICE

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. In the U.S.A., refer to EPA section 608.

6.1 REPAIRING THE REFRIGERATION SYSTEM

The unit is designed as a hermetic system, which reduces the number of potential leak-points for refrigerant. Therefore the suction service, discharge service and manual liquid line valves have been eliminated in comparison to the standard container unit. In conjunction, the sight glass on the water-cooled condenser, and the filter-drier quick–connect nuts have also been removed. These areas have either been completely eliminated, or have been replaced with brazed joints.

To perform maintenance on the system, two process tubes have been provided, which are the liquid line and suction line process tubes, see Figure 6-4 for locations. Refer to Table 6-4 for a list of the tools required to perform the tasks in sections 6.2, 6.3 and 6.4.

6.2 PIERCING VALVES

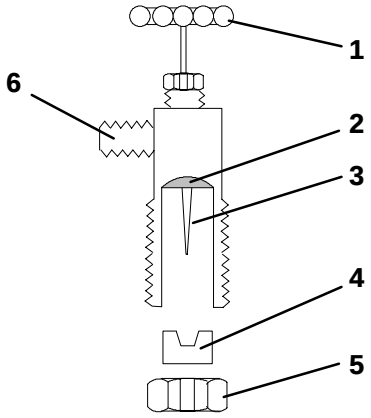
To gain access to the hermetic system, it is recommended to use the Robinair P/N 40288 piercing valve on the units process tubes.

a. Preparation

1. Tubing should be straight and round.
2. Carefully clean the process tubing where the piercing valve will be attached, do NOT scratch the tubing.
3. Make sure there are no dents in the tubing.
4. Apply a little clean refrigerant oil to the tubing where the piercing valve will be placed.

b. Installing

1. Make sure the gasket (item 2, refer to Figure 6-1) is in place, and the piercing needle (item 3) is backed all the way out by turning the hand valve (item 1) counter-clockwise.
2. Remove the nut (item 5) and u-shaped block (item 4) from the base of the piercing valve.
3. Straddle the process tube with the hand valve portion of the piercing valve.
4. Install the u-shaped block and nut onto the base of the piercing valve that was removed in step 2.
5. Tighten the valve to the process tube by turning the nut enough to seal the gasket and to secure the valve to the process tube.
6. Do NOT overtighten. Overtightened valves can actually cause a leak.
7. Install the manifold gauge hose (refer to section 6.3) to the one-quarter inch connector (item 6) using a low or high side R-134a connector (item 13 or 14, Table 6-4), and a low or high side swivel elbow (item 11 or 12).
8. Turn the hand valve clockwise to pierce the tubing and access the refrigeration system.



1. Hand Valve
2. Gasket
3. Piercing Needle
4. U-Shaped Block
5. Nut
6. One-Quarter Inch S.A.E. Connector

Figure 6-1. Piercing Valve

c. Removal

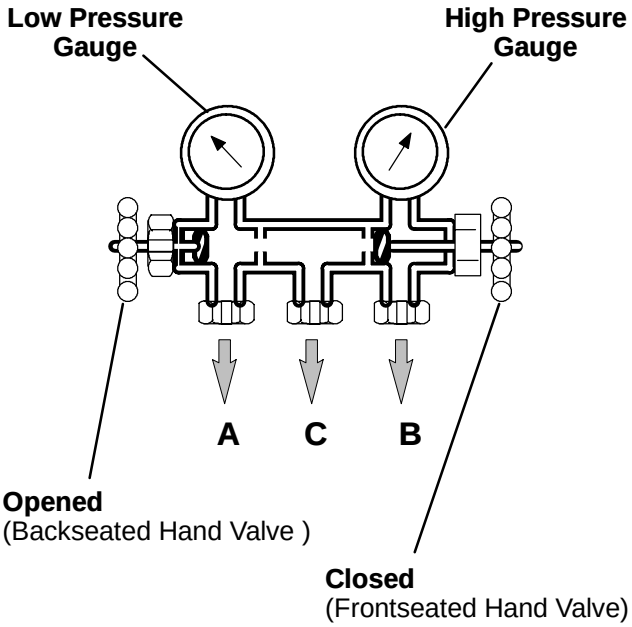
1. Reverse the steps in section 6.2.b.

6.3 MANIFOLD GAUGE SET

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

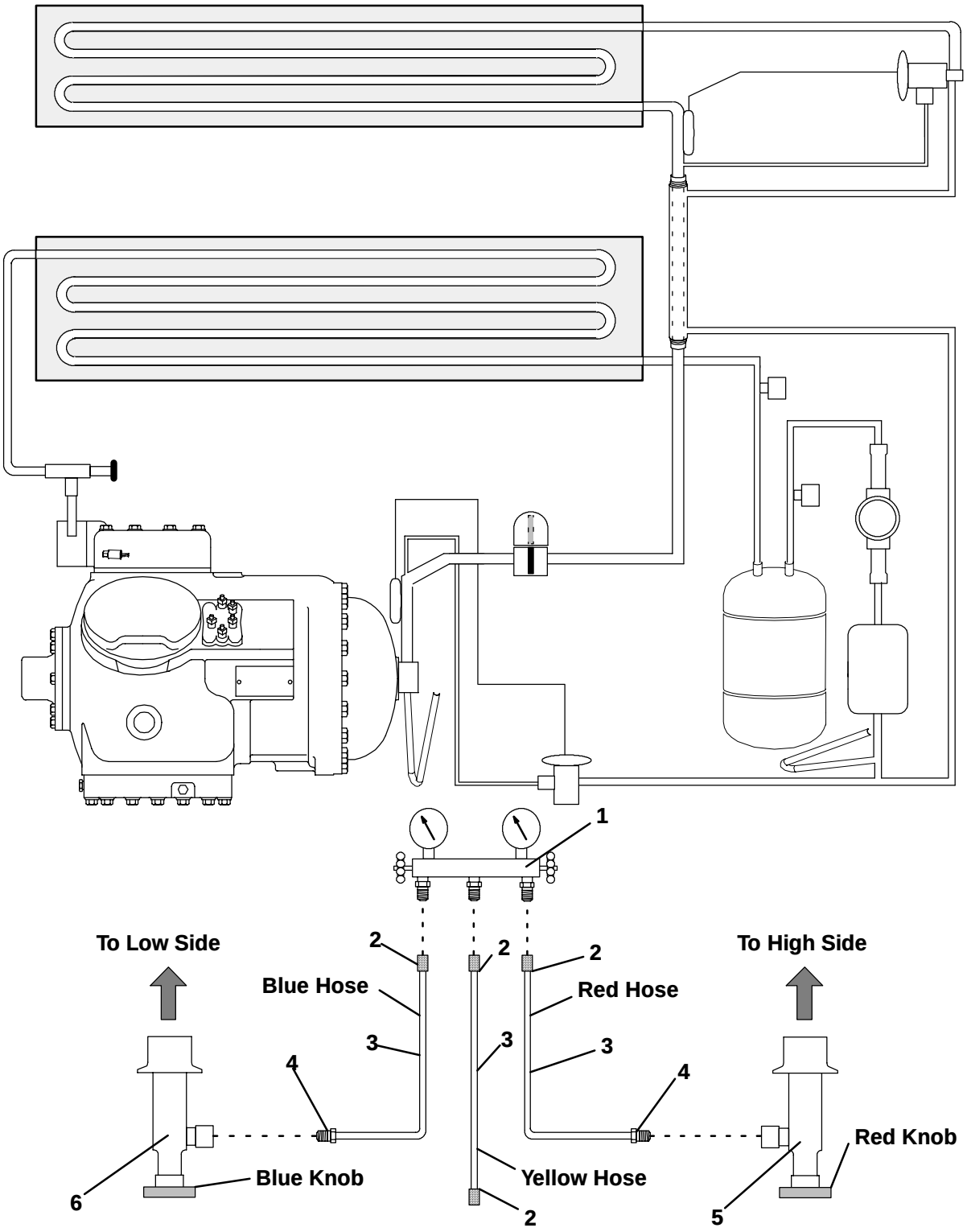
Figure 6-2 shows hand valves, gauges and service ports "A, C and B." When the low pressure hand valve is frontseated (turned all the way in), the low (suction) pressure can be checked. When the high pressure hand valve is frontseated, high (condensing) pressure can be checked. When both valves are open (turned counter-clockwise all the way out), 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 6-3 (CTD P/N 07-00294-00, which includes items 1 through 6) can be used when working on the models covered within this manual.



A. Service Port to Low Side of System
B. Service Port to High Side of System
C. Service Port to Either: Refrigerant Cylinder, Oil Container or Vacuum Pump

Figure 6-2. Manifold Gauge Set



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

Figure 6-3. R-134a Manifold Gauge Set Connection

6.4 REFRIGERANT RECOVERY

1. Disconnect the tube clamp connected to the baffle plate on the liquid line process tube. Remove the baffle plates covering both process tubes.

2. Install the piercing valve (refer to section 6.2) on the liquid line process tube and the suction line process tubes (see Figure 6-4). The valve should be installed as close as possible to the pinched-off end of the liquid line and suction line process tubes. Make sure the tubing is a full round diameter.

3. Install the 3/8 to 1/4 inch adapter to the1/4 inch flare fitting on the piercing valves. Connect the high side and low side of the R-134a manifold gauge set to the 3/8 inch hose fittings.

4. Connect the refrigerant recovery unit to the center hose on the manifold gauge set. Close the piercing valves, rotating the valve stems fully clockwise. Following the instructions for your refrigerant recovery unit start up and open the piercing valves at the appropriate time by turning the valve stems counter-clock wise.

5. When the refrigerant is fully recovered from the system, remove the refrigerant recovery unit. Using dry nitrogen break the vacuum and bring the system pressure to a slightly positive pressure of 2 to 5 psig.

6. Remove any positive pressure from the system through the manifold gauge set and leave the piercing valve open and the gauge set center hose open to prevent any pressure build-up in the refrigeration system.

WARNING

Before proceeding with the repair make certain that the stepper motor suction modulation valve (SMV) is open (refer to section 6.24) and that there is no positive pressure in the system.

7. To reduce the time required for evacuation, dehydration and refrigerant charging of the system, perform the following steps.

   - Remove the piercing valves from the liquid line and suction line process tubes.
   - Using the tubing cutter, cut the process tubes below the pierced hole in liquid line and suction line process tubes.
   - Place the 3/8 inch flare nuts on both process tubes and flare the tube.
   - Connect the 3/8 inch to 1/4 inch flare adapter and the 1/4 inch swivel elbow x R-134a refrigerant adapter to the R-134a gauge set.

The refrigeration unit is now ready for repair, and/or component replacement, refer to sections 6.6 and 6.7.

8. Pressurize the system with nitrogen and R-134a, and leak test the entire system.

9. Connect the vacuum pump to the center hose on the manifold gauge set, and thoroughly evacuate the system to 500 microns.

10. Charge the system with the correct weight (refer to unit model plate, see Figure 2-1 for location) of refrigerant R-134a using an accurate weight scale.

11. Run test the unit.

When it is determined that the unit is performing normally, the unit should be sealed to its original hermetic state as explained below.

12. Use the process tube pinch-off tool to seal the tubes before the 3/8 inch flare assembly (one tube at a time, if necessary).

13. Vent the line to the gauge set and tighten. Check for refrigerant leaks after the pinch-off tool, monitor the gauge set for a pressure rise. If there is a pressure rise, tighten the pinch-off tool until there is no pressure rise at the gauge set.

14. Leave the pinch-off tool in place, and remove the fittings from the liquid line or suction line process tube.

WARNING

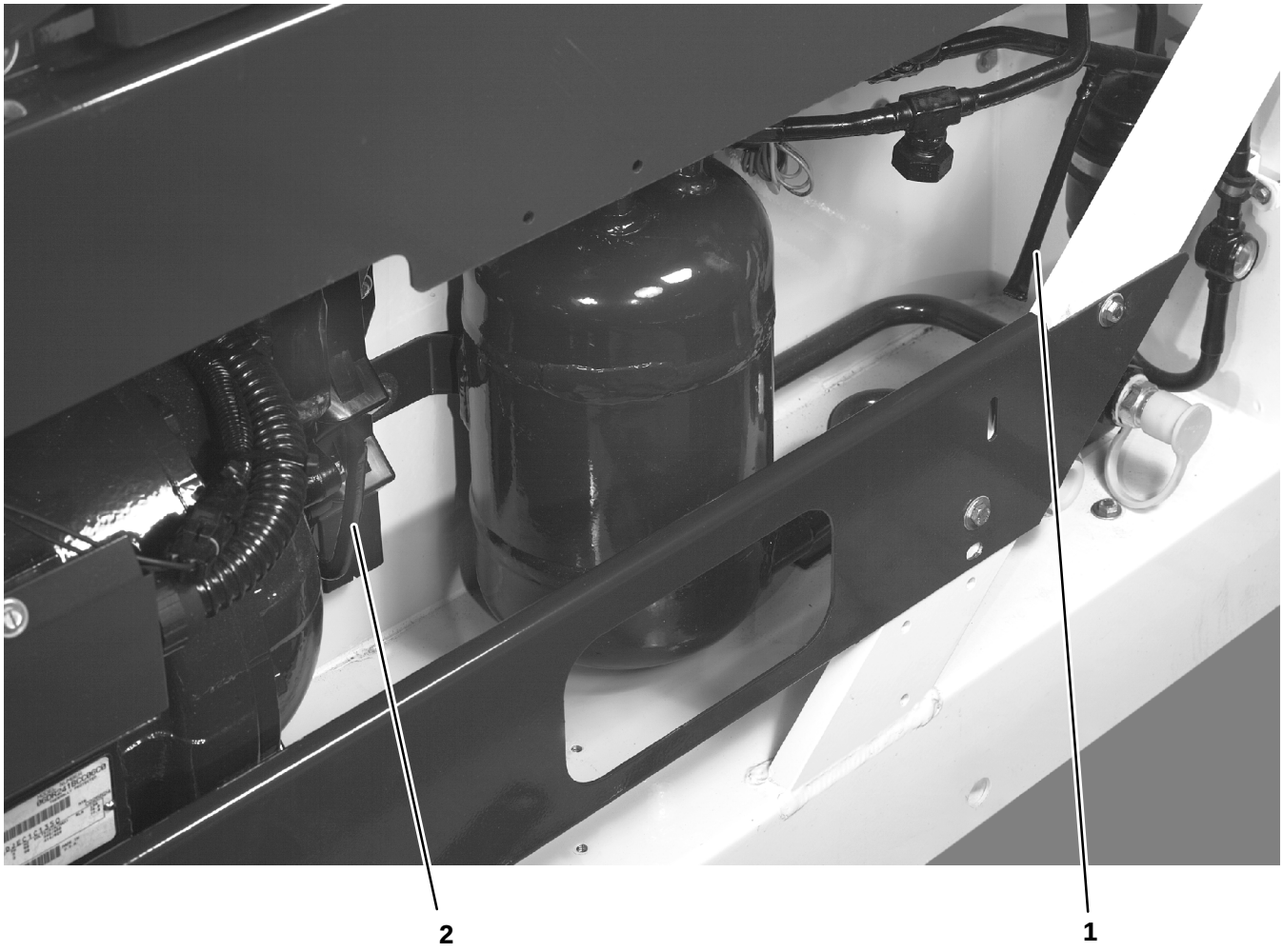
Do not remove the pinch-off tool from the process tubes until the following procedures are completed.

15. Using the tubing cutter, cut-off the excess tubing as close to the pinch-off tool as possible.

16. Use an oxyacetylene torch to braze the exposed end of the process tubes.

17. Remove the pinch-off tool and leak test the process tubes at the brazed end.

18. Install both baffle plates, then connect the tube clamp to the baffle plate on the liquid line process tube.



1. Liquid Line Process Tube
2. Suction Line Process Tube

Figure 6-4. Refrigerant Recovery Process Tubes

6.5 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.

b. If the system is without refrigerant, refer to sections 6.3 and 6.4 and, charge the system with refrigerant to build up pressure between 2.1 to 3.5 kg/cm@ (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 system.

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

d. Evacuate and dehydrate the unit. (Refer to section 6.6.)

e. Charge unit per section 6.7.

6.6 EVACUATION AND DEHYDRATION

6.6.1 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.

6.6.2 Preparation

a. Evacuate and dehydrate only after pressure leak test. (Refer to section 6.5.)

b. Install manifold gauges (refer to section 6.3), and recover the refrigerant (refer to section 6.4).

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

d. If possible, keep the ambient temperature above 15.6_C (60_F) to speed evaporation of moisture. If the 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.

e. To help speed up the evacuation procedure, replace the filter-drier with a section of 3/8 inch ID copper tubing.

6.6.3 Procedure

a. Remove all refrigerant using a refrigerant recovery system.

b. The recommended method to evacuate and dehydrate the system is to connect two evacuation hoses, as shown in Figure 6-5, to the vacuum pump and refrigeration unit. DO NOT use standard service hoses, as they are not suited for evacuation purposes. 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 manifold gauge hand valves 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. 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.

e. Break the vacuum with clean dry refrigerant gas. Use refrigerant specified for the unit. Raise system pressure to approximately 2 psig, monitoring it with the compound gauge.

f. Remove refrigerant using a refrigerant recovery system.

g. Repeat steps (e) through (g) one time.

h. 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 procedure checks for residual moisture and/or leaks.

i. 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 6.7)

6.7 REFRIGERANT CHARGE

6.7.1 Checking the Refrigerant Charge

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. In the U.S.A., refer to EPA section 608.

NOTE

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. The container temperature should be approximately 1.7_C (35_F) or –17.8_C (0_F).

a. Connect the gauge manifold to line piercing valves, refer to sections 6.2, 6.3 and 6.4.

b. Check charge only on air-cooled operation. Refer to Figure 6-37 for charts on compressor pressure.

c. If the discharge/suction pressures are within the normal operating system pressures, then the charge should be correct.

d. If the discharge/suction pressures are NOT within the normal operating system pressures, then refer to sections 5.2, 5.3, 5.7 and 5.11 for possible causes. If the unit is then determined to be low on refrigerant charge, refer to section 6.7.2 or 6.7.3.

6.7.2 Adding Refrigerant to System (Full Charge)

a. Evacuate unit and leave in deep vacuum. (Refer to section 6.6.)

b. Place cylinder of R-134a on scale and connect charging line from cylinder to the liquid line process tube. Purge charging line at liquid line and then note weight of cylinder and refrigerant.

c. Open liquid valve on cylinder. Open liquid line 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 6-9.

NOTE

It may be necessary to finish charging the unit through the suction line process tube in gas form, due to pressure rise in high side of the system. (Refer to section 6.7.3)

d. Backseat the manifold gauge port. Close liquid valve on cylinder.

e. Start unit in cooling mode. Run approximately 10 minutes and check the refrigerant charge. (Refer to section 6.7.1.)

6.7.3 Adding Refrigerant to System (Partial Charge)

a. Examine the unit refrigerant system for any evidence of leaks. Repair as necessary. (Refer to section 6.5.)

b. Maintain the conditions outlined in section 6.7.1.

c. Fully backseat the manifold gauge port.

d. Connect charging line between the suction line process tube and the cylinder of refrigerant R-134a. Open VAPOR valve.

e. Partially frontseat (turn clockwise) the manifold gauge valve and slowly add charge until the refrigerant appears at the proper level (refer to section 6.7.1).

6.7.4 Emergency Shipboard Refrigerant Charging Procedure

If the unit is not maintaining set point, refer to sections 5.2, 5.7 and 5.11 for possible causes. If the unit is then determined to be low on refrigerant charge, follow the steps below.

a. Perform step 6.7.1.a.

b. If the unit is operating on water-cooled condenser switch to air-cooled condenser operation, refer to section 2.6.1.

c. If set point is in a perishable range, temporarily lower the unit set point to ensure that the SMV is fully open for this procedure.

CAUTION

Make sure supply air temperature does not go below the original set point for more than five minutes, or damage to the load may occur.

d. Refer to the pressure temperature curves in Figure 6-37.

e. If the discharge/suction pressures are within the normal operating system pressures, then the charge should be correct.

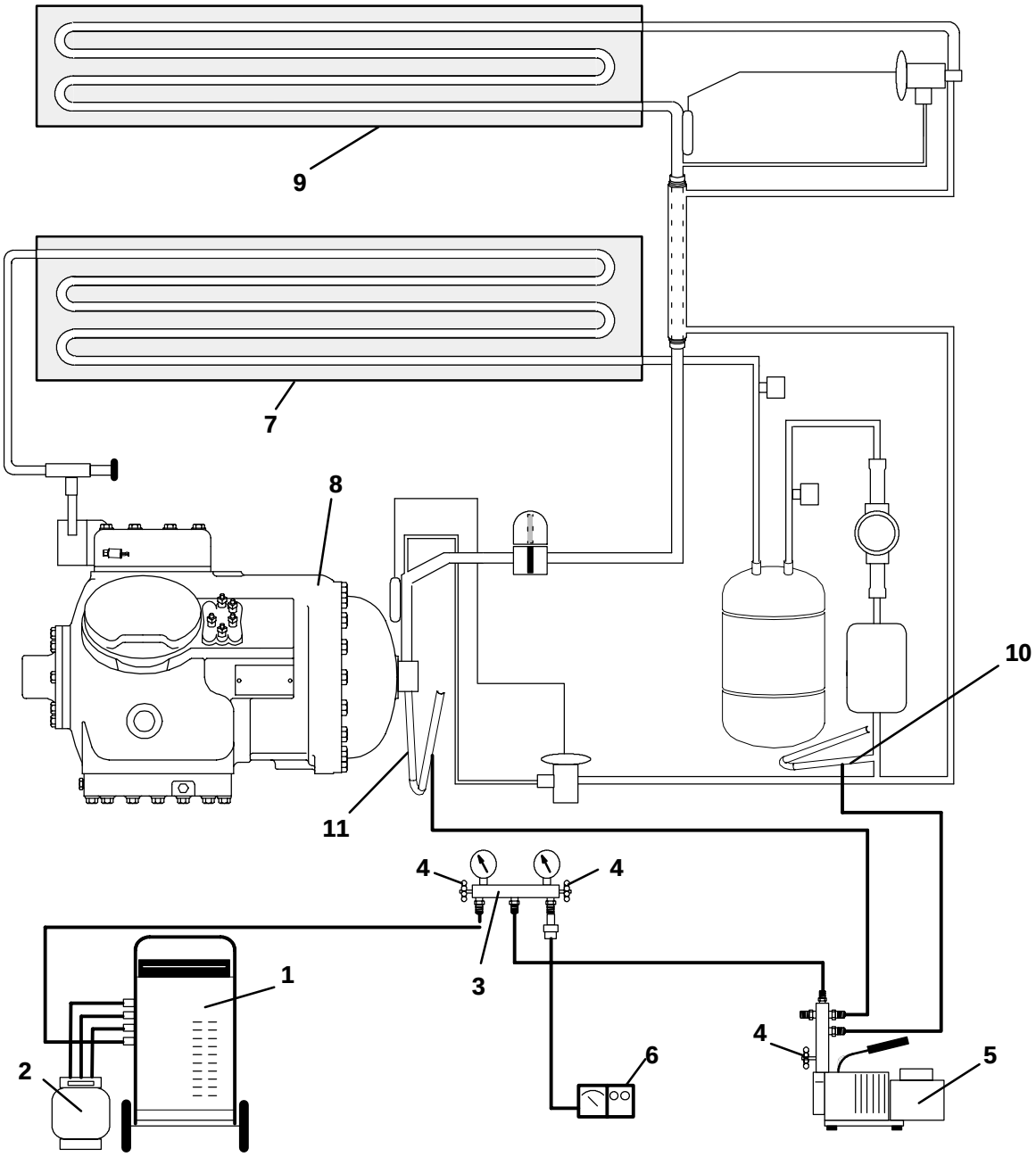
f. If the discharge pressure is more than ten psig below the curve, add three pounds of R-134a refrigerant through the suction line process tube.

g. Return set point to previous temperature setting.

h. The unit should be operating normally. Return to water-cooled operation, if necessary.

i. Leave piercing valves in place for Port repair.

j. Tag the unit for Port/Maintenance repair.



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

Figure 6-5. Vacuum Pump Connections

6.8 COMPRESSOR – MODEL 06DR

WARNING

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

NOTES

S The compressor should not operate in a vacuum greater than 500 mm Hg (20 inches Hg).

S The service replacement compressor is sold without terminal box and cover. Customer should retain the original terminal box, cover, and high pressure switch for use on replacement compressor.

S Check oil level in service replacement compressor. (Refer to sections 2.2 and 6.11.)

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

S Refer to Table 6-7 and Table 6-8 for applicable compressor wear limits and torque values.

S Refer to Figure 6-37 for charts on compressor pressure-temperature.

6.8.1 Removal and Replacement of Compressor

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

b. Remove all refrigerant using a refrigerant recovery system. (Refer to section 6.4)

c. Locate the compressor junction box. Remove wiring. Disconnect wiring from compressor terminals and remove compressor junction box.

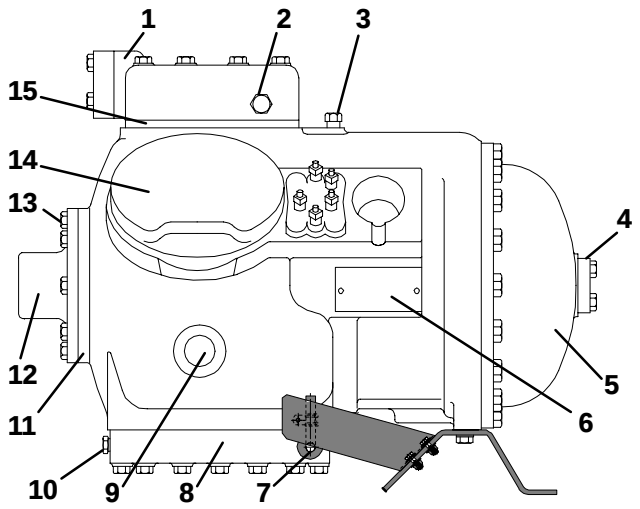
d. Remove bolts from suction and discharge flanges.

e. Remove compressor plate mounting bolts.

f. Remove compressor and mounting plate. Refer to section 2.2 for weight of compressor.

g. Remove high pressure switch (HPS) from compressor and check operation of switch (refer to section 6.13.2).

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



1. Discharge Flange
2. High Side Pressure Connection
3. Low Side Pressure Connection
4. Suction Flange
5. Motor End Cover
6. Serial/Model No. Plate
7. Crankcase Heater (Optional)
8. Bottom Plate
9. Sight Glass
10. Oil Drain Plug
11. Bearing Head
12. Oil Pump
13. Oil Fill Plug (Refer to section 6.11)
14. Cylinder Head
15. Valve Plate

Figure 6-6. Compressor – Model 06DR

i. Install replacement compressor terminal wiring kit, following instructions included with kit.

j. Install high pressure switch on compressor.

k. Install compressor and mounting plate in unit.

l. Connect junction box(es) to compressor and connect all wiring per wiring diagram. Install junction box cover(s).

m. Install new gaskets on suction and discharge flanges.

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

o. Install a new filter-drier. (Refer to section 6.12)

p. Attach manifold gauge set (with hand valves near vacuum pump) to the liquid line and suction line process tubes. Dehydrate and evacuate compressor to 500 microns (75.9 cm Hg vacuum = 29.90 inches Hg vacuum). *Turn off valves on both hoses to pump*.

q. Fully backseat (open) both hand valves of manifold gauge set.

r. Remove vacuum pump lines.

s. Start unit and check refrigerant charge. (Refer to section 6.7.1.)

t. Check moisture-liquid indicator for wetness. Change filter-drier if necessary. (Refer to section 6.12)

u. Check compressor oil level per section 6.11. Add oil if necessary.

6.9 COMPRESSOR DISASSEMBLY

WARNING

Before disassembly of the compressor make sure to relieve the internal pressure very carefully by slightly loosening the bolts on both suction and discharge flanges, then lightly tap the center of the valve flanges with a lead hammer to break the seal.

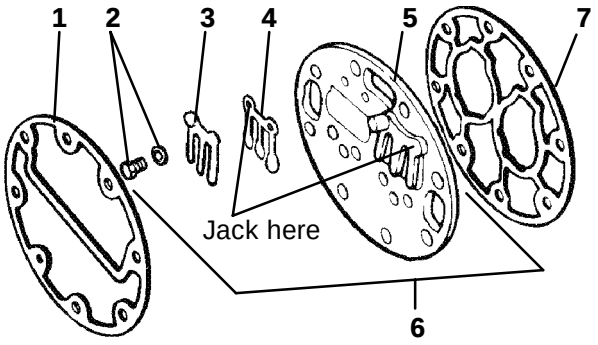
CAUTION

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 6-6 compressor illustration.) Refer to Table 6-7 and Table 6-8 for compressor wear limits and bolt torque values.

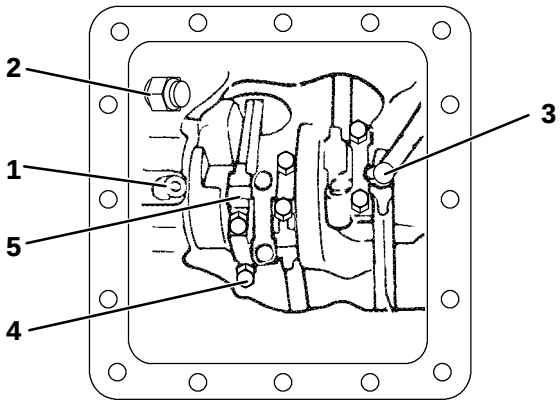
a. Place the compressor in a position where it will be convenient to drain the oil. Remove the oil plug on the oil pump inlet passage (see Figure 6-9 for location) to vent the crankcase. Loosen the drain plug (see Figure 6-6) in bottom plate and allow the oil to drain out slowly. Remove the plug slowly to relieve any crankcase pressure. Some units have a plug in the bottom center of the crankcase which may be removed for draining the motor end more quickly.

b. Remove cylinder head capscrews. If the cylinder head is stuck, tap the center of the cylinder head with a wooden or lead mallet. DO NOT STRIKE THE SIDE OF THE CYLINDER HEAD! Be careful not to drop the head or damage the gasket sealing surface. (See Figure 6-6 and Figure 6-7.) Remove cylinder head gasket.



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 6-7. Exploded View of Valve Plate



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

Figure 6-8. Bottom Plate Removed

c. Remove valve stops and valves. After they have been removed, free the valve plate from the cylinder deck by using the outside discharge valve hold-down capscrew as a jack screw through the tapped hole of the valve plate. Remove the valve plate gasket, see Figure 6-7, item 7.

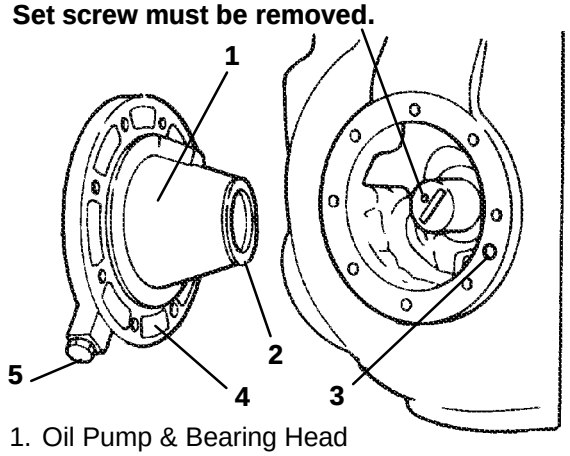
d. Turn the compressor on its side and remove the bottom plate and the oil suction screen hold down plate. Match mark each connecting rod cap and connecting rod for correct reassembly. Remove the bolts and connecting rod caps (see Figure 6-8). Push the piston rods up as far as they will go without having the piston rings extend above the cylinders.

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.

e. If necessary, remove the oil return check valve. Inspect it for check valve operation (flow in one direction only). Replace the assembly with a new unit if check valve operation is impaired. (See Figure 6-8.)

f. To remove the oil pump. Remove eight capscrews, oil pump bearing head assembly, gasket and thrust washer. (See Figure 6-9.)



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

Figure 6-9. Oil Pump and Bearing Head

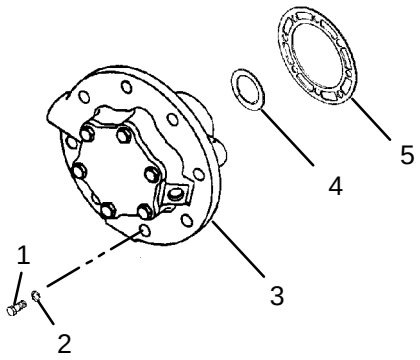
NOTE

If it was determined that the oil pump is not operating properly, the entire oil pump and bearing head assembly must be replaced. Replacement parts for the pump are NOT available. However, in the event the pump requires inspection or cleaning, disassemble and reassemble by referring to Figure 6-10. Clean all parts and coat all moving parts with compressor oil before proceeding with reassembly.

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, remove the cover horizontally and in line with the motor axis.

h. Remove the refrigerant suction strainer. If it is removed with ease it may be cleaned with solvent and replaced. (See Figure 6-11.) If the strainer is broken, corroded or clogged with dirt that is not easily removed, replace the strainer. Install new gaskets upon reassembly.

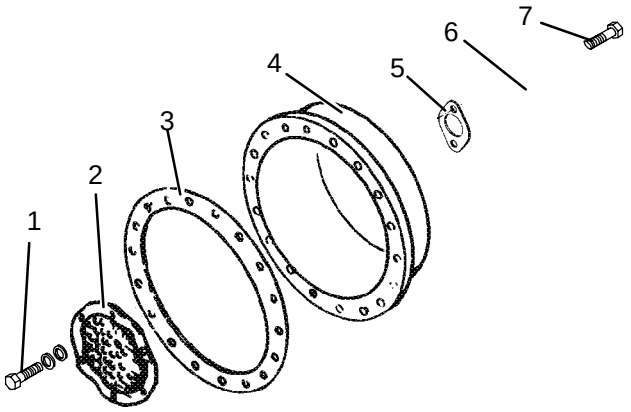
i. Block the compressor crankshaft so that it cannot turn. Use a screwdriver to bend back the tabs on the lockwasher and remove the equalizer tube. (See Figure 6-13.) The slinger at the end of the shaft draws vapor from the crankcase. It may discharge through a tee or a single equalizer tube.



1. Capscrew, Bearing Head
2. Gasket, Capscrew
3. Oil Pump and Bearing Head
4. Thrust Washer
5. Oil Pump Cover Gasket

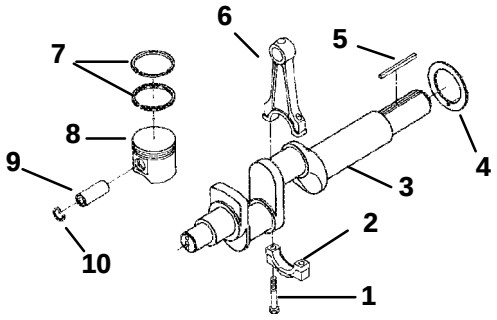
Figure 6-10. Low Profile Oil Pump

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



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

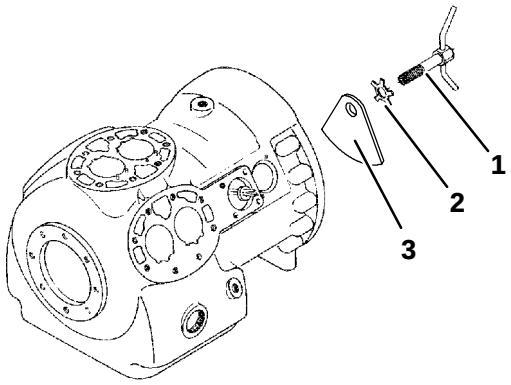
Figure 6-11. Motor End Cover



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

Figure 6-12. Crankshaft Assembly

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

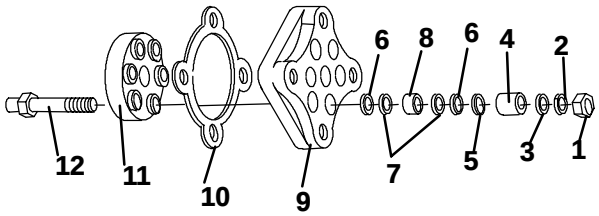


1. Equalizer Tube and Lockscrew Assembly
2. Lockwasher
3. Counterweight – Motor End

Figure 6-13. Removing Equalizing Tube and Lock Screw Assembly

Disassemble and assemble the terminal plate as shown in Figure 6-14.

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 a leak, tighten the terminal bushing nut only enough to stop the escape of gas. Do not tighten until the 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.



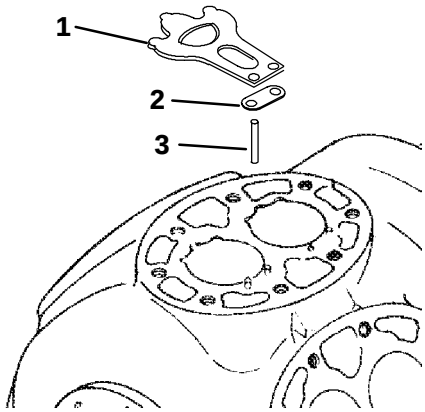
NOTE: Parts shown are for one terminal.

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 6-14. Terminal Mounting Assembly

6.10 COMPRESSOR REASSEMBLY

To clean compressor parts, use a suitable solvent with proper precautions. Coat all moving parts with the proper compressor oil before assembly. Refer to Table 6-8 for applicable compressor torque values.



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

Figure 6-15. 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 6-15) and will assume their original position when reinstalled. No two valves are likely to wear in exactly the same way. Never interchange used valves.

Do not omit the suction valve positioning springs. (See Figure 6-15.) 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 toward 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 approximately 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) respectively.

Compression ring

Figure 6-16. 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.

CAUTION

The set screw on the crankshaft must be removed for the oil pump installation (see Figure 6-9).

3. Install the pump end thrust washer on the two dowel pins located on the bearing head. (See Figure 6-9)

CAUTION

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

4. Install the bearing head assembly with a new gasket on the compressor crankshaft. Carefully push oil pump on by hand, ensuring that the thrust washer remains on the dowel pins. The tang on the end of the drive 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 and should be oriented as shown in Figure 6-17.
5. Align the gasket and install the eight capscrews in the mounting flange. Refer to Table 6-8 for applicable torque values.
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. Turn the shaft by hand to see that it moves freely.

7. Install the oil suction screen, the oil suction screen hold down plate and the bottom plate.

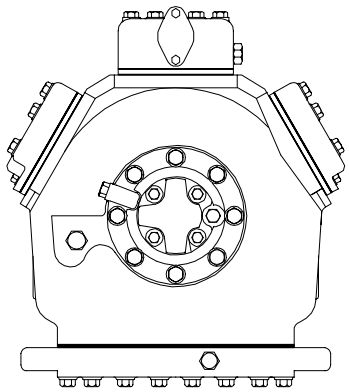


Figure 6-17. Compressor Oil Pump End View

6.11 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. Checking the Oil Level in the Compressor

1. Operate the unit in cooling mode 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 6.11.a.3.
3. Turn unit off to check the oil level. The correct oil level range should be between the bottom to one-eighth level of the sight glass. If the level is above one-eighth, oil must be removed from the compressor. To remove oil from the compressor, follow step d in this section. 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 liquid line process tube.

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 liquid line process tube (refer to sections 6.3 and 6.4), and immerse the common connection of the gauge manifold in an open container of refrigeration oil. Crack the manifold 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, SLOWLY frontseat the manifold liquid hand valve and induce a vacuum in the compressor crankcase. Oil will flow through the liquid line process tube into the compressor. Add oil as necessary.

Run unit for 20 minutes in cooling mode. Check oil level at the compressor sight glass.

c. Adding Oil to Service Replacement Compressor

NOTES

- The correct oil charge is 3.6 liters (7.6 U.S. pints).
- Service replacement compressors are shipped without oil.
- When first adding oil to the compressor, add only three liters (6.3 pints) to the compressor. Run the unit for 20 minutes in cooling mode. Check the oil level in the compressor sight glass. Add oil as necessary. This procedure is designed to compensate for excess oil that may have migrated with refrigerant to other parts of the system during unit operation.

If compressor is without oil:

If oil is present in the compressor, ensure that it is the correct oil. Add oil (refer to sections 2.2 and 6.11) through the oil fill plug. (See Figure 6-6.) Some compressors have the oil plug located on the crankcase, at the right or left side of the oil pump.

d. Removing Oil from the Compressor

1. If the oil level recorded in step a.3 is above one-eighth level of the capacity of the sight glass, oil must be removed from the compressor.
2. Close (frontseat) the manifold liquid hand valve and pump unit down to 1.2 to 1.3 kg/cm@ (2 to 4 psig). Frontseat the manifold vapor hand 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 correct level (maximum is one-eight level of the sight glass). Replace the plug securely back into the compressor.
4. Repeat step (a) to ensure proper oil level.
5. Return the system to its hermetic state by referring to section 6.4.

6.12 FILTER-DRIER

On units equipped with a water-cooled condenser, if the sight glass appears to be flashing or bubbles are constantly moving through the moisture liquid indicator/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.

a. To Check Filter-Drier

1. Test for a restricted or plugged filter-drier 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.
2. A second test for moisture in the filter-drier is that the moisture-liquid indicator shows moisture in the system.

b. To Replace Filter-Drier

WARNING

Residual system oil can cause a fire and potential injury. To avoid the possibility of an oil fire when replacing the filter drier use the following procedure.

Oil Fire extinguishing source is REQUIRED to be at your disposal during the repair.

NOTE

Run unit in a FULL COOL operation for 20 minutes before beginning Procedure. This will circulate the majority of the oil back to the compressor.

1. Recover refrigerant (refer to section 6.4) and replace filter-drier. Do not allow contaminants and moisture into the system.
2. Evacuate the unit per section 6.6.
3. After unit is in operation, inspect for moisture in system.
4. Remove strap from around the filter drier.
5. Using a small tube cutter, cut the liquid line just below the moisture–line indicator. Make the cut just below the brazed joint of the moisture–line indicator and U–tube. Approximately, 1 inch below the brazed joint. Refer to Figure 6-18.

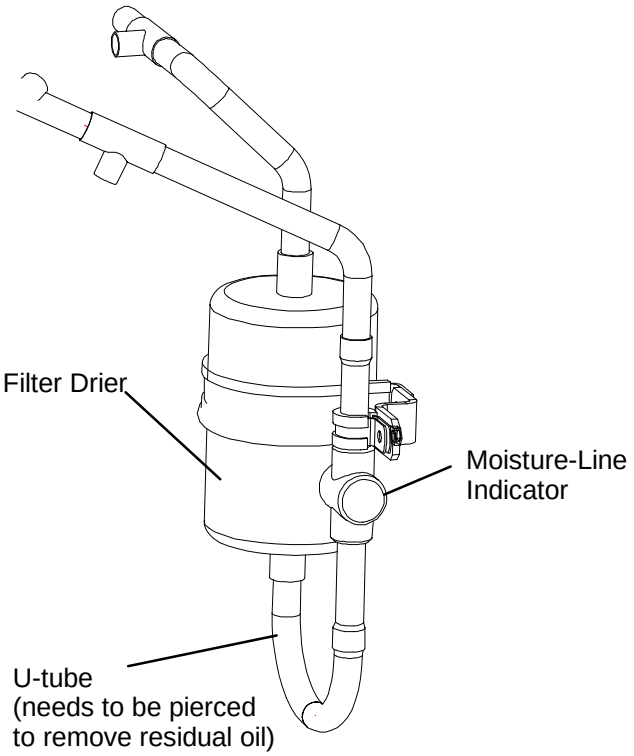


Figure 6-18. Filter-Drier and U-tube

6. Using the small tube cutter, cut the U–tube just below the filter drier, and remove the old U–tube completely.
7. Allow oil to drain.

WARNING

Due to the nature of refrigeration systems, there may be some residual oil. There is still a potential for fire. Be prepared to extinguish the fire.

8. Braze out the filter drier and remains of the U–tube, use kit P/N 76–50085–00 and braze in the new Filter Drier and U–tube.

NOTE

Place a clean rag moistened with clean water on the Moisture line indicator. This will help prevent any heat damage to the indicator.

9. Install strap on filter drier.
10. Use an abrasive cloth to clean all brazed joints.
11. Apply paint to all brazed joints and any other areas that there is bare metal.
12. Finish process of Evacuation and Dehydration of the system. Then recharge the system. Refer to section 6.7.

6.13 HIGH PRESSURE SWITCH (HPS)

6.13.1 Replacing High Pressure Switch

a. Turn unit start-stop switch OFF. Recover refrigerant (refer to section 6.4).

b. Disconnect wiring from defective switch. The high pressure switch is located on the center head and is removed by turning counterclockwise. (See Figure 2-3 for location of HPS.)

c. Install a new high pressure switch after verifying switch settings. (Refer to section 6.13.2.)

d. Evacuate and dehydrate the compressor per section 6.6.1.

6.13.2 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 6.13.1.

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

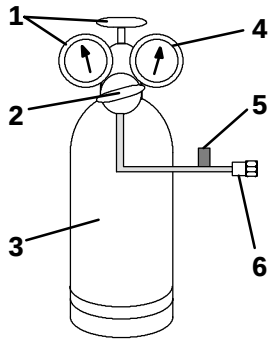
c. Connect hose to a cylinder of dry nitrogen. (See Figure 6-19.)

d. Set nitrogen pressure regulator at 26.4 kg/cm@ (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 25 kg/cm@ (350 psig). If a light is used, light will go out. If an ohmmeter is used, the meter will indicate open circuits.

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



1. Cylinder Valve and Gauge
2. Pressure Regulator
3. Nitrogen Cylinder
4. Pressure Gauge
(0 to 36 kg/cm@ = 0 to 400 psig)
5. Bleed-Off Valve
6. 1/4 inch Connection

Figure 6-19. Typical Setup for Testing High Pressure Switch

6.14 EVAPORATOR COIL AND HEATER ASSEMBLY

The evaporator section, including the coil, should be cleaned regularly. The preferred cleaning fluid is fresh water or steam. Another possible cleaner is Oakite 202 or similar, 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.

a. To Replace the Evaporator Coil

1. Recover refrigerant (refer to section 6.4).
2. With power OFF and power plug removed, remove the screws securing the panel covering the evaporator section (upper panel).
3. Disconnect the defrost heater wiring.
4. Disconnect the sensor from the coil. The defrost termination sensor (DTS) is located on the middle coil support as shown in Figure 2-2.
5. Remove middle coil support.

6. Remove the mounting hardware from the coil.

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

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

9. Install coil assembly by reversing above steps.

10. Leak check connections per section 6.5. Evacuate the unit per section 6.6 and add refrigerant charge per section 6.7.2.

6.15 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, and that the power plug and cable are disconnected.

a. Remove the lower access panel (Figure 2-1) by removing the T.I.R. locking device lockwire and mounting screws.

b. Determine which heater(s) need replacing by checking resistance on each heater as shown in section 2.3.

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

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

6.16 EVAPORATOR FAN AND MOTOR ASSEMBLY

The evaporator fans circulate air throughout the container by pulling air in through 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 2.3.) The fan motor bearings are factory lubricated and do not require additional grease.

a. Replacing the Evaporator Fan Assembly

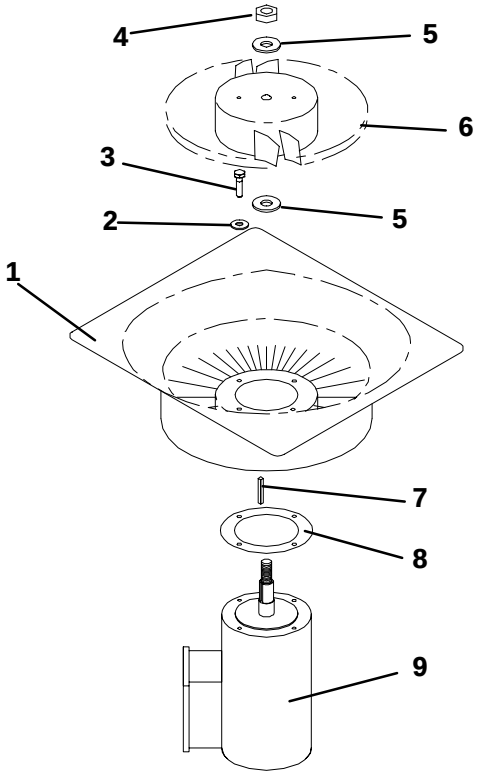
WARNING

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

1. Remove upper access panel (see Figure 2-1) by removing mounting bolts and T.I.R. locking device. Reach inside of unit and remove the Ty-Rap securing the wire harness loop. Then unplug the connector by twisting to unlock and pulling to separate.
2. Loosen four 1/4-20 clamp bolts that are located on the underside of the fan deck at the sides of the of the fan assembly. Slide the loosened clamps back from the fan assembly.
3. Slide the fan assembly out from the unit and place on a sturdy work surface.

b. Disassemble the Evaporator Fan Assembly

1. Attach a spanner wrench to the two 1/4-20 holes located in the fan hub. Loosen the 5/8-18 shaft nut by holding the spanner wrench stationary and turning the 5/8-18 nut counter-clockwise (see Figure 6-20).
2. Remove the spanner wrench. Use a universal wheel puller and remove the fan from the shaft. Remove the washers and key.
3. Remove the four 1/4-20 x 3/4 long bolts that are located under the fan that support the motor and stator housing. Remove the motor and plastic spacer.



1. Stator
2. Flat washer, 1/4
3. Bolt, 1/4-20 x 3/4
4. Locknut, 5/8-18
5. Flat washer, 5/8
6. Impeller Fan
7. Key
8. Mylar Protector
9. Evaporator Motor

Figure 6-20. Evaporator Fan Assembly

c. Assemble the Evaporator Fan Assembly

1. Assemble the motor and plastic spacer onto the stator.
2. Apply loctite to the 1/4-20 x 3/4 long bolts and torque to 0.81 mkg (70 inch-pounds).
3. Place one 5/8 flat washer on the shoulder of the fan motor shaft. Insert the key in the keyway and lubricate the fan motor shaft and threads with a graphite-oil solution (such as Never-seez).
4. Install the fan onto the motor shaft. Place one 5/8 flat washer with a 5/8-18 locknut onto the motor shaft and torque to 40 foot-pounds.
5. Install the evaporator fan assembly in reverse order of removal. Torque the four 1/4-20 clamp bolts to 0.81 mkg (70 inch-pounds) Apply power momentarily to check for proper fan rotation (refer to section 2.3). If fan spins backward, then motor wiring or motor is defective.
6. Replace access panel making sure that panel does not leak. Make sure that the T.I.R. locking device is lockwired.

6.17 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 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), or –5_C (+23_F) optionally, should cause the motor to run in high speed.

NOTE

The evaporator fan motors will always start in high speed.

Controller settings below –10_C (+14_F), or –5_C (+23_F) optionally, should cause the motor to run in low speed.

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

3. Motor not starting, and IP-EM's are not tripping.

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. The 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 2-1). For removal of the evaporator fan assembly, refer to section 6.16.

WARNING

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

c. Checking the capacitor

If the capacitor is suspected of malfunction, you may choose to simply replace it. Direct replacement requires a capacitor of the same value. Two methods for checking capacitor function are:

1. 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.

2. 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 are its ability to locate capacitors that have failed to hold their microfarad ratings, or those that are breaking down internally during operation. It is also useful in identifying capacitors when their microfarad rating marks have become unreadable.

6.18 CONDENSER COIL

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

WARNING

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

a. To Replace Condenser Coil

1. Remove the refrigerant charge per section 6.4.
2. Remove the condenser coil guard.
3. Unsolder discharge line and remove the line to the receiver or water-cooled condenser (if so equipped).
4. Remove coil mounting hardware and remove the coil.
5. Install replacement coil and solder connections.
6. Leak-check the coil per section 6.5. Evacuate the unit per section 6.6, then charge the unit with refrigerant per section 6.7.1.

6.19 CONDENSER FAN AND MOTOR ASSEMBLY

WARNING

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

The condenser fan rotates counter-clockwise (viewed from front of unit), pulls air through the the condenser coil, and discharges horizontally through the front of the unit. To replace motor assembly:

a. Open condenser fan screen guard.

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

CAUTION

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

c. Remove motor mounting hardware and replace the motor. It is recommended that new locknuts be used when replacing motor. Connect wiring per wiring diagram.

d. Install fan loosely on motor shaft (hub side in). DO NOT USE FORCE. If necessary, tap the hub only, not the hub nuts or bolts. Install venturi. Apply “Loctite H” to fan set screws. Adjust fan within venturi so that the outer edge of the fan projects 3.2 to 6.4 mm (3/16” ¦ 1/16”) back from edge of the venturi. Spin fan by hand to check clearance.

e. Close and secure condenser fan screen guard.

f. Apply power to unit and check fan rotation. If fan motor rotates backward, reverse wire numbers 5 and 8.

6.20 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.

6.21 POWER AUTOTRANSFORMER (TRANS) – Optional

If the unit does not start, check the following:

a. Make sure the 460 vac (yellow) power cable is plugged into the receptacle (item 3, Figure 2-7) and locked in place.

b. Make sure that circuit breakers CB-1 and CB-2 are in the "ON" position. If the circuit breakers do not hold in, check voltage supply.

c. There is no internal protector for this particular transformer design, therefore, no checking of the internal protector is required.

d. Using a voltmeter, and with the primary supply circuit ON, check the primary (input) voltage (460 vac). Next, check the secondary (output) voltage (230 vac). The transformer is defective if voltage is not available.

6.22 TRANSFORMER BRIDGING UNIT (TBU)

The transformer bridging unit (TBU) will reduce attenuation (i.e., loss of signal power in a transmission) that occurs when a high frequency remote monitoring unit (RMU) signal is passed through an autotransformer. The TBU allows high frequency remote monitoring signals to effectively bypass the 460/230 vac autotransformer (TRANS).

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, and that the power plug and cable are disconnected.

If the device does not appear to be functioning, check the following:

a. Make sure power to the unit is OFF.

b. Refer to Figure 2-7 for the location of TBU.

c. Disconnect the TBU from across the autotransformer. This will isolate the device and allow for accurate measurements.

d. Using a capacitor meter (i.e., Fluke 87), measure between L1 and L1, L2 and L2, L3 and L3.

e. The readings should be 0.44 μF, plus or minus 14%.

f. If the readings do NOT fall in the above described range, the device must be replaced.

NOTE

An ohmmeter may be used as a cross check for shorted capacitors in the TBU. However, it will NOT accurately check for an open capacitor; as the ohmmeter will read open for both good or open capacitors.

6.23 SENSOR CHECKOUT PROCEDURE (AMBS, DTS, RRS, RTS, SRS & STS)

An accurate ohmmeter must be used to check the resistance values shown in Table 6-5.

Due to the variations and inaccuracies in ohmmeters, thermometers or other test equipment, a reading within 2% of the chart value would indicate a good sensor. If a sensor is defective, the resistance reading will usually be much higher or lower than the resistance values given in Table 6-5.

6.23.1 Checking Sensor (RRS, RTS, SRS or STS)

a. Place the sensor (sensing bulb) in a 0_C (32_F) ice-water bath. The 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) measured on a laboratory thermometer.

b. Start unit and check air temperature/data readout on the control panel. The reading should be 0_C (32_F); if it is not, continue on to the following step.

c. Turn unit OFF and disconnect power supply.

d. Refer to section 6.27 for removal of the Controller module.

RTS or STS:

Using the plug connector marked "EC" that is connected to the Controller module. Locate the wires marked RTS or STS, depending on which sensor needs to be replaced. Follow that wire to the connector and using the pins of the plug, measure the ohms resistance. Readings are shown in Table 6-5.

RRS or SRS:

Using the plug connector marked "EC" that is connected to the Controller module. Locate the wires marked RRS or SRS, depending on which sensor needs to be replaced. Follow that wire to the connector and using the pins of the plug, measure the ohms resistance. Readings are shown in Table 6-5.

6.23.2 Replacing Sensor (STS and SRS)

To properly position a unit supply sensor, the sensor must be fully inserted into the probe holder. This positioning will give the sensor the optimum amount of exposure to the supply air stream, and will allow the Controller to operate correctly. Insufficient probe insertion into the probe holder will result in poor temperature control due to the lack of air flow over the sensor.

It is also necessary to ensure that the probe tip does not contact the evaporator back panel. The design minimum clearance of 6 mm (1/4 inch) should be maintained (see Figure 6-21).

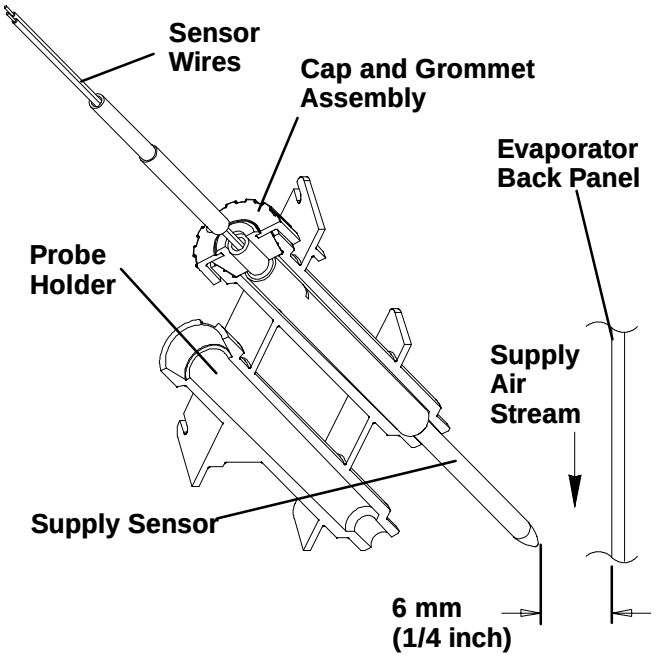


Figure 6-21. Supply Sensor Positioning

a. Turn unit power OFF and disconnect power supply.

b. Remove and save any cover (if present) over wiring and probe holder.

c. Cut cable 5 cm (2 inches) from shoulder of defective sensor and discard the defective probe only. Save cap and grommet assembly for reuse on the replacement probe. **Do not cut the grommet.**

d. Cut one wire of existing cable 41 mm (1-5/8 inches) shorter than the other wire.

e. Cut one replacement sensor wire (opposite color) back 41 mm (1-5/8 inches). (See Figure 6-22.)

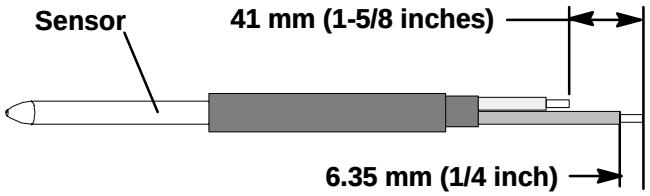


Figure 6-22. Sensor (RRS, RTS, SRS or STS)

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

g. Slide a large piece of heat shrink tubing over the cable, and place the two small pieces of heat shrink tubing, one over each wire, before adding crimp fittings as shown in Figure 6-23.

h. Slide the cap and grommet assembly, which was saved in step (c.), onto the replacement sensor.

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

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

k. Slide heat shrink tubing over splice so that both ends of tubing cover both ends of crimp as shown in Figure 6-23.

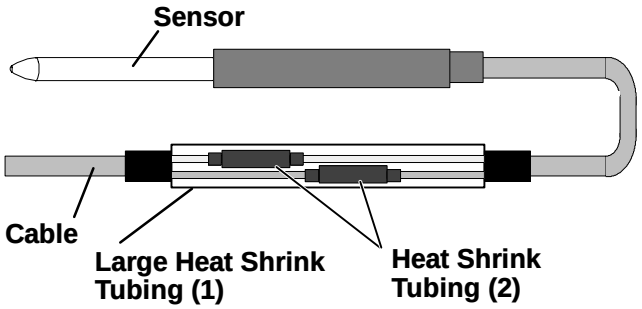


Figure 6-23. Sensor and Cable Assembly (RRS, RTS, SRS or STS)

l. 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.

m. Slide large heat shrink tubing over both splices and shrink tubing and heat as in step (l.).

CAUTION

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

n. Position sensor in unit per Figure 6-21 and check sensor resistance as detailed in section 6.23.1.

o. Reinstall the cover (if present) that was removed in step (b.) over wiring and probe holder.

NOTE

The P5 Pre-Trip test must be run to inactivate the alarm (refer to section 3.2.1).

6.23.3 Replacing Sensor (RRS and RTS)

a. Turn unit power OFF and disconnect power supply.

b. Cut cable 5 cm (6 inches) from shoulder of defective sensor and discard the defective probe only.

c. Cut one wire of existing cable 41 mm (1-5/8 inches) shorter than the other wire.

d. Cut one replacement sensor wire (opposite color) back 41 mm (1-5/8 inches). (See Figure 6-22.)

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

f. Slide a large piece of heat shrink tubing over the unit cable, and place the two small pieces of heat shrink tubing, one over each wire, before adding crimp fittings as shown in Figure 6-23.

g. Slip crimp fittings over dressed wires (keeping 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 6-23.

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).

CAUTION

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

l. Check sensor resistance as detailed in section 6.23.1.

m. Reinstall the return sensor as shown in Figure 6-24. For proper placement of the return sensor, be sure to position the enlarged positioning section of the sensor against the the side of the mounting clamp.

NOTE

The P5 Pre-Trip test must be run to inactivate the alarm (refer to section 3.2.1).

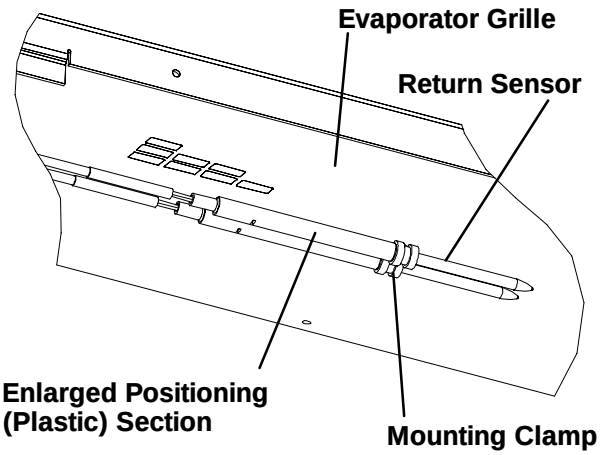


Figure 6-24. Return Sensor Positioning

6.23.4 Checking Sensor (AMBS or DTS)

a. Turn unit OFF and disconnect power supply.

b. Refer to section 6.27 for removal of the Controller module.

AMBS or DTS:

Using the plug connector marked "EC" that is connected to the Controller module. Locate the wires marked AMBS or DTS, depending on which sensor needs to be replaced. Follow that wire to the connector and using the pins of the plug, measure the ohms resistance. Readings are shown in Table 6-5.

6.23.5 Replacing Sensor (AMBS or DTS)

a. Turn unit power OFF and disconnect power supply.

b. Cut wires to 25.4 cm (10 inches) from the back of the mounting stud of the defective sensor and discard.

c. Cut one of the two wires from step b 25.4 mm (1.0 inch) shorter than the other wire.

d. Cut one replacement sensor wire back 25.4 mm (1.0 inch). (See Figure 6-25.)

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

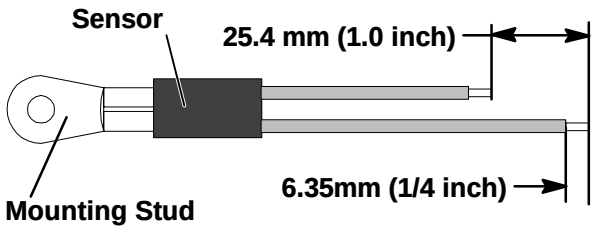


Figure 6-25. Sensor (AMBS or DTS)

f. Slide two small pieces of heat shrink tubing over each wire before adding crimp fittings as shown in Figure 6-26.

g. Slip crimp fittings over dressed wires. 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 6-26.

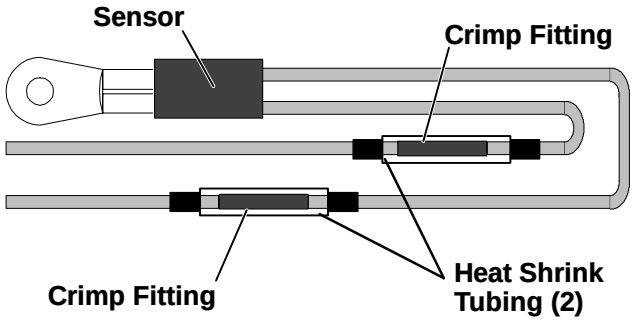


Figure 6-26. Sensor and Wire Assembly (AMBS or DTS)

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.

CAUTION

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

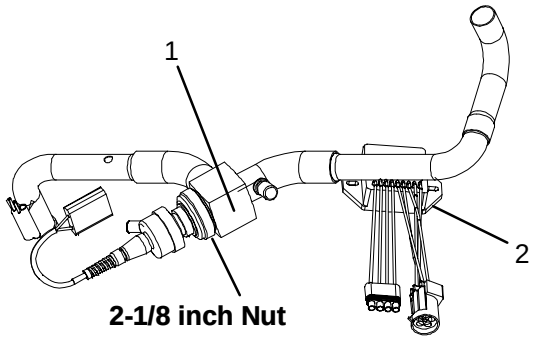
k. Secure sensor to unit and check sensor resistance as detailed in section 6.23.4.

NOTE

The DTS sensor must have "Presstite" insulating material placed completely over the sensor to insure proper function of the sensor.

6.24 STEPPER MOTOR SUCTION MODULATION VALVE (SMV)

On start up of the unit, the valve will reset to a known open position. This is accomplished by assuming the valve was fully open, driving it fully closed, resetting the percentage open to zero, then opening to a known 21% staging position. This makes the unit ready to start and normal operation will begin.



1. Stepper Motor Suction Modulation Valve (SMV)
2. Drive Module (SD)

Figure 6-27. Stepper Motor Suction Modulation Valve (SMV)

a. Pre-Check procedure

1. Check unit for abnormal operation.
2. Check charge. If refrigerant is low repair as required and again check operation.
3. If sufficient capacity cannot be maintained or unit is tripping excessively on high pressure switch (HPS) in high ambients, check coil and clean if required.

If capacity or control cannot be maintained turn unit OFF, then back ON. This will reset the valve in the event the controller lost communication with the valve, and may correct the problem.

NOTE

Carefully listen to the valve. During reset, the valve will make a ratcheting noise that may be heard or felt (this depends upon background noise) as it is attempting to close. If this can be heard or felt, it indicates that the controller and drive module are attempting to close the valve, and may serve as a quick indication that the drive module is in working order.

During the first few minutes of unit operation, compressor reliability enhancement logic (CREL) may

be in effect. This places the valve at a 21% staging position and is sufficient to drive the temperature of the supply probe down several degrees during this interval.

After the CREL time-out has been met, the valve will start responding to the control logic and open or close, relative to the demand. Scrutinize the unit operation for a few minutes. While in pulldown the unit will open the SMV to a maximum discharge pressure of 350 psig in high ambient conditions, or as much as the current setting and control logic will allow. The current level should be high. A lower discharge pressure will be seen in lower ambient temperatures. Once the unit has reached set point, the SMV will go into control mode. Both the discharge/suction pressures, and current draw will go significantly lower. Once below set point, the suction pressure should go into a vacuum within several minutes. Should the operation differ as mentioned, the SMV or drive module may be faulty.

4. Attach a manifold gauge set, refer to section 6.1.

Perishable operation:

If the operation of the unit is in question, place the set point to approximately 6°C (11°F) less than the current box temperature, so the unit goes into pulldown. Run the unit for approximately one minute. Record readings on gauges and current draw. The current draw and pressures should go up. Place set point to 0.5°C (0.9°F) above current box temperature to fully modulate valve, and run for approximately one minute.

NOTE

The unit may shut off for a short time. Wait until the unit self starts and sufficient time has elapsed to cause the valve to fully modulate.

Record new gauge readings and current draw. The suction pressure should go into a vacuum and the current draw should have gone down. If little or no change to the suction pressure or current draw occurs, this is an indication of a malfunctioning SMV.

Frozen operation:

In frozen mode the valve will tend to stay open as much as possible. Again, this is dependent upon current limit setting and control logic. Turn the unit OFF and ON, as in the perishable mode, and watch the gauges. The valve will run at 21% open if CREL logic is active, and will open to maximum allowable after this. Dependent on ambient conditions, there should be an increase in suction pressure and current draw as the valve opens, however, this may be difficult at times to fully determine.

5. If the unit still does not operate properly, stop unit, and check out the SMV system, refer to section 6.24.b.

b. Checking the Stepper valve

Disconnect the four pin connector to the stepper SMV. With a reliable digital ohmmeter, check the winding resistance. In normal ambient, the valve should have 72 to 84 ohms measured on the red/green (a-b terminals) and on the white/black (c-d terminals) leads. If an infinite or zero reading occurs, check connections and replace the motor. If near normal or normal reading occurs, refer to section 6.24.e.

c. SMA-12 portable stepper drive tester

The SMA-12 portable stepper drive tester (P/N 07-00375-00) is a battery operated stepper drive which will allow opening and closing of the SMV, which allows a more thorough check of the motor.

To check operation:

1. Stop the unit, disconnect the four pin connector from the stepper module to the valve located on the suction line near the valve, and attach the SMA-12 stepper drive to the connector going to the valve.
2. Set the SMA-12 pulse per second (PPS) to one PPS and either open or close valve. Each LED should light sequentially until all four are lit. Any LED failing to light indicates an open on that leg which indicates a poor connection or an open coil. Repair or replace as required to achieve proper operation.
3. Restart unit, set the step rate to 200 PPS on SMA-12 for the valve, and close stepper valve while watching the suction gauge. Within one minute the suction pressure will go into a vacuum. This is an indication that the valve is moving.
4. If no change in suction pressure is detected, check for resistance (refer to section 6.24.b.), and check connections for proper continuity and retest. If the valve is functioning and all connections and motor resistance are good, check the drive module. (Refer to section 6.24.d.)
5. If the valve is determined as faulty after completing the above steps, perform a high side pump down. Remove valve powerhead assembly, and replace with a NEW valve powerhead assembly, torque nut to 35 ft-lb, evacuate low side, and open all valves.

WARNING

DO NOT disassemble piston from NEW powerhead assembly! Doing so may result in damage to piston.

d. Checking the Drive Module

1. Turn unit OFF.
2. Disconnect the four pin connector to stepper SMV.
3. Attach the positive lead of a AC volt meter, and set to read up to 24 volts to outlet pin "A" (1A) of the four pin connector and the negative lead to the "B" pin (1B).
4. Turn ON unit for 40 seconds, and watch the volt meter. There should be approximately 9 to 12 volts shown on the meter.
5. Repeat for pins "C" and "D" (pins 2 A and 2 B).
6. If only one set of pins reads a voltage, check connections and retest.
7. If the retest reads out the same, the drive module or controller is faulty.
8. If no voltage is present in any step, the output from the controller to the drive module may be faulty, and will require checking the connections and wires from the controller to the drive module. Refer to section 6.24.e.
9. To replace the drive module, disconnect all connectors, unscrew from mounting, and replace with a NEW drive module in reverse order.

e. Checking the Controller

1. Turn the unit OFF.
2. Disconnect the six pin connector to the stepper drive from the controller.
3. Attach the positive lead of a DC voltmeter set to read up to 50 VDC to outlet pin "A" of the six pin connector, and the negative lead to TP-9 of controller or pin "B" (GD).
4. Turn ON the unit for 40 seconds, and watch the voltmeter. There should be approximately 24 to 32 VDC shown on "A" pin (DC).
5. There should be zero volts on pin "B" (GD).
6. There should be approximately 24 to 32 VDC on pin "E" (ON).
7. Pins "C" and "D" will have zero to 5 volts transistor logic (TTL) signals present, however, this can only be checked with the connector assembled as this is an open collector type circuit.

By checking the outputs on "A," "B," and "E" it can be verified that the controller is attempting to communicate with the drive module. To be thorough, and if it is desired, the TTL signals on pins "C" and "D" can be checked as follows:

- Make up a jumper assembly in which the drive module and controller connectors can be joined as in Figure 6-28 with the jumper completing the circuits from the controller to the drive module.
- Remove the insulation from a one inch section of wire, which join the two connector halves.
- Connect the positive lead of the voltmeter to the bare section of wire "C" and "B," and run as before by resetting unit.
- Repeat for wires "D" and "B."

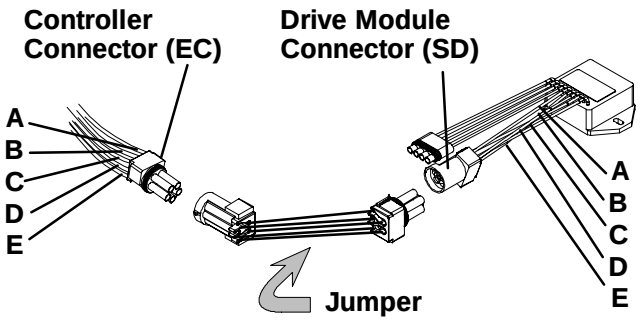


Figure 6-28. Jumper Assembly

There should be approximately five volts DC on pins "C" and "D" (S1 and S2) when measured as above. If not the connections or controller is faulty.

If any of these pins are not consistent, the connections or controller is suspect. Check and replace as required.

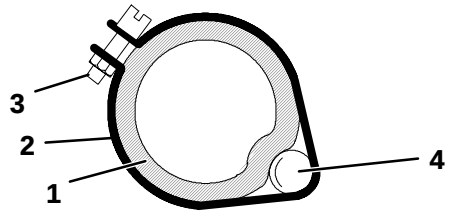
6.25 HERMETIC THERMOSTATIC EXPANSION VALVE

The thermal expansion valve (see Figure 6-30) is an automatic device which maintains constant superheat of the refrigerant gas leaving the evaporator, regardless of suction pressure.

The valve functions are:

- Automatic response of the refrigerant flow to match the evaporator load.
- Prevention of liquid refrigerant entering the compressor.

Unless the valve is defective, it seldom requires any maintenance other than minor periodic maintenance to insure that the thermal bulb is tightly secured to the suction line and wrapped with "Presstite." (See Figure 6-29)



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

Figure 6-29. Hermetic Thermostatic Expansion Valve Bulb

a. Checking Superheat

NOTE

Proper superheat measurement should be completed at –18_C (0_F) container box temperature where possible.

1. Open the heater access panel to expose the expansion valve (see Figure 2-1).

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

3. Connect an accurate gauge to the piercing valve on the liquid line process tube (refer to sections 6.2, 6.3 and 6.4).

4. Set the temperature set point to –18_C (0_F), and run unit until unit has stabilized.

5. From the temperature/pressure chart (Table 6-9), determine the saturation temperature corresponding to the evaporator outlet test pressure at the suction modulation valve.

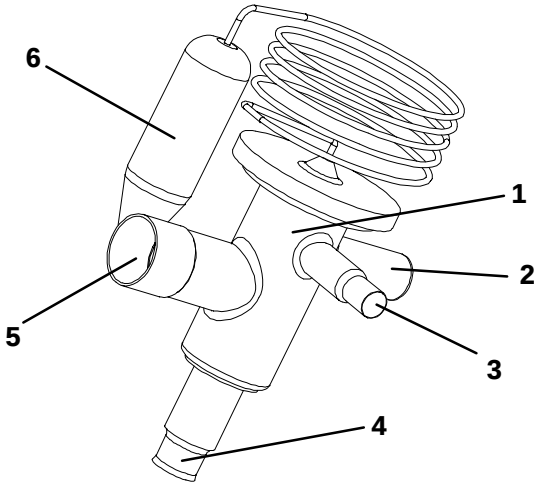
6. Note the temperature of the suction gas at the expansion valve bulb.

   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.

b. Removing the Expansion Valve

NOTES

- The hermetic TXV does NOT have adjustable superheat.
- All connections on the hermetic TXV are bi–metallic, copper on the inside and stainless on the outside.
- All joints on the hermetic TXV (inlet, outlet and equalizer lines) are brazed.
- Bi–metallic connections heat up very quickly.



1. Hermetic Thermostatic Expansion Valve
2. Non-adjustable Superheat Stem
3. Equalizer Connection
4. Inlet Connection
5. Outlet Connection
6. Hermetic Expansion Valve Bulb

Figure 6-30. Hermetic Thermostatic Expansion Valve

1. Recover refrigerant (refer to section 6.4).
2. Remove cushion clamps located on the inlet and outlet lines.
3. Unbraze the equalizer connection (1/4”), the outlet connection (5/8”) and then the inlet connection (3/8”). See Figure 6-31. Be careful to protect the insulation on the heaters and their wires.
4. Remove insulation (Presstite) from expansion valve bulb.
5. Unstrap the bulb, located below the center of the suction line (4 o’clock position), and remove the valve (one strap.)

c. Installing the Expansion Valve

1. Clean the suction line with sandpaper before installing bulb to ensure proper heat transfer. Apply thermal grease to the indentation in the suction line.
2. Strap the thermal bulb to the suction line, making sure bulb is placed firmly into the suction line. See Figure 6-29 for bulb placement.
3. Insulate the thermal bulb.
4. Braze inlet connection to inlet line, see Figure 6-31.
5. Braze outlet connection to outlet line.
6. Reinstall the cushion clamps on inlet and outlet lines.
7. Braze the equalizer connection to the equalizer line.
8. Check superheat (refer to section 2.2 and Table 6-9). Container box temperature should be at -18_C (0_).

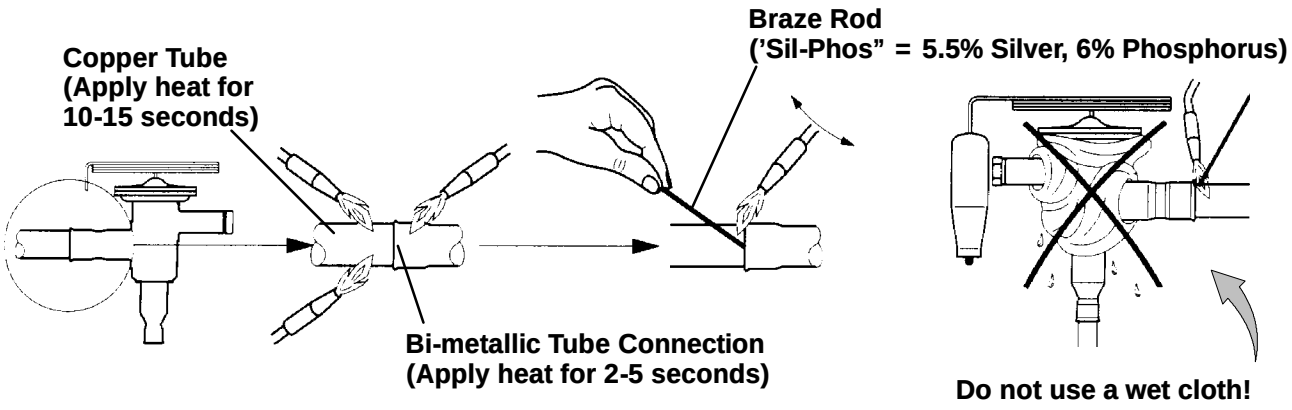


Figure 6-31. Hermetic Thermostatic Expansion Valve Brazing Procedure

6.26 POWER FACTOR CORRECTOR CAPACITORS (PFC)

The power factor corrector capacitors are of the permanent-split capacitor type. There are a total of three capacitors with discharge resistors enclosed in a single case.

a. When to check for a defective capacitor

The capacitors assist in correcting current draw by the compressor. If one or more of the capacitors is faulty, there will be an imbalance in current. In addition, the power consumption of the unit will increase.

b. Removing the capacitor

WARNING

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

WARNING

Before removing the capacitors the terminals must be checked for voltage with a multimeter. The discharge resistors installed on the unit (capacitors) should bring the voltage to a safe level in a minute. However, there may be a broken resistor that retains voltage for a longer period, it is highly recommended to wait 15 minutes and to check for voltage.

1. The capacitors are located on the unit sidewall above the evaporator fan deck, and may be removed by two methods:

   (a.) *If container is empty,* open upper rear panel of the unit. The capacitors will be on the right and may be serviced after disconnecting power plug.

   (b.) *If container is full,* turn the unit power OFF and disconnect power plug. Remove the upper fresh air makeup vent (see Figure 2-1).

WARNING

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

c. Checking the capacitor

If the capacitor is suspected of malfunction, you may choose to simply replace it. Direct replacement requires a capacitor of the same value. Two methods for checking capacitor function are:

1. 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. The reading should read about 330,000 ohms (for a good capacitor) due to the discharge resistors.

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.

2. 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 are its ability to locate capacitors that have failed to hold their microfarad ratings, or those that are breaking down internally during operation. It is also useful in identifying capacitors when their microfarad rating marks have become unreadable.

6.27 CONTROLLER/DATACORDER

a. Handling of Controller/DataCORDER

These guidelines should be followed when handling the Controller/DataCORDER module. These steps should be implemented when replacing the module, when doing *any* arc welding on the unit, or *when service to the refrigeration unit requires handling and removal of the Controller.*

CAUTION

Remove Controller/DataCORDER module and unplug all connectors before performing any arc welding on any part of the container.

Do not remove wire harnesses from modules unless you are grounded to the unit frame with a static safe wrist strap.

1. Obtain a grounding wrist strap and a static dissipation mat. The wrist strap, when properly grounded, will dissipate any potential buildup on the body. The dissipation mat will provide a static-free work surface on which to place and/or service the Controller/DataCORDER module.

NOTE

Use a dissipation mat, order CTD P/N 07-00277-00.

2. Disconnect and secure power to the unit.

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

4. Carefully remove the Controller/DataCORDER. Do not touch any of the electrical components if possible. Place the module on the static mat.

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

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

b. Removing and Installing the Controller/DataCORDER Module

Removal:

1. Disconnect all front wire harness connectors (MA, MB, MC, KA & KB) and move wiring out of way.

2. Loosen one mounting screw (see Figure 6-32, item 1) and pull out the top of the module (item 2). Lift up and out.

3. Turning the module around will give access to the two back connectors (EC) which can be disconnected. Remove module.

4. Remove the new Controller/DataCORDER module from its packaging and install it in the refrigeration unit. Place the old module into the same packaging that accompanied the new module. *Make sure that you package it in the exact manner that you received it.*

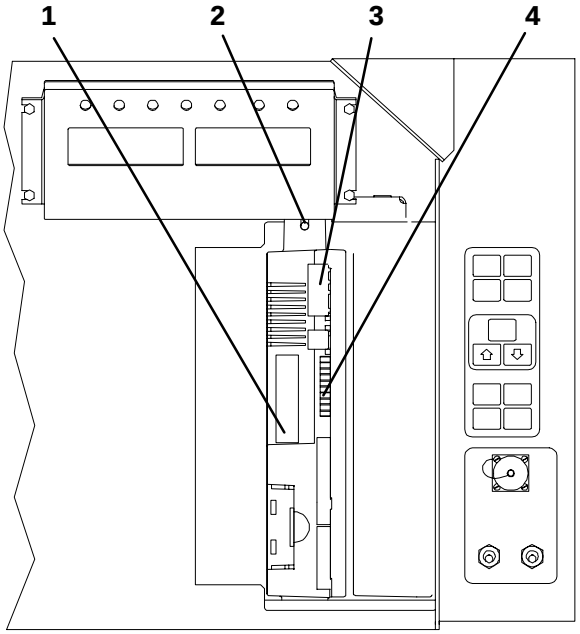
NOTE

This packaging has been designed to protect the Controller/DataCORDER module from both physical and electrostatic discharge damage during storage and transit.

Installation:

Install the module by reversing the steps in section 6.27.b.

Torque values for mounting screws (item 1, Figure 6-32) are 0.23 mkg (20 inch-pounds), and 0.12 mkg (10 inch-pounds) for all connectors (MA, MB, MC, KA & KB).



1. Controller/DataCORDER Software Programming Port
2. Mounting Screw
3. Controller/DataCORDER Module
4. Test Points

Figure 6-32. Controller side of the Control Box

6.27.1 Controller/DataCORDER Programming Procedure

To load new software into the module, the programming card is inserted into the programming/software port.

WARNING

The unit must be OFF whenever a programming card is inserted or removed from the programming/software port.

The metal door on the programming card must be facing to the left when inserting.

a. Procedure for loading Operational Software

1. Turn unit OFF, via start-stop switch (ST).
2. Insert the programming card for Operational Software into the programming/software port. (See Figure 6-32)
3. Turn unit ON, via start-stop switch (ST).
4. The Display module will read:
   (a.) If the correct card is being used the digital display will alternate back and forth between the messages “rEV XXXX” and “Press EntR.”
   (b.) If a defective card is being used: the Display will blink the message “bAd CArd.” (Turn start-stop switch OFF and remove the card.)

5. Press the ENTER key on the keypad.
6. The Display will show the message “Pro SoFt.” This message will last for up to one minute.
7. The Display module will read:
   (a.) When the software loading has successfully completed: the Display will show the message “Pro donE.”
   (b.) If a problem occurs while loading the software: the Display will blink the message “Pro FAIL” or “bad 12V.” (Turn start-stop switch OFF and remove the card.)
8. Turn unit OFF, via start-stop switch (ST).
9. Remove the programming card from the programming/software port.
10. Turn unit ON, via start-stop switch (ST).

b. Procedure for loading Configuration Software

1. Turn unit OFF using start-stop switch (ST).
2. Insert the programming card, for Configuration Software, into the programming/software port. (See Figure 6-32.)
3. Turn unit ON using start-stop switch (ST).
4. The Display module will read:
   (a.) If the correct card is being used, the digital display will show “nt40” on the left LCD display and “511XXX” on the right LCD display. “XXX” will indicate the dash number for a given unit model number, use the UP or DOWN ARROW key to scroll through the list to obtain the proper model dash number (i.e., For the unit 69NT40-511-201, the left display will show “nt40,” press the UP or DOWN ARROW key until the right display shows “511201.”)
   (b.) If a defective card is being used, the Display will blink the message “bAd CArd.” (Turn start-stop switch OFF and remove the card.)
5. Press the ENTER key on the keypad.
6. The Display module will read:
   (a.) When the software loading has successfully completed, the Display will show the message “EEPrM donE.”
   (b.) If a problem occurs while loading the software, the Display will blink the message “Pro FAIL” or “bad 12V.” Turn start-stop switch OFF and remove the card.
7. Turn unit OFF using start-stop switch (ST).
8. Remove the programming card from the programming/software port.
9. Turn unit ON using start-stop switch (ST).

6.27.2 Controller Trouble-Shooting

A group of test points (tp) are provided on the Controller (see Figure 6-32, item 3) for trouble-shooting electrical circuits (refer to section 5). A description of the test points follows:

NOTE

Use a digital voltmeter to measure ac voltage between TP’s and ground (TP9), except for TP8.

TP2

This test point enables the user to check if the internal protector for the compressor motor (IP-CP) is open or closed (and the Auto Transformer-IP if so equipped).

TP3

This test point enables the user to check if the optional water pressure switch (WP) contact is open or closed.

TP 4

This test point enables the user to check if the internal protector for the condenser fan motor (IP-CM) is open or closed.

TP 5

This test point enables the user to check if the internal protectors for the evaporator fan motor (IP-EM1 or IP-EM2) is open or closed.

TP 9

This test point is the chassis (unit frame) ground connection.

TP 10

This test point enables the user to check if the heat termination thermostat (HTT) contact is open or closed.

6.28 WATER-COOLED CONDENSER

The water-cooled condenser is of the shell and coil type with water circulating 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.

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

a. Turn unit off and disconnect main power.

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

What You Will Need:

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

2. 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.

3. Fresh clean water.

4. Acid proof pump and containers or bottles with rubber hose.

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 highly useful to you.

Summary of Procedure:

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

b. Flush.

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

d. Flush.

e. Neutralize.

f. Flush.

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

Detailed Procedure:

1. 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.

2. 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.

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

4. 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 –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.

5. Fill the tubes with this solution by filling from the bottom. See Figure 6-33. Important: be sure to provide a vent at the top for escaping gas.

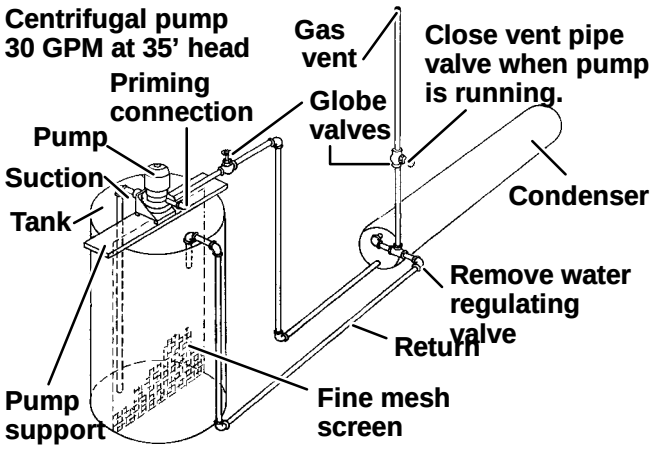


Figure 6-33. Water-Cooled Condenser Cleaning – Forced Circulation

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 6-34) 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. Air pockets in the solution should be avoided 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. Following the water flush, 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.

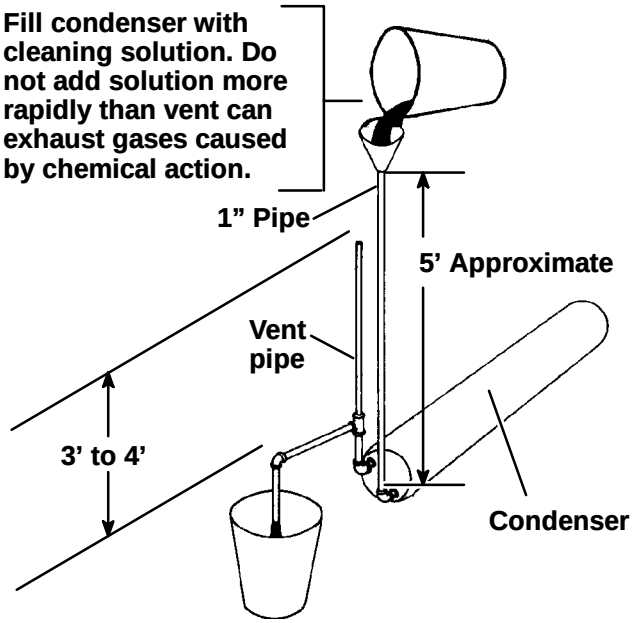


Figure 6-34. Water-Cooled Condenser Cleaning – Gravity Circulation

6.29 CONTROL BOX REPAIRS

6.29.1 Introduction

This procedure provides instructions for repair of the Carrier Transicold composite control box. Damage to the control box may be in the form of a chip or hole, a crack, a damaged thread insert or damage to the door hinge inserts. Generally, the object of the repair must be to ensure sufficient strength is restored to the damaged area and the repair must keep the box water tight. Information on repair kits and repair procedures for each type of damage is provided in the following paragraphs. Ambient temperature must be above 7°C (45°F) for proper curing of epoxy repairs.

6.29.2 Cracks

Cracks in the control box are repaired using a fiberglass patch over the damaged area. Materials required are included in the Fiberglass Patch Kit supplied with Crack Repair Kit, CTD part number 76-00724-00SV (see Table 6-1).

h. The surface must be clean and dry. Roughen the surface with sandpaper to ensure a good bond.

i. Cut the fiberglass cloth to allow a 25mm (1–inch) overlap around the area to be repaired.

j. Stretch and position the cloth over the area to be repaired and secure it with masking tape.

k. Make up sufficient epoxy glue to cover the cloth by mixing equal parts of resin and hardener. Saturate the cloth with the epoxy glue, spreading evenly.

l. Remove the tape and overlap the edge of the cloth approximately 6 to 12 mm (1/4" to 1/2") with glue.

m. Epoxy will dry in 45–60 minutes. When completely cured (12 hours), use sandpaper to smooth edges of the patch.

6.29.3 Chips And Holes

Chips and holes in the control box are repaired using a piece of aluminum or stainless steel to cover the damaged area. The material can be cut to suit and riveted in place. An adhesive sealant must be used to make the repair watertight. The adhesive sealant (Sikaflex 221) is included in Crack Repair Kit CTD part number 76-00724-00SV (see Table 6-1). **Do not use an acetone based silicone sealant** (Which can be identified by a vinegar–like odor).

a. To make up the patch, cut a piece of aluminum or stainless steel so that it will overlap the damaged area by at least 40 mm (1 1/2") on all sides.

b. Choose rivet locations and drill the rivet holes in the corresponding locations on the control box and patch piece.

c. Apply the adhesive sealant around the damaged area to form a seal between the control box and the patch piece.

d. Rivet the patch piece in place.

e. File smooth any rough edges (including rivets) that may come into contact with wires.

6.29.4 Inserts

The threaded brass inserts that are molded into the control box will need to be replaced if the threads become stripped, or if the insert becomes loose. The inserts and epoxy are contained in repair kit, CTD part number 76-50084-00 (see Table 6-2). There are 6 different inserts used in the control box. Refer to Figure 6-36 for the locations of the various inserts.

NOTE

An epoxy application gun is also needed, CTD part number 07 – 00391 – 00.

The damaged insert must be removed from the control box. Table 6-3 identifies the drill size and drill depth to be used for each insert. A stop ring should be used on the drill bit to limit the depth.

a. Center the drill bit on the insert and drill to the prescribed depth.

b. Remove the chips from the drilled hole.

c. Mix the two component epoxy and fill the hole 1/2 way to the top with epoxy.

d. Press the insert in until it is flush with the surface.

e. Wipe away any excess epoxy. The part is ready for service after the bond material has hardened and is tack free (approximately 20 minutes)

6.29.5 Door Hinge Inserts

If the door hinges have been pulled from the control box drill and reinstall the hinge as shown in Figure 6-35 and described in the following steps.

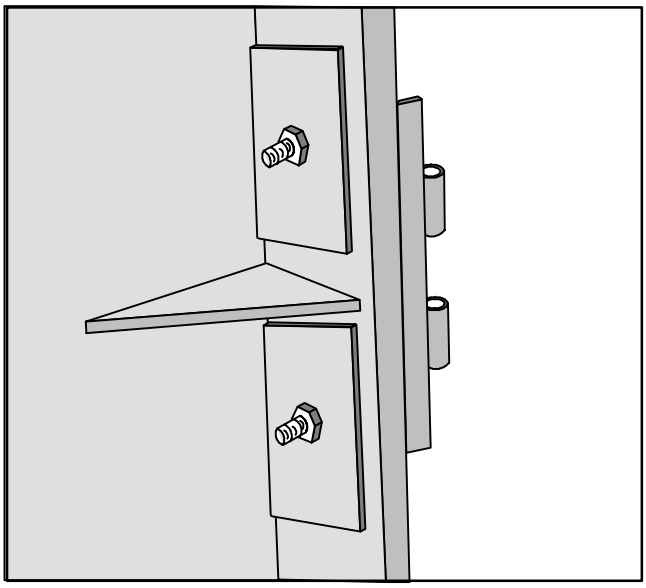


Figure 6-35 Door Hinge Repair

Materials needed:

7. Cut two square pieces of 3 mm thick (1/8 inch) aluminum or stainless steel approximately 40 mm (1 5/8") square. These squares will serve as backing plates.
8. Two nuts, bolts (10 – 24 x 1") and washers for each insert that needs repair.

a. Drill a 1/4" hole in the center of each square backing plate.

b. Pass the bolts through the bolts holes in the door hinge, then through the control box at the location where the hinge insert pulled out.

c. From inside the control box, slide the backing plates over the bolts and secure in place with the washers and nuts.

Table 6-1 Crack, Chip & Hole Repair Kit

ITEM	DESCRIPTION	PART NUMBER	Qty
1	Crack Repair Kit – Includes	76–00724–00SV	1
2	. . . Fiberglass Patch Kit (Loctite FK–98 or 80265)	76–00724–00Z	10
3	. . . Sikaflex 221 Adhesive Sealant (Sikaflex 232–361)	02–00067–02Z	10
4	. . . Instruction Sheet	98–02339–00	10

Table 6-2 Insert Repair Kit

ITEM	DESCRIPTION	PART NUMBER	Qty
1	Insert Repair Kit – Includes	76–50084–00	1
2	. . . Insert - 17.53 x 9.91 mm (..690 x .390 in) 1/4–20 Threads	34–06231–01	10
3	. . . Insert - 15.88 x 6.35 mm (.625 x .250 in) 10-24 Threads	34–06231–03	10
4	. . . Insert - 25.15 x 7.54 mm (.990 x .297 in) 10-24 Threads	34–06231–04	10
5	. . . Insert - 10.16 x 9.53 mm (.400 x .375 in) 10-24 Threads	34–06231–05	10
6	. . . Insert - 12.7 x 9.91 mm (.5 x .390 in) 1/4–20 Threads	34–06231–06	10
7	. . . Insert - 9.53 x 6.76 mm (.375 x .266 in) 10-24 Threads	34–06231–07	10
8	. . . Durabond Epoxy E20–HP (Loctite 29314)	02–0082–00	1
9	. . . Static Mixing Tube (Loctite 983440)	07–00390–00	1
10	. . . Instruction Sheet	98–02338–00	1

Note: Insert repair procedures require use of an Application Gun, Carrier part number 07–00391–00 (Loctite 983435)

Table 6-3 Drill Information

Item	Insert part number	Drill size and depth
1	34- 06231- 01	10.3 mm x 17.8 mm deep (.404 in. x .700 in. deep)
2	34- 06231- 03	6.8 mm x 16.3 mm deep (.266 in. x .640 in. deep)
3	34- 06231- 04	7.9 mm x 25.4 mm deep (.3125 in. x 1.0 in. deep)
4	34- 06231- 05	6.9 mm (.270 in.) Drill completely through.
5	34- 06231- 06	10.3 mm (.404 in.) Drill completely through.
6	34- 06231- 07	6.8 mm (.266 in.) Drill completely through.

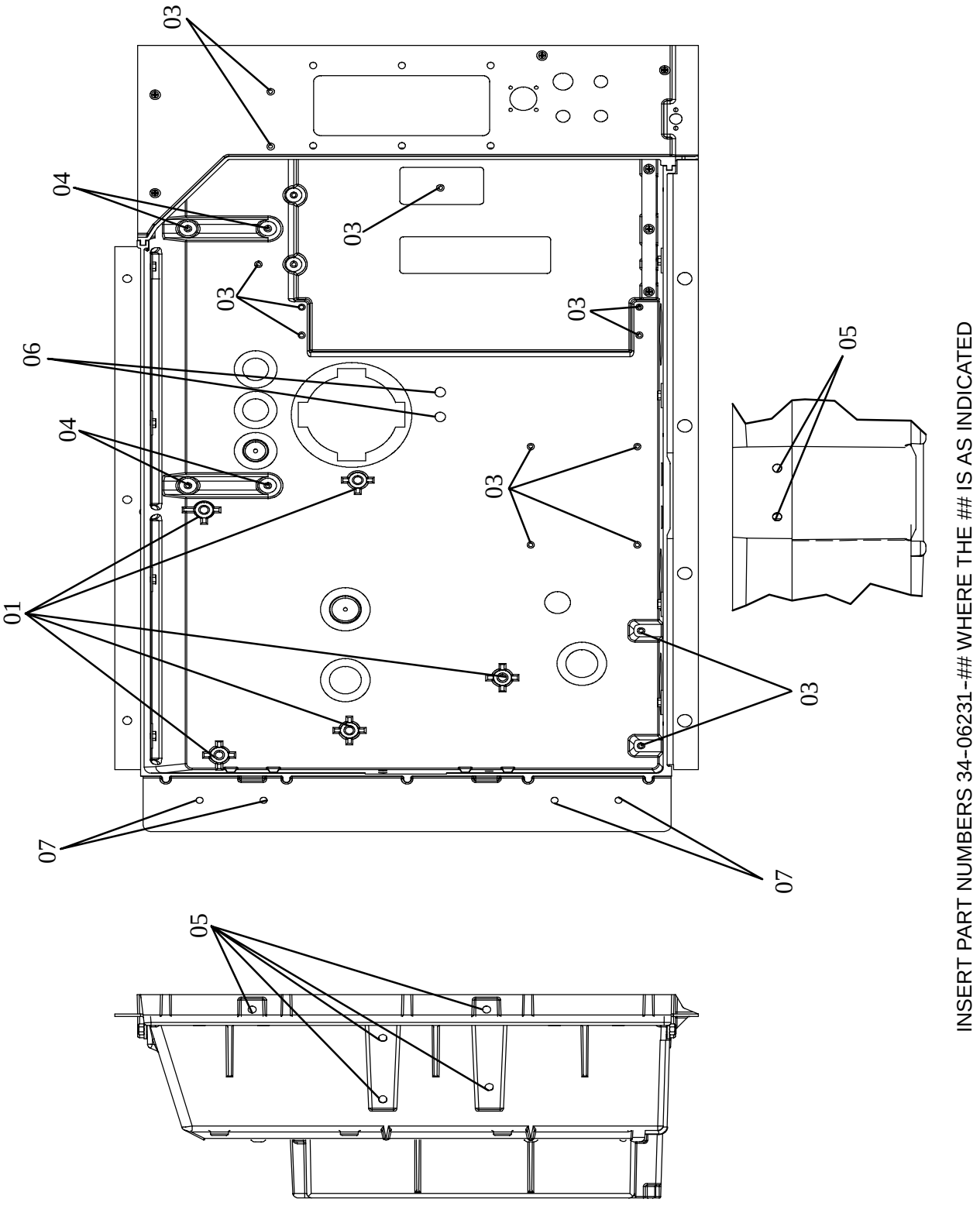


Figure 6-36. Insert Location

Table 6-4. Tools Required	
ITEM	**DESCRIPTION**
1	Piercing Valve, Hand Valve type (For 3/8 inch ID copper tube)
2	Pinch-off Tool (Robinair P/N 12396)
3	Oxyacetylene Torch with brazing tip
4	Safety Glasses
5	Brazing alloy Sil-Foss 5%
6	Refrigerant Recovery Unit
7	Flaring Tool (suitable for 3/8 inch ID copper tube)
8	3/8 inch Flare Nut (P/N 40-00097-06)
9	R-134a Refrigerant Gauge Set (P/N 07-00294-00)
10	Adapter Fitting (1/4 inch x 3/8 inch male reducing flare union, P/N 40-00182-11)
11	Ninety degree swivel elbow (Low side, P/N 40-00519-00
12	Ninety degree swivel elbow (High side, P/N 40-00519-01
13	R-134a Quick connector (Low side, P/N 40-00520-00)
14	R-134a Quick connector (High side, P/N 40-00520-01)
15	Vacuum Pump (8 m^3H = 5 cfm volume displacement, P/N 07-00176-01)
16	Tube Cutter
17	Assorted hand tools as necessary for intended repair
18	Cleaning materials, abrasive cloth, tube wire brush, stainless steel wool, etc.
19	Cylinder of R-134a refrigerant
20	Cylinder of dry nitrogen

Table 6-5. AMBS, DTS, RRS, RTS, SRS and STS Temperature-Resistance Chart		
Temperature Centigrade	**Temperature Fahrenheit**	**Resistance (Ohms)**
RRS, RTS, SRS and STS:		
0	32	32,650 ¦ 91
25	77	10,000 ¦ 50
AMBS and DTS		
0	32	32,650 + 1720 – 1620
25	77	10,000 + 450 – 430

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

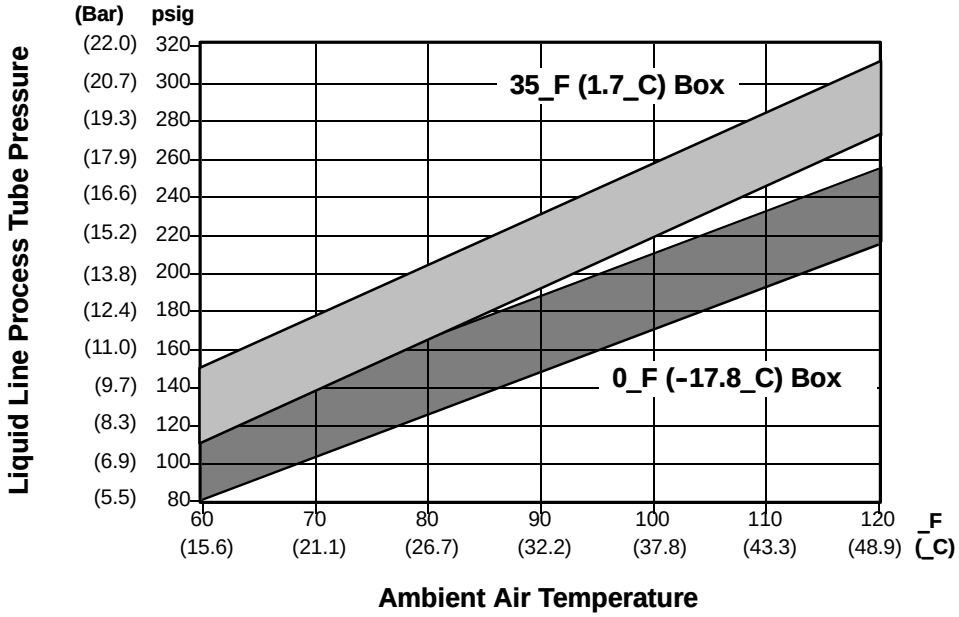
Table 6-7. Wear Limits For Compressors						
PART NAME	**FACTORY MAXIMUM**		**FACTORY MINIMUM**		**MAXIMUM WEAR BEFORE REPAIR**	
	INCHES	**MM**	**INCHES**	**MM**	**INCHES**	**MM**
MAIN BEARING						
Main Bearing Diameter	1.6268	41.3207			.0020	0.0508
Main Bearing Journal Diameter			1.6233	41.2318	.0020	0.0508
PUMP END						
Main Bearing Diameter	1.3760	34.9504			.0020	0.0508
Main Bearing Journal Diameter			1.3735	34.8869	.0020	0.0508
CONNECTING ROD	1.3768	34.9707			.0020	0.0508
Piston Pin Bearing			0.6878	17.4701	.0010	0.0254
CRANKPIN DIAMETER			1.3735	34.8869	.0025	0.0635
Throw	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 6-8. 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 Flange
				Discharge Flange
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				

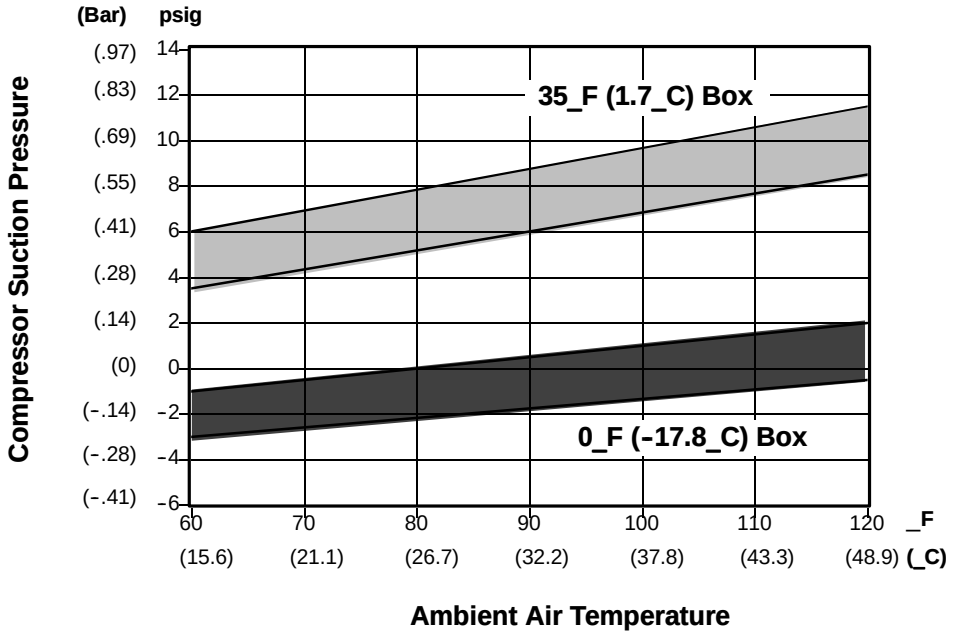
Table 6-9. Temperature-Pressure Chart - R-134a									
BOLD FIGURES = Inches Mercury Vacuum (cm Hg VAC)									
LIGHT FIGURES = psig (kg/cm@)									
TEMPERATURE		**PRESSURE**			**TEMPERATURE**		**PRESSURE**		
_F	**_C**	**Psig**	**Kg/cm^2**	**Bar**	**_F**	**_C**	**Psig**	**Kg/cm^2**	**Bar**
-40	-40	14.6	37.08	-.49	30	-1	26.1	1.84	1.80
-35	-37	12.3	31.25	-.42	32	0	27.8	1.95	1.92
-30	-34	9.7	24.64	-.33	34	1	29.6	2.08	2.04
-25	-32	6.7	17.00	-.23	36	2	31.3	2.20	2.16
-20	-29	3.5	8.89	-.12	38	3	33.2	2.33	2.29
-18	-28	2.1	5.33	-.07	40	4	35.1	2.47	2.42
-16	-27	0.6	1.52	-.02	45	7	40.1	2.82	2.76
-14	-26	0.4	.03	.03	50	10	45.5	3.30	3.14
-12	-24	1.2	.08	.08	55	13	51.2	3.60	3.53
-10	-23	2.0	.14	.14	60	16	57.4	4.04	3.96
-8	-22	2.9	.20	.20	65	18	64.1	4.51	4.42
-6	-21	3.7	.26	.26	70	21	71.1	5.00	4.90
-4	-20	4.6	.32	.32	75	24	78.7	5.53	5.43
-2	-19	5.6	.39	.39	80	27	86.7	6.10	5.98
-0	-18	6.5	.46	.45	85	29	95.3	6.70	6.57
2	-17	7.6	.53	.52	90	32	104.3	7.33	7.19
4	-16	8.6	.60	.59	95	35	114.0	8.01	7.86
6	-14	9.7	.68	.67	100	38	124.2	8.73	8.56
8	-13	10.8	.76	.74	105	41	135.0	9.49	9.31
10	-12	12.0	.84	.83	110	43	146.4	10.29	10.09
12	-11	13.2	.93	.91	115	46	158.4	11.14	10.92
14	-10	14.5	1.02	1.00	120	49	171.2	12.04	11.80
16	-9	15.8	1.11	1.09	125	52	184.6	12.98	12.73
18	-8	17.1	1.20	1.18	130	54	198.7	13.97	13.70
20	-7	18.5	1.30	1.28	135	57	213.6	15.02	14.73
22	-6	19.9	1.40	1.37	140	60	229.2	16.11	15.80
24	-4	21.4	1.50	1.48	145	63	245.6	17.27	16.93
26	-3	22.9	1.61	1.58	150	66	262.9	18.48	18.13
28	-2	24.5	1.72	1.69	155	68	281.1	19.76	19.37

NOTE

Curves to be used as troubleshooting guide only for model series 69NT40-511-200 to 69NT40-511-299 with fresh air makeup vent closed, unit powered on 460 VAC/60hz and SMV 100% open.



Liquid Line Process Tube Pressure Versus Ambient Air Temperature at Stable Box Temperature



Compressor Suction Pressure Versus Ambient Air Temperature at Stable Box Temperature

Figure 6-37. R-134a Compressor Pressure Versus Ambient Temperature

SECTION 7

ELECTRICAL WIRING SCHEMATIC AND DIAGRAMS

7.1 INTRODUCTION

This section contains Electrical Schematics and Wiring Diagrams covering the Models listed in NO TAG. 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

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 the condenser fan grille before turning power OFF and disconnecting power plug.

WARNING

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

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

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 tapping sides of the valve flanges/pads with a hammer to break the seal.

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.

WARNING

Do not attempt to do service work on the Controller/DataCORDER module. Breaking of the warranty seal will void the warranty.

CAUTION

Remove the Controller/DataCORDER module and unplug all wire harness connectors before performing any arc welding on any part of the container.

Do not remove wire harnesses from module unless you are grounded to the unit frame with a static safe wrist strap.

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. In the U.S.A., refer to EPA section 608.

LEGEND

ZONE	SYMBOL		DESCRIPTION
D19	AMBS	—	AMBIENT SENSOR
J1	CB1	—	CIRCUIT BREAKER 460V
D1	CB2	—	OPTIONAL CIRCUIT BREAKER 230V (DVM OPTION) TERMINAL BLOCK WHEN CB2 NOT PRESENT
M9,P5	CF	—	CONDENSER FAN CONTACTOR
A3	CI	—	COMMUNICATIONS INTERFACE MODULE (OPTION)
M7,P1,K8	CH	—	COMPRESSOR CONTACTOR
M8	C-L	—	COOL LIGHT (OPTION)
H9,T6	CM	—	CONDENSER FAN MOTOR
E7,T1	CP	—	COMPRESSOR MOTOR
C19	CPDS	—	COMPRESSOR DISCHARGE SENSOR (TEMP.)
E19	CPSS	—	COMPRESSOR SUCTION SENSOR (TEMP.) (OPTION)
H20	CPT	—	CONDENSER PRESSURE TRANSDUCER
B16	CR	—	CHART RECORDER (OPTION)
M1	CS	—	CURRENT SENSOR
T4	DHBL	—	DEFROST HEATER - BOTTOM LEFT
T4	DHBR	—	DEFROST HEATER - BOTTOM RIGHT
T4	DHTL	—	DEFROST HEATER - TOP LEFT
R4	DHTR	—	DEFROST HEATER - TOP RIGHT
M13	DL	—	DEFROST LIGHT (OPTION)
R4	DPH	—	DRAIN PAN HEATER
K20	DPT	—	DISCHARGE PRESSURE TRANSDUCER (OPTION)
D19	DTS	—	DEFROST TEMPERATURE SENSOR
D1	DVM	—	DUAL VOLTAGE MODULE (OPTIONAL)
F2	DVR	—	DUAL VOLTAGE RECEPTACLE (OPTIONAL)
L11,M10,P7,P9,P12	EF	—	EVAPORATOR FAN CONTACTOR (HIGH SPEED)
E10,G10,T9,T13	EM	—	EVAPORATOR FAN MOTOR
M11,P8,P12	ES	—	EVAPORATOR FAN CONTACTOR (LOW SPEED)
C6,E18,F18,G5,H4	F	—	FUSE
	FLA	—	FULL LOAD AMPS
M6	HM	—	HOUR METER
H7	HPS	—	HIGH PRESSURE SWITCH
M12,P3	HR	—	HEATER CONTACTOR
G20	HS	—	HUMIDITY SENSOR
H12	HTT	—	HEAT TERMINATION THERMOSTAT
T20	IC	—	INTERROGATOR CONNECTOR (OPTION)
E7,E10,G10,H9	IP	—	INTERNAL PROTECTOR
M16	IRL	—	IN-RANGE LIGHT (OPTION)
G15	MDS	—	MANUAL DEFROST SWITCH
R2	PFC	—	POWER FACTOR CORRECTOR (CAPACITORS)
F20,M20,N20,P20	PR	—	PROBE RECEPTACLE (USDA OPTION)
L8,L13,L15	RM	—	REMOTE MONITORING RECEPTACLE (OPTION)
L19	RRS	—	RETURN RECORDER SENSOR (OPTION)
C19	RTS	—	RETURN TEMPERATURE SENSOR
D20	SD	—	STEPPER MOTOR DRIVE
B20	SMV	—	STEPPER MOTOR SUCTION MODULATION VALVE
J20	SPT	—	SUCTION PRESSURE TRANSDUCER (OPTION)
L20	SRS	—	SUPPLY RECORDER SENSOR (OPTION)
K4	ST	—	START-STOP SWITCH
B19	STS	—	SUPPLY TEMPERATURE SENSOR
D1	TBU	—	TRANSFORMER BRIDGING UNIT (OPTION)
K7	TC	—	CONTROLLER RELAY (COOLING)
D5	TCC	—	TRANSFRESH COMMUNICATIONS CONNECTOR (OPTION)
K10	TE	—	CONTROLLER RELAY (HIGH SPEED EVAPORATOR FANS)
G5	TFC	—	TRANSFRESH CONTROLLER (OPTION)
K12	TH	—	CONTROLLER RELAY (HEATING)
K14	TI	—	INRANGE RELAY
K13	TF	—	DEFROST RELAY
K9	TN	—	CONTROLLER RELAY (CONDENSER FAN)
G9,J7,J9, J10,J12,M16	TP	—	TEST POINT
M3	TR	—	TRANSFORMER
D1	TRANS	—	TRANSFORMER AUTO 230/460 (OPTION)
E5	TRC	—	TRANSFRESH REAR CONNECTOR (OPTION)
K11	TV	—	CONTROLLER RELAY (LOW SPEED EVAPORATOR FANS)
E9	WP	—	WATER PRESSURE SWITCH (OPTION)

Figure 7-1. Electrical Schematic – See Model Chart (Sheet 1 of 2)

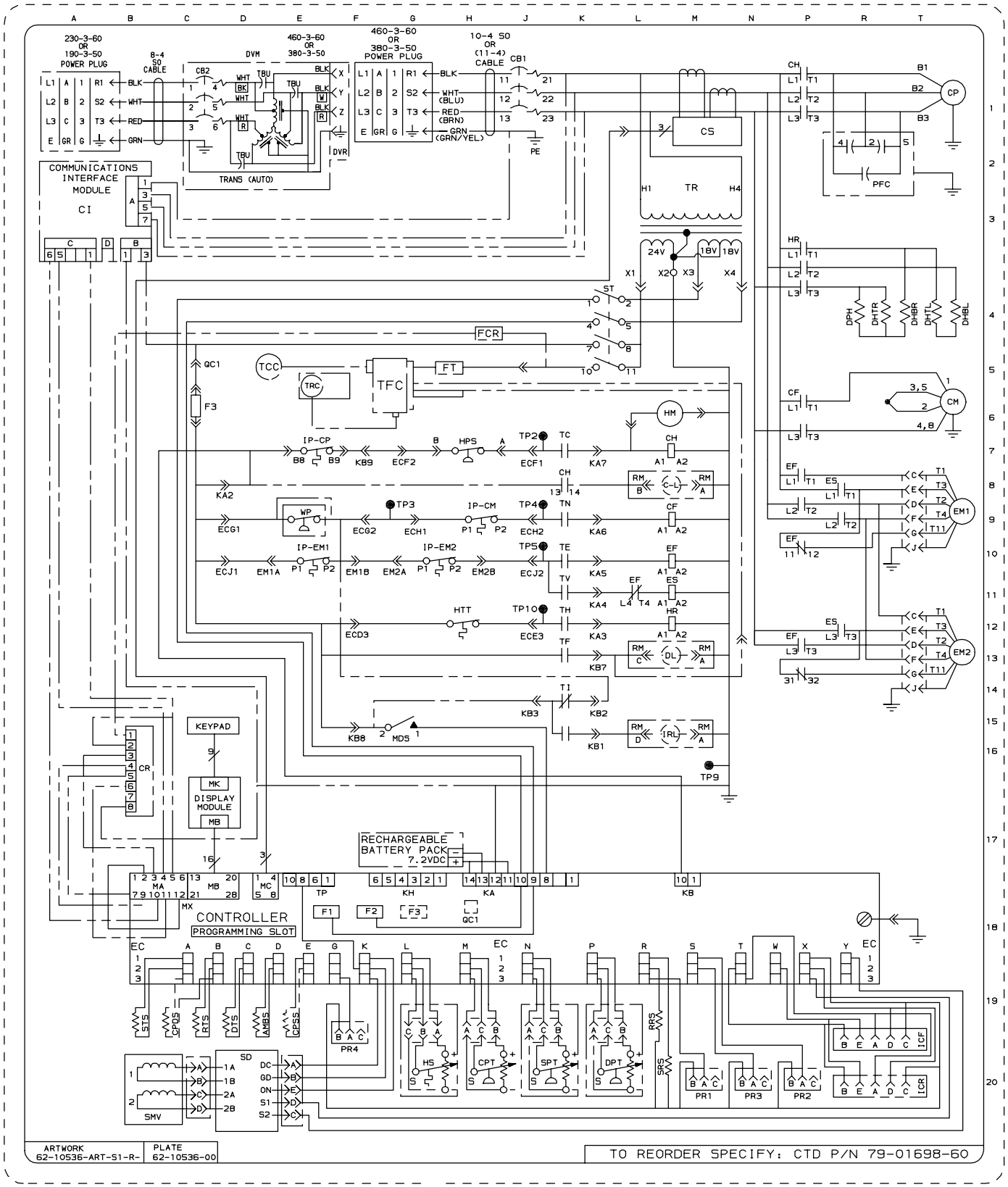


Figure 7-1. Electrical Wiring Schematic – See Model Chart (Sheet 1 of 2)

LEGEND

ZONE	SYMBOL	DESCRIPTION
D19	AMBS	— AMBIENT SENSOR
J1	CB1	— CIRCUIT BREAKER 460V
D1	CB2	— OPTIONAL CIRCUIT BREAKER 230V (DVM OPTION) TERMINAL BLOCK WHEN CB2 NOT PRESENT
M9,P5	CF	— CONDENSER FAN CONTACTOR
A3	CI	— COMMUNICATIONS INTERFACE MODULE (OPTION)
M7,P1,K8	CH	— COMPRESSOR CONTACTOR
M8	C-L	— COOL LIGHT (OPTION)
H9,T6	CM	— CONDENSER FAN MOTOR
E7,T1	CP	— COMPRESSOR MOTOR
C19	CPDS	— COMPRESSOR DISCHARGE SENSOR (TEMP.)
E19	CPSS	— COMPRESSOR SUCTION SENSOR (TEMP.) (OPTION)
H20	CPT	— CONDENSER PRESSURE TRANSDUCER
B16	CR	— CHART RECORDER (OPTION)
M1	CS	— CURRENT SENSOR
T4	DHBL	— DEFROST HEATER - BOTTOM LEFT
T4	DHBR	— DEFROST HEATER - BOTTOM RIGHT
T4	DHTL	— DEFROST HEATER - TOP LEFT
R4	DHTR	— DEFROST HEATER - TOP RIGHT
M13	DL	— DEFROST LIGHT (OPTION)
R4	DPH	— DRAIN PAN HEATER
K20	DPT	— DISCHARGE PRESSURE TRANSDUCER (OPTION)
D19	DTS	— DEFROST TEMPERATURE SENSOR
D1	DVM	— DUAL VOLTAGE MODULE (OPTIONAL)
F2	DVR	— DUAL VOLTAGE RECEPTACLE (OPTIONAL)
L11,M10,P7,P9,P12	EF	— EVAPORATOR FAN CONTACTOR (HIGH SPEED)
E10,G10,T9,T13	EM	— EVAPORATOR FAN MOTOR
M11,P8,P12	ES	— EVAPORATOR FAN CONTACTOR (LOW SPEED)
C6,E18,F18,G5,H4	F	— FUSE
	FLA	— FULL LOAD AMPS
M6	HM	— HOUR METER
H7	HPS	— HIGH PRESSURE SWITCH
M12,P3	HR	— HEATER CONTACTOR
G20	HS	— HUMIDITY SENSOR
H12	HTT	— HEAT TERMINATION THERMOSTAT
T20	IC	— INTERROGATOR CONNECTOR (OPTION)
E7,E10,G10,H9	IP	— INTERNAL PROTECTOR
M16	IRL	— IN-RANGE LIGHT (OPTION)
G15	MDS	— MANUAL DEFROST SWITCH
R2	PFC	— POWER FACTOR CORRECTOR (CAPACITORS)
F20,M20,N20,P20	PR	— PROBE RECEPTACLE (USDA OPTION)
L8,L13,L15	RM	— REMOTE MONITORING RECEPTACLE (OPTION)
L19	RRS	— RETURN RECORDER SENSOR (OPTION)
C19	RTS	— RETURN TEMPERATURE SENSOR
D20	SD	— STEPPER MOTOR DRIVE
B20	SMV	— STEPPER MOTOR SUCTION MODULATION VALVE
J20	SPT	— SUCTION PRESSURE TRANSDUCER (OPTION)
L20	SRS	— SUPPLY RECORDER SENSOR (OPTION)
K4	ST	— START-STOP SWITCH
B19	STS	— SUPPLY TEMPERATURE SENSOR
K7	TC	— CONTROLLER RELAY (COOLING)
D5	TCC	— TRANSFRESH COMMUNICATIONS CONNECTOR (OPTION)
K10	TE	— CONTROLLER RELAY (HIGH SPEED EVAPORATOR FANS)
G5	TFC	— TRANSFRESH CONTROLLER (OPTION)
K12	TH	— CONTROLLER RELAY (HEATING)
K14	TI	— INRANGE RELAY
K13	TF	— DEFROST RELAY
K9	TN	— CONTROLLER RELAY (CONDENSER FAN)
G9,J7,J9, J10,J12,M16	TP	— TEST POINT
M3	TR	— TRANSFORMER
D1	TRANS	— TRANSFORMER AUTO 230/460 (OPTION)
E5	TRC	— TRANSFRESH REAR CONNECTOR (OPTION)
K11	TV	— CONTROLLER RELAY (LOW SPEED EVAPORATOR FANS)
E9	WP	— WATER PRESSURE SWITCH (OPTION)

Figure 7-2. Electrical Schematic – See Model Chart (Sheet 1 of 2)

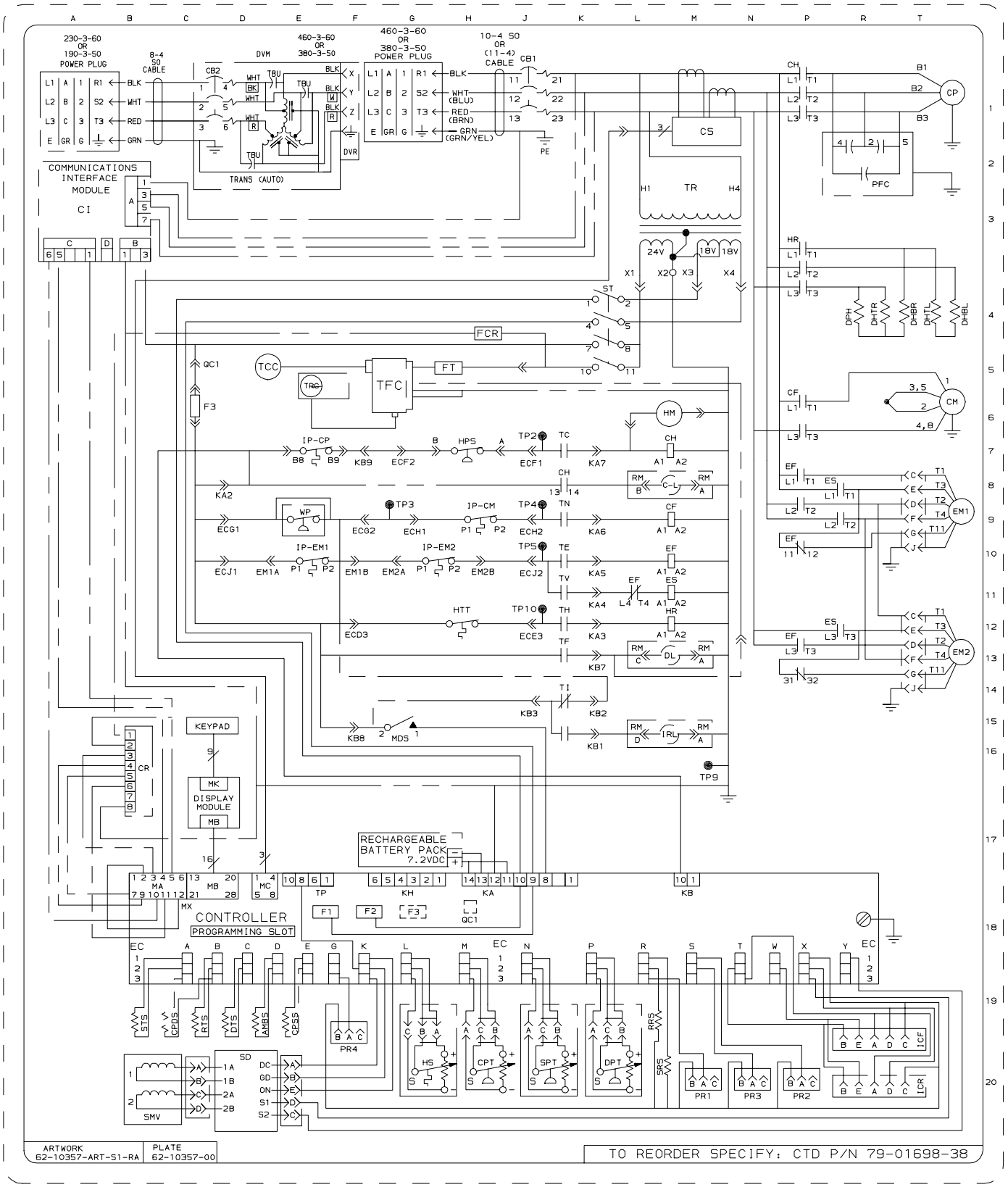


Figure 7-2. Electrical Wiring Diagram – See Model Chart (Sheet 2 of 2)

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