Carrier TRANSICOLD

OPERATION AND SERVICE MANUAL

TRAILER REFRIGERATION UNIT

Phoenix Advantage, Phoenix Xtra and Phoenix Multi-Temp

NDA–79/89

62–02426

$6.00

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT'D)

TABLE OF CONTENTS (CONT'D)

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (CONT'D)

LIST OF TABLES

OPERATION AND SERVICE MANUAL

TRAILER REFRIGERATION UNIT

NDA–79/89
Phoenix Advantage, Phoenix Xtra and Phoenix Multi-Temp

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

SECTION 1
DESCRIPTION

1.1 INTRODUCTION

WARNING

Beware of V–belts and belt driven components as the unit may start automatically. Before servicing unit, make sure the start–run stop switch is in the OFF position. Also disconnect the negative battery cable.

The model NDA configuration is a one piece, self–contained, fully charged, pre–wired, refrigeration–heating “nosemount” diesel powered unit for use on insulated trailers to maintain cargo temperatures from −20°F to +80°F (−28.9 to +26.7°C). The model/serial number plate is located inside of the unit on the rear frame as shown in Figure 1–1.

The evaporator fits into a rectangular opening in the upper portion of the trailer front wall. When installed, the evaporator section is located inside the trailer; and the condensing section is outside and on the front of the trailer.

The condensing unit consists of an engine–compressor drive package, condenser fan, condenser/radiator coil, control panel, control box, refrigerant controls, piping, wiring, defrost air switch, and associated components.

The evaporator assembly consists of an evaporator coil, evaporator fan, expansion valve, two defrost thermostats (termination switches), defrost damper, heat exchanger (Advantage only) and a damper solenoid. The location of the thermostats are shown in Figure 1–6. The return air sensor is also shown in Figure 1–6.

Heating is accomplished by circulating hot gas directly from the compressor to the evaporator coil. Three electric solenoid valves control the refrigerant circuit to improve the operating reliability of the heating system.

Automatic evaporator coil defrosting is initiated by either sensing the air pressure drop across the coil with a differential air switch or with the built–in timer in the microprocessor.

The control box and panel include manual switches, microprocessor with light emitting diodes (LED), ammeter, fuses, and associated wiring. Also, the model NDA is equipped with a remote light bar as standard equipment. It is mounted separately on the front roadside corner of the trailer.

The temperature controller is a microprocessor solid state controller (Refer to section 1.10). Once the controller is set at the desired trailer temperature, the unit will operate automatically to maintain the desired temperature within very close limits. The control system automatically selects high and low speed cooling or high and low speed heating as necessary to maintain the desired temperature within the trailer.

The refrigeration compressor used is a Carrier Model O5G equipped with Varipowr as standard equipment. Varipowr is used as a compressor capacity control to unload the compressor during periods of reduced loads. This provides closer temperature control, reduces potential for top freezing and reduces power required to operate the compressor; thus reducing power consumption.

For power, Carrier Transicold Model CT4–134, diesel engine is used. The engine gives excellent fuel economy and has easy starting characteristics. The engine is equipped with spin–on lube oil and fuel filter for easier filter changes.

NOTE

Throughout this manual, whenever the “left” or “right” hand side of the engine is referred to, it is the side as viewed from the flywheel end of the engine.

The diesel engine drives the compressor directly through a nylon drive gear and adapter. The adapter also includes a V–belt sheave which drives the jackshaft. The condenser/evaporator fanshaft is driven with a V–belt from the jackshaft. A separate V–belt from the jackshaft drives the alternator.

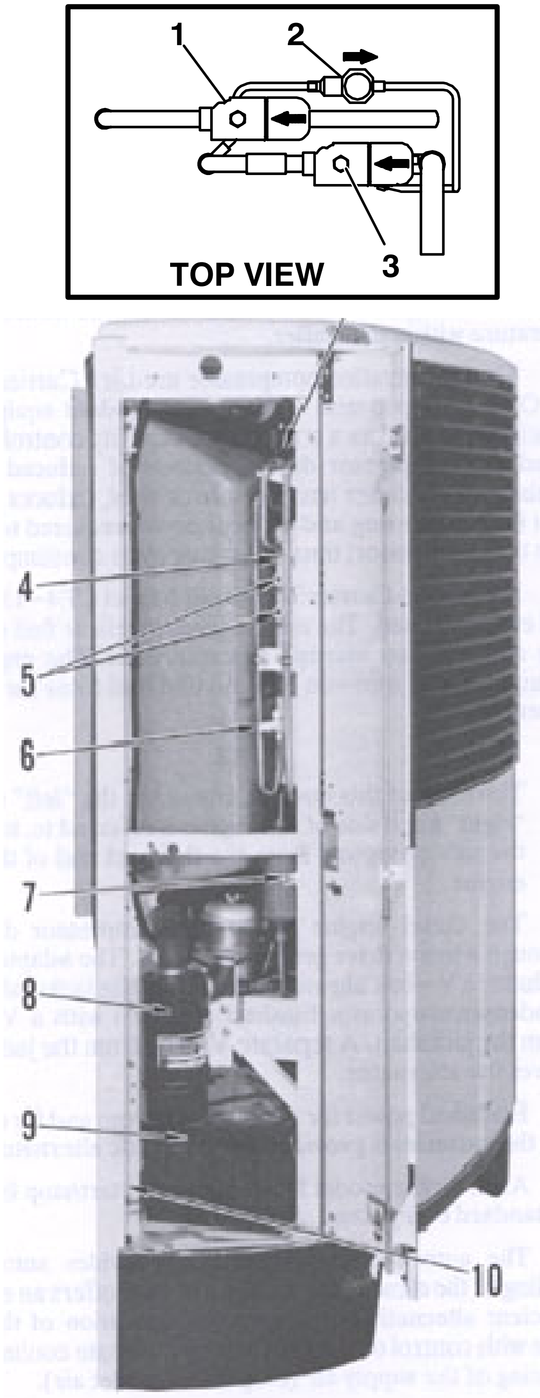
Electrical power for the control system and for charging the batteries is provided by the 12 vdc alternator.

Also, on the model NDA, the auto start/stop feature is standard equipment.

The auto start/stop operation provides automatic cycling of the diesel engine, which in turn offers an energy efficient alternative to continuous operation of the engine with control of temperature by alternate cooling and heating of the supply air (evaporator outlet air).

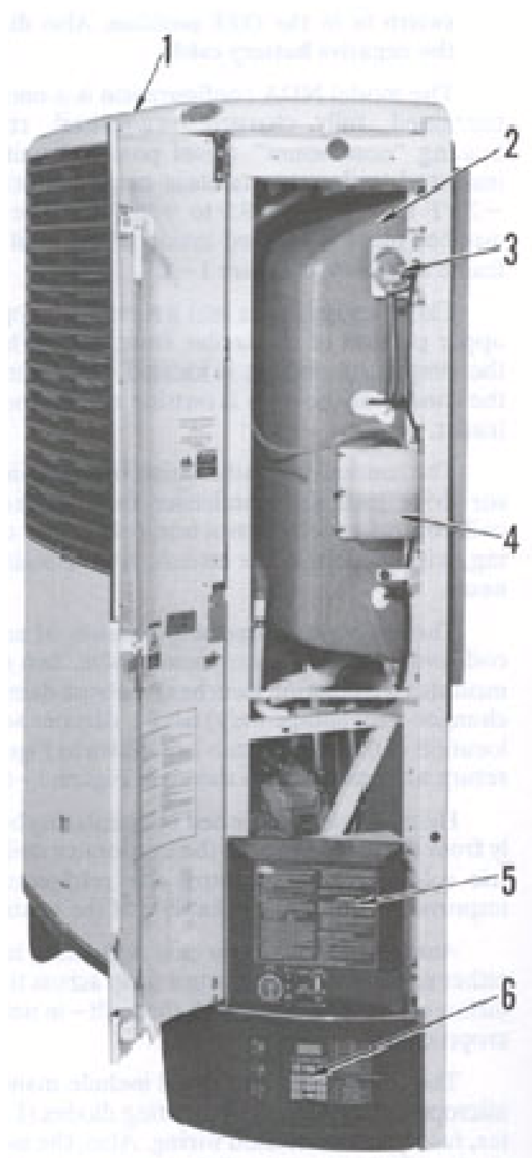
Table 1–1. Model Chart

Model		Refrigerant	Engine	Engine High Speed	Engine Low Speed
NDA–791	Phoenix Advantage	R–502	CT4–134–DI	1900 rpm	1350 rpm
NDA–799	Phoenix Advantage	R–502	CT4–134–TV	1900 rpm	1350 rpm
NDA–899	Phoenix Xtra	R–502	CT4–134–TV	2200 rpm	1400 rpm



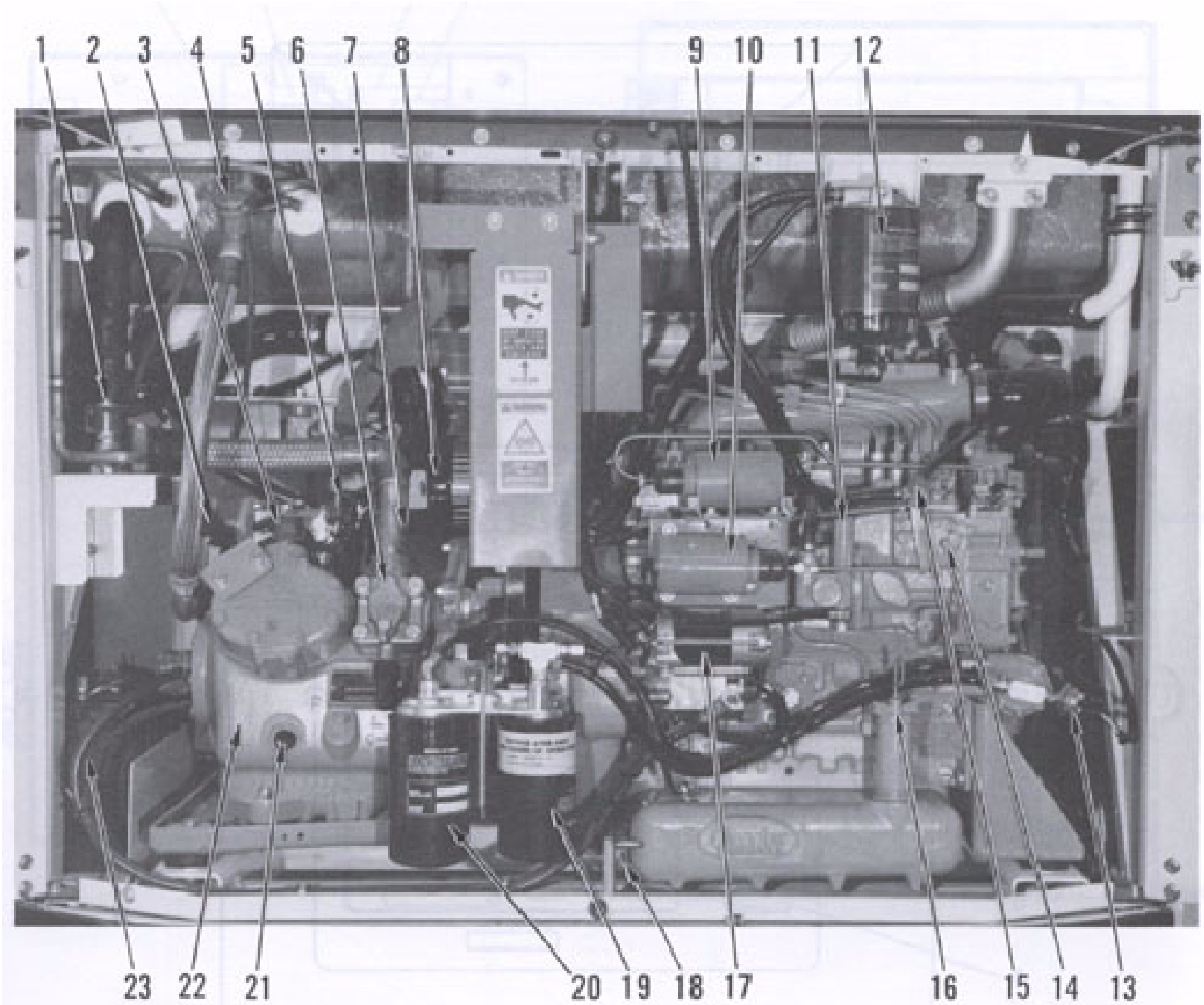
1. Condenser Pressure Control Solenoid Valve (SV−1)
2. Bypass Check Valve
3. Hot Gas Solenoid Valve (SV−3)
4. Receiver
5. Receiver Sight Glass
6. Receiver Manual Outlet Valve
7. Filter−Drier
8. Engine Air Cleaner
9. Battery
10. Model/Serial No. Location

Figure 1−1. Curbside



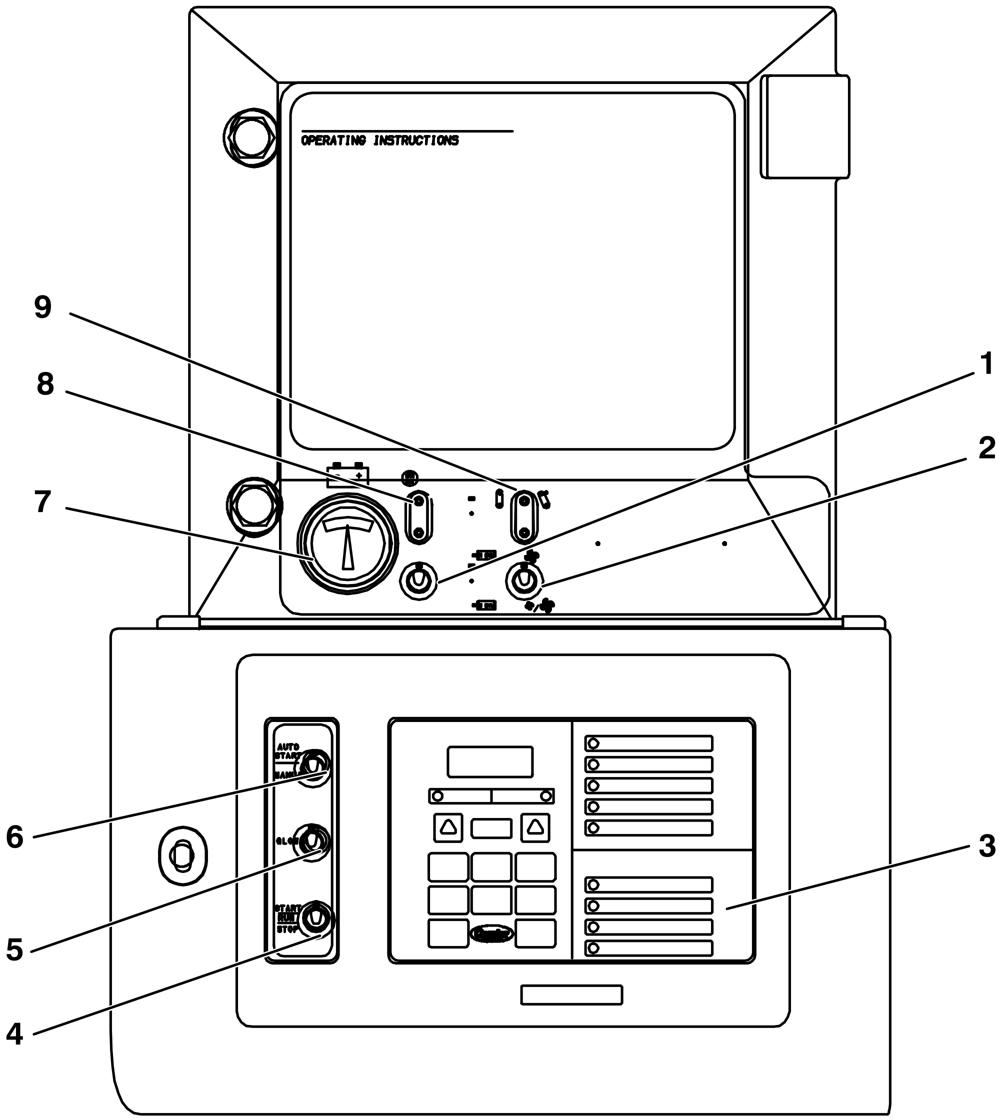
1. Radiator Fill Neck Location
2. Evaporator Section
3. Defrost Air Switch
4. Radiator Overflow Reservoir
5. Control Panel
6. Microprocessor

Figure 1−2. Roadside



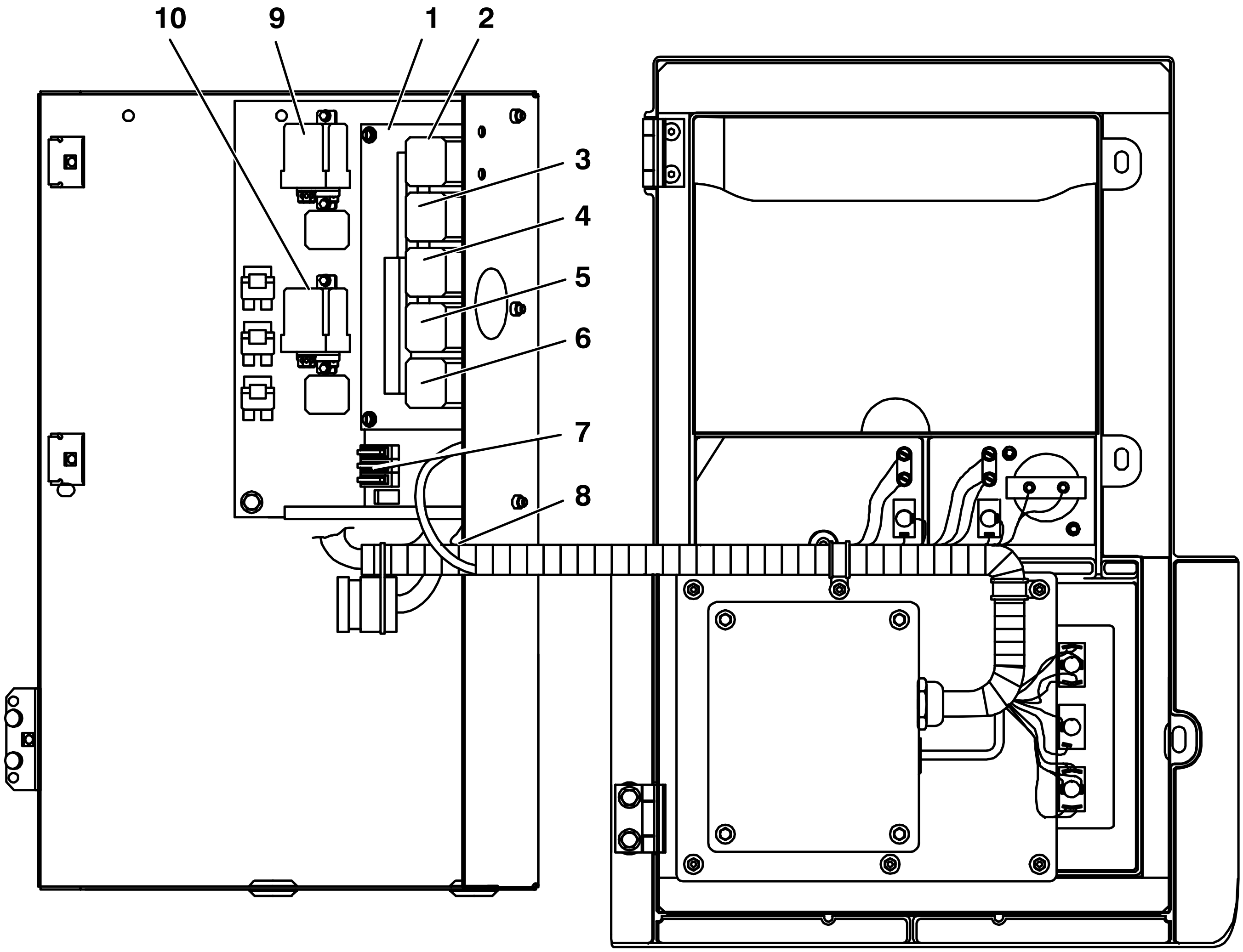
1. Liquid Line Solenoid Valve (SV−2)
2. Discharge Service Valve
3. Unloader Solenoid Valve
4. Discharge Line Check Valve
5. High Pressure Cutout Switch (HP−1) and Head Pressure Control Switch (HP−2)
6. Suction Service Valve
7. Suction Pressure Transducer (SPT)
8. Alternator and Regulator
9. Speed Control Solenoid
10. Run Solenoid
11. Mechanical Fuel Pump
12. Fuel Filter
13. Oil Pressure Switch
14. Injection Pump
15. Fuel Bleed Valve
16. Lube Oil Fill
17. Starter Motor
18. Oil Drain
19. Full Flow Lube Oil Filter
20. Bypass Lube Oil Filter (Optional)
21. Compressor Sight Glass
22. Compressor
23. Battery

Figure 1−3. Front View



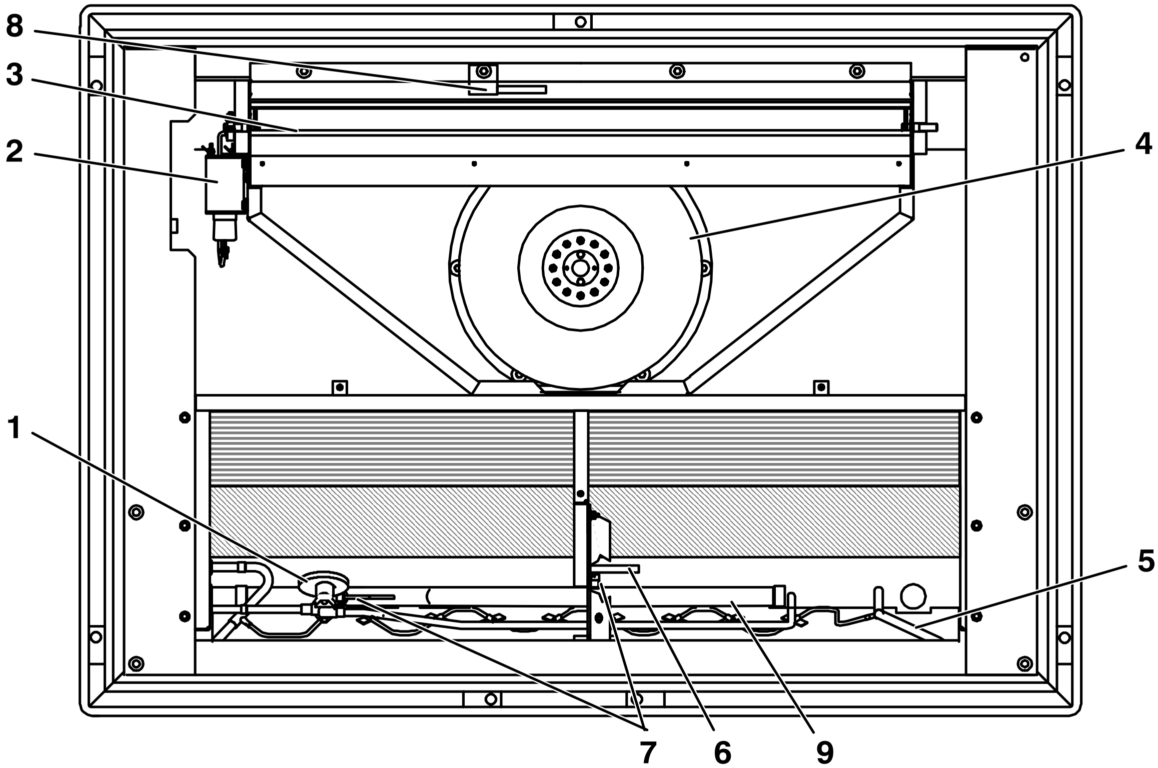
1. Pre−Trip Switch
2. Air Flow Switch
3. Microprocessor
4. Start−Run−Stop Switch
5. Glow Switch
6. Engine − Auto Start Switch
7. Ammeter
8. Defrost Test Points
9. Off−Time Switch

Figure 1−4. Control Panel

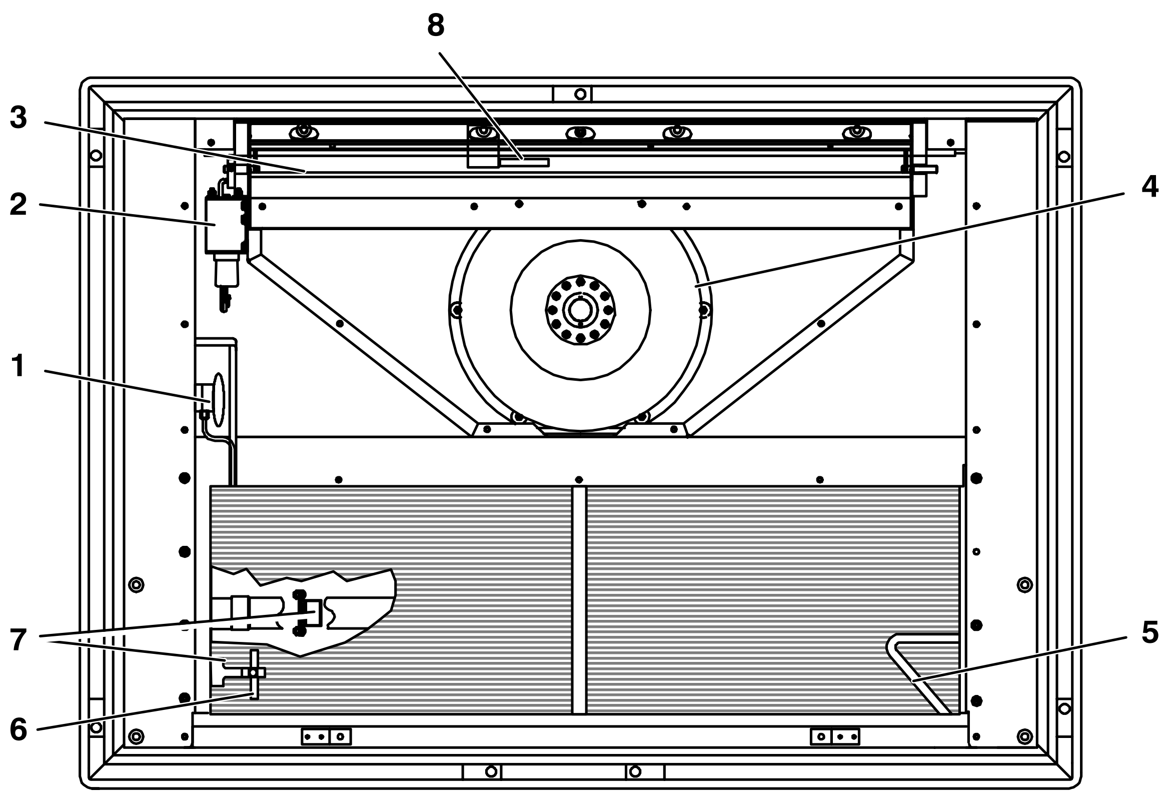


1. Diode – Relay Board
2. Defrost Relay
3. Speed Relay
4. Heat Relay (HR1)
5. Run Relay
6. Heat Relay (HR2)
7. Fuses
   Top Fuse (F2 – 30 Amp)
   Second Fuse (F3 – 20 Amp)
   Third Fuse (F4 – 5 Amp)
   Bottom Fuse (F8 – 20A)–Optional
8. Fuse (F1 – 80 Amp)
9. Starter Solenoid Relay
10. Glow Plug Relay

Figure 1–5. Control Box – Door Open



NDA−79 Phoenix Advantage



NDA−89 Phoenix Xtra

1. Expansion Valve and Bulb Location
2 Damper Actuator Solenoid
3. Damper
4. Evaporator Fan
5. Hot Gas Line (Evaporator Drain Pan)
6. Return Air Sensor
7. Defrost Termination Thermostats
8. Supply Air Sensor (Optional)
9 Heat Exchanger

Figure 1−6. Evaporator Section − Panels and Grille Removed

1.2 ENGINE DATA

CT4−134DI / TV (V2203DI / V2203TV):

a. Bore/Stroke

3.43 in. (87mm) /3.64 in. (92.4 mm)

b. Compression Ratio

CT4−134DI (V2203DI)	20.5 : 1
CT4−134TV (V2203TV)	22 : 1

c. Cooling System

Capacity:

10 U.S. quarts (9.46 liters)−includes 1 quart (0.95 liter) in coolant recovery bottle.
(Refer to section 4.3.1)

Type of Anti−Freeze:

Ethylene Glycol 5 quarts (4.73 liters)
Water 5 quarts (4.73 liters)
(Refer to section 4.3.1)

Thermostat:

Starts to Open 177 to 182°F (80 to 83°C)
Fully Open 203°F (95°C)

d. Cylinders (Number)

Four

e. Displacement

134 cu. in. (2.2 liters)

f. Firing Order

1−3−4−2

g. Fuel

Winter Diesel No. 1
Summer Diesel No. 2

h. Glow Plug Amperage

7.0 amps per plug at 10.5 vdc (nominal)

i. Horsepower

CT4−134DI	33.0 hp @ 1900 rpm
CT4−134DI	25.0 hp @ 1350 rpm
CT4−134TV	36.0 hp @ 2200 rpm
CT4−134TV	34.0 hp @ 1900 rpm
CT4−134TV	25.0 hp @ 1350 rpm

j. Injection Setting

CT4−134DI 3250 to 3400 psi (228.5 to 239.0 kg/cm^2)
CT4−134TV 1991 to 2133 psi (140 to 150 kg/cm^2)

k. Valve Clearance (Cold):
(Intake and Exhaust):

0.0071 to 0.0087 inch
(0.18 to 0.22 mm)

l. Weight (Dry): with Accessories:

417.8 lb (189.5 kg)

m. Lubrication System

19 U.S. quarts (18 liters)
(Includes 1 U.S. quart = 0.95 liter)

Oil Pressure:

40 to 60 psig (2.8 to 4.2 kg/cm^2)
(Engine in high speed)

Oil Pressure Safety Switch Setting Closes:

15 (± 3) psig (1.05 kg/cm^2)

Lube Oil Viscosity:

Outdoor Temperature

Fahrenheit	Centigrade	SAE
Below 32°	0°C	10W or 10W30
32° to 77°F	0° to 25°C	20 or 10W30
Over 77°F	Over +25°C	30 or 15W40

Oil Change Intervals:

First 400 hours, thereafter as listed below.

CAUTION

The maximum oil change interval is 1 year (for either approved oil). The only approved synthetic lube oil is Mobil Delvac 1. The normal oil change intervals (listed below) should be reduced if the equipment is operated under extreme conditions such as in dirty environments.

Engine	Unit Features	API Class CD (Hours)	MOBIL DELVAC 1 (Hours)
CT4−134TV	Oil Bath Air Cleaner w/o Bypass Oil Filter	1000	2000
	Dry Type Air Cleaner w/Bypass Oil Filter	1500	3000
CT4−134DI	Oil Bath Air Cleaner w/o Bypass Oil Filter	1500	3000
	Dry Type Air Cleaner w/Bypass Oil Filter	2000	4000

1.3 REFRIGERATION SYSTEM DATA

a. Compressor

Model: O5G (41 cfm)

Number of Cylinders: 6

Maximum Number of Unloaders: 2

Weight (Less Service Valves): 137 lb (62 kg)

b. Compressor Oil Charge

8 U.S. Pints (3.8 litres). (Refer to section 4.12 for service replacement compressor.)

c. Approved Compressor Oils

Shrieve−Zerol Refrigeration Fluid 150 (synthetic)

d. Compressor Oil Sight Glass

Oil level should be between bottom to 1/4 of sight glass with the compressor in operation.
(Refer to section 4.13)

e. Defrost Air Switch

Initiates Defrost:

1.40 (± .07) inch (35 ± 1.8 mm) WG

f. Solid State Defrost Timer

Optional Setting:

1–1/2, 3, 6, or 12 hours

g. Defrost Thermostats

Opens: 50 ± 5°F (10 ± 3°C)

Closes: 40 ± 5°F (4.4 ± 3°C)

h. Expansion Valve Superheat

Setting at 0°F (–17.8°C) box temperature:

12 to 14°F (6.7 to 7.8°C)

i. Fusible Plug Setting

208 to 220°F (97.8°F to 104.4°C)

j. Head Pressure Control Switch (HP–2)

Cutout: 350 ± 10 psig (26 ± 0.7 kg/cm^2)

Cut–in: 235 ± 10 psig (16.5 ± 0.7 kg/cm^2)

k. High Pressure Switch (HP–1)

Cutout: 428 ± 10 psig (30 ± 0.7 kg/cm^2)

Cut–in: 320 ± 10 psig (22.5 ± 0.7 kg/cm^2)

l. Refrigeration Charge R–502

29 lb (13.2 kg)

m. Weights (Approximate)

Unit:

1690 lb. (767 kg) – **Advantage**

1720 lb. (780 kg) – **Xtra**

Battery:

Dry: 35 lb (16 kg)

Wet: 50 lb (22.7 kg)

Integral Fuel Tank:

Capacity: 33.5 gal. (126.8 litre)/ 285 lb (129 kg)

Draw: 30 gal. (113.6 litres)/ 255 lb (115.7 kg)

1.4 SAFETY DEVICES

System components are protected from damage caused by unsafe operating conditions by automatically shutting down the unit when such conditions occur. This is accomplished by the safety devices listed in Table 1–2.

1.5 ENGINE SCREW THREADS

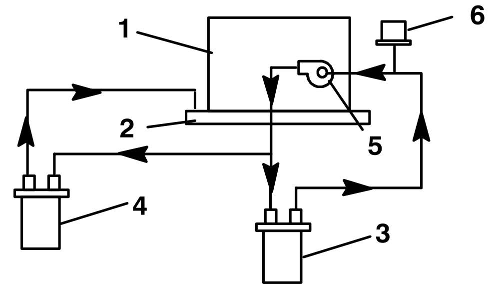
All threads used on the diesel engine are metric except the oil drain plug which is American Standard Pipe Thread (NPT).

1.6 ENGINE AIR SYSTEM

The air cleaner is put on the engine to prolong its life and performance by preventing dirt and grit from getting into the engine causing excessive wear on all operating parts. However, it is the responsibility of the operator to give the air cleaner equipment regular and constant attention in accordance with the instructions. (Refer to section 4.3.5)

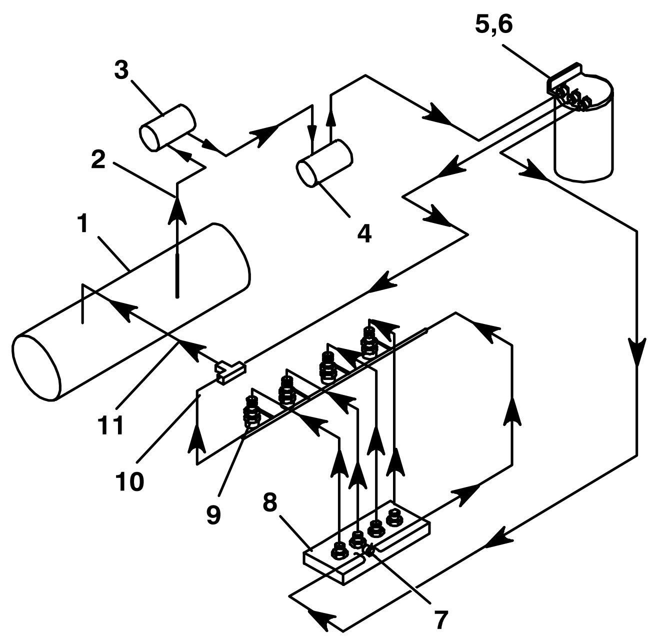
Clean air is supplied to the engine through the air cleaner (See Figure 1–1). The air is necessary for complete combustion and scavenging of the exhaust gases. As the engine piston goes through the intake stroke, the piston draws clean fresh air down into the cylinder for the compression and power strokes. As the engine goes through its exhaust stroke, the upward movement of the piston forces the hot exhaust gases out of the cylinders through the exhaust valves and the exhaust manifold. If the air filter is allowed to become dirty, the operation of the engine would be impaired.

1.7 LUBE OIL AND FUEL FLOW DIAGRAMS



1. Engine Block
2. Oil Pan
3. Full Flow Oil Filter
4. Bypass Oil Filter
5. Engine Oil Connection
6. Oil Pressure Switch

Figure 1–7. Lube Oil Flow Diagram



1. Fuel Tank
2. Fuel Supply Line
3. Fuel Pump (Optional)
4. Mechanical Lift Pump
5. Fuel Filter
6. Fuel Warmer (Optional)
7. Fuel Bleed Valve
8. Injection Pump
9. Injector Nozzles
10. Fuel Leak–off Line
11. Fuel Return Line

Figure 1–8. Fuel System Diagram

Table 1–2. Safety Devices

	Unsafe Conditions		Safety Device		Device Setting
1.	Low engine lubricating oil pressure	1.	Oil pressure safety switch (OP) – automatic reset	1.	Opens below 15 ± 3 psig (2.1 ± 1.2 kg/cm^2)
2.	High engine cooling water temperature	2.	Water temperature sensor (microprocessor)	2	Opens above 230 ± 5°F (110 ± 3°C)
3.	Excessive current draw by glow plug circuit	3.	Fuse (F1)	3.	Opens at 80 amps
4.	Excessive current draw by control circuit and starter solenoid (SS)	4.	Fuse (F2)	4.	Opens at 30 amps
5.	Excessive current draw by control circuit	5.	Fuse (F3)	5.	Opens at 20 amps
6.	Excessive current draw by microprocessor	6.	Fuse (F4)	6.	Opens at 5 amps
7.	Excessive compressor discharge pressure	7.	High pressure cutout switch (HP–1) – automatic reset	7.	Refer to Section 1.3.l. for switch settings

1.8 COMPRESSOR UNLOADER

The compressor is equipped with unloaders for capacity control. This consists of a self–contained, suction cut–off arrangement which is electronically controlled by the temperature controller.

The capacity controlled cylinders are easily identified by the solenoid which extends from the side of the cylinder head. When the solenoid energizes, cylinders unload, preventing suction gas from being drawn into the cylinder(See Figure 1–9). The unloaded cylinders operate with little or no pressure differential, consuming very little engine power. A de–energized solenoid reloads the cylinders as shown typically in Figure 1–10.

NOTE

There is a delay of 30 seconds between de–energizing one set of unloaders to de–energizing the other set of unloaders.

a. Temperature Control Within 2.7°F (1.5°C) of Set Point

1. Cool light (CL) or heat light (HL) illuminated (depending on mode of operation).

2. If in low speed cooling, unloader relays (UFR & URR) energize to unload compressor banks (compressor in two cylinder operation).

3. The heat mode forces the rear unloader (UR) to a loaded condition (de–energized). In low speed heating, unloader relay (UFR) energizes to unload compressor bank (compressor in four cylinder operation).

b. Major Working Parts

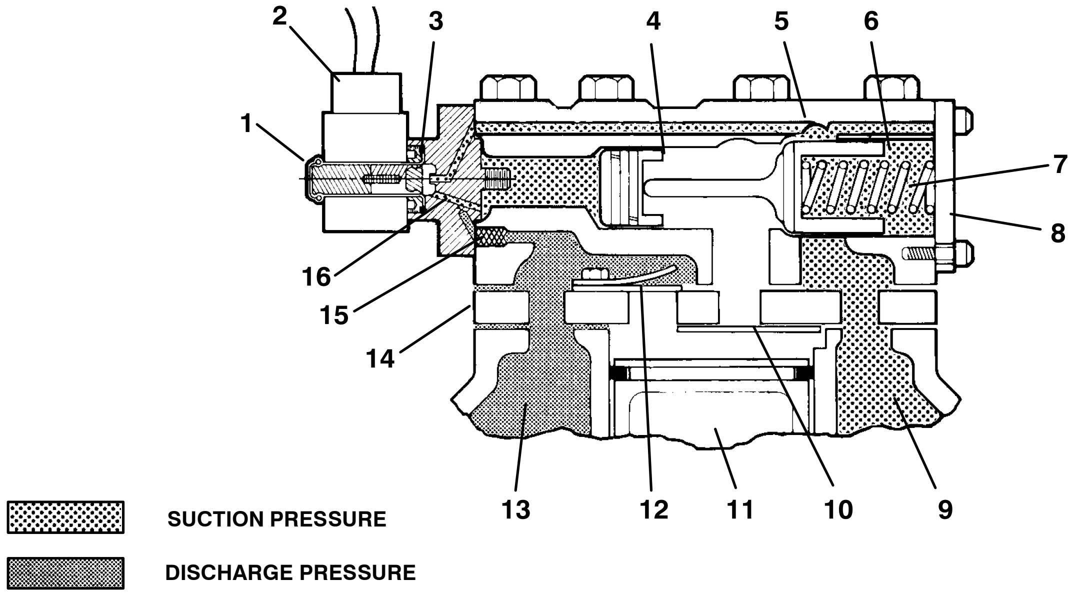
1. Solenoid and valve system
2. Unloader piston assembly
3. Spring and cover plate

c. Unloaded Operation

When the unloader valve solenoid energizes, the capacity control valve port opens (item 3, Figure 1–9). This allows the discharge gas behind the unloader piston assembly (item 4) to vent back to the suction side. The unloader valve spring (item 7) at this point, can move the unloader valve body to the left, blocking the unloader suction port. The cylinder bank is now isolated from the compressor suction manifold to unload these two cylinders. No refrigerant is allowed into the cylinders and no compression takes place.

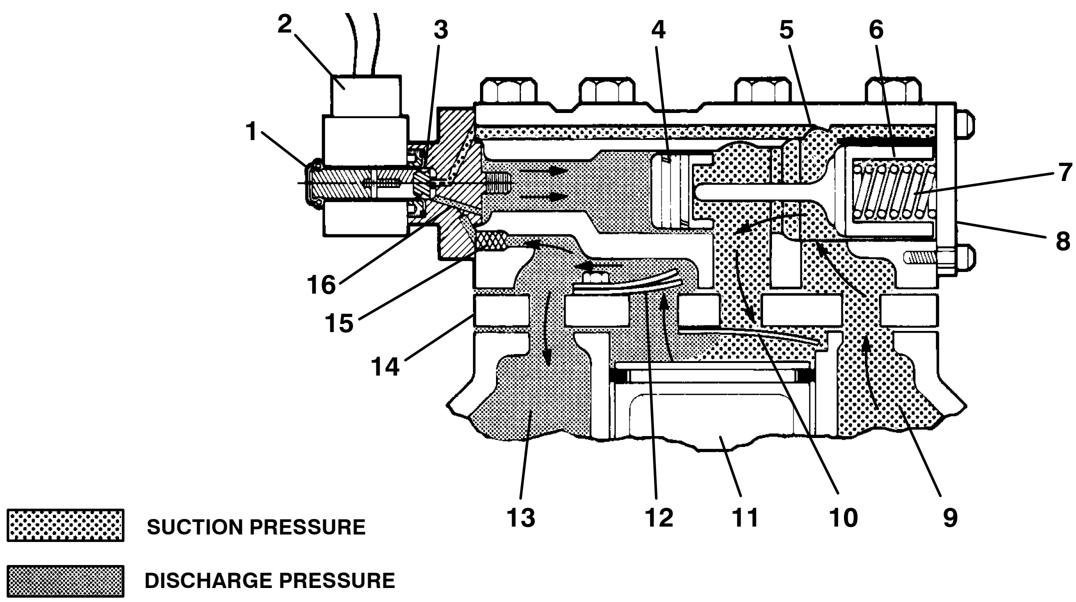
d. Loaded Operation

When the unloader valve solenoid de–energizes, the capacity control valve port closes (item 3, Figure 1–10). This allows discharge pressure to build–up behind the unloader piston assembly. A high enough pressure will compress the unloader valve spring, opening the unloader suction port. Suction gas can now be drawn into the cylinders, running the bank fully loaded.



1. Solenoid Valve
2. Coil
3. Capacity Control Valve (Open)
4. Unloader Piston Assembly
5. Unloader Head
6. Unloader Valve Body
7. Unloader Valve Spring
8. Cover Plate
9. Suction Manifold
10. Suction Valve
11. Piston
12. Discharge Valve
13. Discharge Manifold
14. Valve Plate
15. Strainer
16. Bleed Orifice

Figure 1–9. Compressor Cylinder Head (Unloaded) Suction Cutoff



1. Solenoid Valve
2. Coil
3. Capacity Control Valve (Closed)
4. Unloader Piston Assembly
5. Unloader Head
6. Unloader Valve Body
7. Unloader Valve Spring
8. Cover Plate
9. Suction Manifold
10. Suction Valve
11. Piston
12. Discharge Valve
13. Discharge Manifold
14. Valve Plate
15. Strainer
16. Bleed Orifice

Figure 1–10. Compressor Cylinder Head (Loaded) Suction Cutoff

1.9 BATTERY CHARGING ALTERNATOR SYSTEM

1.9.1 Introduction

Table 1 – 3. Alternator and Manuals

Prestolite Alternator No.	Prestolite Manual No.	Amps
8EM2012NA	25 – 197	65

It is recommended that the applicable manual (see chart above) be obtained from *Prestolite Electric, 7585 Empire Drive, P.O. Box 6210, Florence, Kentucky, 41042, U.S.A.*, for complete overhaul and service information of the alternator, and regulator, if required.

The mechanical construction of the alternator differs from the d – c generator in that the field rotates and the (armature) generating windings are stationary. The field current necessary to control the output of the alternator is supplied from the solid – state regulator. This integral voltage regulator, which incorporates an IC, all silicon semiconductor and thick – film construction, controls the current feed to the field via the brushes and rotor slip rings.

Two completely sealed ball bearings support the rotor in the front and rear housing.

CAUTION

Observe proper polarity when installing battery, negative battery terminal must be grounded. Reverse polarity will destroy the rectifier diodes in alternator. As a precautionary measure, disconnect positive battery terminal when charging battery in unit. Connecting charger in reverse will destroy the rectifier diodes in alternator.

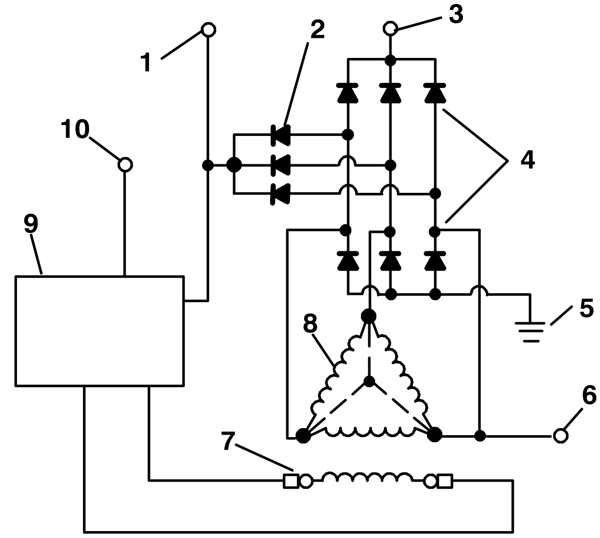
1.9.2 Alternator Operation

The alternator converts mechanical and magnetic energy to alternating current (A.C.) and voltage, by the rotation of an electromagnetic field (rotor) inside a three phase stator assembly. The alternating current and voltage is changed to direct current and voltage, by passing A.C. energy through a three phase, full – wave rectifier system. Six silicon rectifier diodes are used. (See Figure 1 – 11)

1.9.3 Integral Voltage Regulator Operation (12 volts d – c)

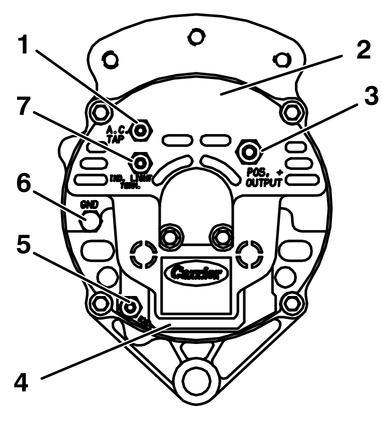
The regulator is an all – electronic, transistorized device. No mechanical contacts or relays are used to perform the voltage regulation of the alternator system. The electronic circuitry should never require adjustment and the solid state active elements used have proved reliable enough to warrant a sealed unit. The system is temperature compensated to permit the ideal charging rate at all temperatures.

The regulator is an electronic switching device. It senses the voltage appearing at the auxiliary terminal of the alternator and supplies the necessary field current for maintaining the system voltage at the output terminal. The output current is determined by the load.



1. 12vdc Test Lamp Terminal (D+)
2. Diode Trio
3. Positive Output(B+)
4. Rectifier
5. Ground
6. AC Tap
7. Rotor (Field)
8. Stator
9. Integral Regulator
10. Excite

Figure 1 – 11. Alternator Schematic Diagram



1. AC Tap
2. Back Cover
3. Positive Output(B+)
4. Integral Regulator
5. Excite
6. Ground
7. 12vdc Test Lamp Terminal (D+)

Figure 1 – 12. Alternator and Regulator

1.10 MICROPROCESSOR CONTROLLER

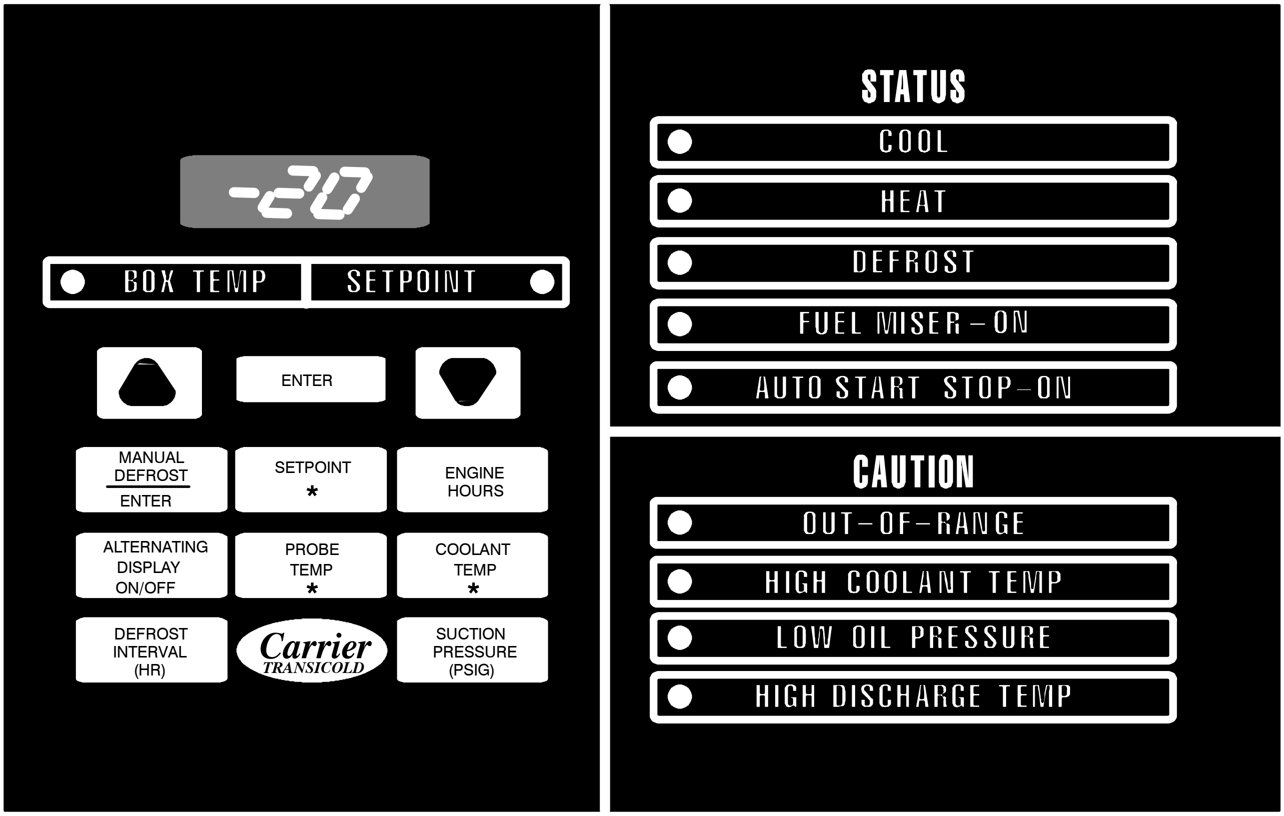


Figure 1–13. Microprocessor Control Panel

Table 1–4. Keypad LED, Digital Display Troubleshooting Messages

Failed Component or Circuit	Failure Mode	Panel LED Indication	Digital Display Readout
Oil Pressure Switch	Open	Low Oil Pressure On	None (Normal)
Oil Pressure Switch	Closed	None	None (Normal)
Water Temperature Sender	Shorted	High Coolant Temperature On	266 Flashing*
Water Temperature Sender	Open	High Coolant Temperature Flashing	–4 Flashing*
Control Probe RAS or SAS**	Open	Cool LED Flashing	–36 Flashing
Control Probe RAS or SAS*	Shorted	Cool LED Flashing	100 Flashing
DA	Shorted	Defrost LED Flashing	None (Normal)
DT	Shorted	Defrost LED Flashing	None (Normal)
Automatic Restart	Failure to Start	Auto Start/Stop on LED Flashing	None (Normal)
Out of Range (Pulldown)	If set point has not been reached since unit was started	Out of Range LED On	None (Normal)
Out of Range	±6° deviation from from set point for 15 minutes	Out of Range LED Flashing	None (Normal)

* Appropriate function must be accessed on keypad to display reading.
** If programmed for dual control only.

1.10.1 General

The microprocessor controller is housed in the control panel on the lower roadside corner of the unit. This controller consists of three printed circuit boards: a microprocessor/display, analog interface (or option board) and a relay board. The microprocessor/display and analog interface board are mounted directly to the key pad. Most outputs to control the operation of the unit are switched through the relay board which connects to the analog interface board through a ribbon cable. The relay board has five interchangeable relays that may be replaced. The microprocessor is totally self–contained and does not contain any serviceable components.

When the microprocessor wants to energize a specific relay, it will internally complete the ground path through the ribbon cable to the relay. This process will be referred to in this manual as "pulling the relay coil low." For example when the controller wants to energize the run relay (RR), it will "pull pin JJ1 low."

CAUTION

Under no circumstances should anyone attempt to service the microprocessor!(see section 4.27) Should a problem develop with the microprocessor, contact your nearest Carrier Transicold dealer for replacement.

The Carrier Transicold microprocessor controller incorporates the following features:

– Display box temperature
– Display controller set point and adjustment
– Display alternating between box temperature and controller set point
– Defrost interval timer
– Manual defrost initiation switch
– Display Remote probe temperature (optional)
– Display of supply and return air temperatures (optional)
– Display of engine and standby operating hours
– Display of engine coolant temperature and protective shutdown device
– Display of suction pressure
– Out–of–range detector
– Diagnostic display of protective shutdown devices
– Auto–start/stop operation
– Communicate unit operating data to a satellite

1.10.2 Controls and Display (See Figure 1–13)

a. Setpoint Key

To display set point, press the SETPOINT key. The set point in memory will be displayed for five seconds. When set point is displayed, the set point light emitting diode (LED) will also be illuminated. The display will revert to displaying box temperature if no other keys are pressed.

NOTE

When changing the set point, always remember to ENTER the set point.

To change set point, press the SETPOINT key. Then use the up/down arrows to adjust the set point to the desired setting. Press the ENTER key to enter the new value into memory. It is a good practice to always verify the set point after changing it by pressing the SETPOINT KEY.

b. Up/Down Arrows

The up and down arrows are used to change the values of set point and defrost interval. Also the up and down arrows are used to select ambient or discharge temperature, refer to Probe Temperature Key.

c. Enter Key

The ENTER key is used to enter new values of set point and defrost interval into memory. This key is also used to access other microprocessor functions as described herein.

d. Manual Defrost Key

To initiate a manual defrost, press the MANUAL DEFROST and ENTER keys simultaneously.

e. Alternating Display On/Off

Press the ALTERNATING DISPLAY ON/OFF key to have the display alternate between box temperature and set point at three second intervals. To terminate alternating display, press key again.

f. Defrost Interval Key

The microprocessor controller is equipped with a solid state defrost interval timer. Defrost intervals of 1.5, 3, 6, and 12 hours may be selected. To display the current defrost interval in memory, simply press the DEFROST INTERVAL key.

NOTE

Always remember to ENTER the new value when changing the defrost interval.

To change the defrost interval, press the DEFROST INTERVAL key. Use the up/down arrows to obtain the desired setting. Once the desired setting is obtained, press the ENTER key to enter the value into memory.

g. Probe Temperature Key

The Probe Temperature Key is used to display probes RAS and SAS temperature.

When this key is selected, the active (controlling) probe temperature will be displayed. On units equipped with dual probes for supply and return air control, press the PROBE TEMP and ENTER keys simultaneously to display the inactive probe temperature. If a second probe is not present, "EEE" will be displayed.

h. Engine Hours Key

Pressing the ENGINE HOURS key will display the number of accumulated engine operating hours. Note that the microprocessor will retain this value if power is removed from the unit (such as battery removal). Operating hours over 9,999 must be recorded manually as the processor will revert back to zero hours and begin counting again.

i. Coolant Temperature Key

Press COOLANT TEMP key to display engine coolant temperature.

j. Suction Pressure Key

Suction pressure may be displayed by pressing the SUCTION PRESSURE key.

k. Set point Light Emitting Diode (LED)

The set point light illuminates whenever set point is being displayed.

l. Box Temperature (LED)

The box temperature light illuminates whenever box temperature is being displayed.

1.10.3 Status Indicators (Light Emitting Diodes) (See Figure 1–13)

a. Cool LED

Indicates the unit is operating in cool mode.

b. Cool LED Flashing

Indicates a defective temperature probe. On units equipped with supply and return air probes, control of unit would automatically be changed to the other probe. In the event of probe failure on a single probe unit, the unit would be controlled as follows.

1. If the set point temperature is greater than 10°F (12.2°C), the unit would stop.
2. If the set point temperature is less than 10°F (12.2°C), the unit would operate in low speed cool (compressor fully loaded).

c. Heat LED

Indicates the unit is operating in heat mode.

d. Defrost LED

Unit is operating in defrost mode. During defrost, both heat and defrost LEDs are illuminated and “dF” appears on the display.

e. Defrost LED Flashing

Indicates a defrost mode failure. Unit is operating on override timer. Check defrost system. Refer to section 1.10.6 for defrost mode failure.

f. Fuel Miser–On LED

Unit is operating in fuel saving mode with compressor unloaded.

g. Auto Start/Stop–On LED

Unit is operating in auto start/stop mode.

h. Auto Start/Stop–On LED Flashing

Indicates the engine has not started after three successive auto start attempts or unit has failed to run a minimum of seven minutes, three consecutive times. Check starting system.

1.10.4 Caution Indicators(Light Emitting Diodes) (See Figure 1–13)

a. Out–Of–Range LED

Active probe temperature is outside of the tolerance band of ± 3°F (1.7°C) of set point. Unit on initial pulldown.

b. Out–Of–Range LED Flashing

Active probe temperature is outside of the tolerance band of ± 6°F (3.3°C) of set point for 15 minutes after unit was in–range. For set points below +10°F (–12.2°C) (frozen range) the unit is only considered out–of–range for temperatures above set point.

For example – with the controller set point at –10°F (–23.3°C), a box temperature of –20°F (–28.9°C) would not be considered out–of–range. But, if the box temperature was 0°F (–17.8°C), this would be out–of–range.

c. High Coolant Temperature LED

Engine coolant temperature excessive. Unit has shutdown to prevent engine damage.

d. High Coolant Temperature LED Flashing

Indicates a defective coolant temperature sensor. The unit will continue to operate normally. This condition should be corrected immediately as the protective shutdown is not functional.

e. Low Oil Pressure LED

Engine oil pressure low. Unit has shutdown to prevent engine damage.

f. High Discharge Temperature LED

The high discharge temperature LED is NOT APPLICABLE for these units.

1.10.5 Digital Display

a. Introduction

A four–digit liquid crystal display (LCD) is incorporated on the processor. The following parameters may be displayed:

- Box temperature
- Set point temperature
- Defrost interval setting
- Remote probe temperature
- Supply/return air temperature
- Engine/standby operating hours
- Engine coolant temperature
- Suction pressure

b. Other Display Functions (Display Message/Description)

–dF–

Indicates unit is operating in defrost. Display may be over ridden by any keypad function.

PPPP

Indicates unit is operating in pretrip mode. Display may be overridden by any keypad function.

c. Diagnostics

In addition to the above, the LCD is also used as a diagnostic interface with the operator to troubleshoot problems. Diagnostic messages are shown below:

–SP– (during self–test)

Indicates a valid set point has not been entered.

–Lb–

Indicates a low battery condition (Refer to section 1.11).

–Hb–

Indicates a high battery or over voltage condition (Refer to section 1.11).

EEEE (when reading alternate probe)

Indicates alternate probe not present or defective.

–36 (Flashing)*

On *single probe* units, probe has failed open. On *dual probe* units, both probes have failed open.

100 (Flashing)*

On *single probe* units, probe has failed closed (shorted). On *dual probe* units, both probes have failed closed.

***Note:** When probe failure occurs, cool LED will also flash.

Err1, Err2 or Err3 (during self–test)

Indicates processor logic errors. The processor is nonfunctional and must be replaced.

1.10.6 Defrost Mode Failure

The microprocessor controller monitors operation of the defrost termination switch and defrost air switch to prevent the possibility of damaging a load due to the fact that the unit is "stuck" in defrost.

Defrost mode failure is indicated by a flashing defrost LED as stated in section 1.10.3.e.

During defrost mode failure, the unit is allowed to defrost for a maximum of one hour. After this period, the unit is allowed to function normally in order to maintain load temperature for one hour. The unit is then placed back in defrost for one hour. This cycle repeats until the problem is corrected. Also, should the problem be corrected at any time, the unit returns to normal operation.

1.10.7 Controller Interface Connections (See Figure 5–1)

a. Connection Terminology

Connections to the analog interface and relay boards have terminal connections labeled "JA" thru "JK". Pin numbers are called out after the connection block number. Thus, the designation JC–3 would refer to a wire from the 3 pin on connection block JC.

b. Connection Block Descriptions (See Figure 1–5 and 5–1)

(1) Relay Board

JA Relay board inputs and outputs

JB Relay board inputs and outputs

(2) Analog interface Board

JC Main connections to analog interface board (mostly inputs)

JD Return air sensor input

JE Supply air sensor input

JF Auto–start connections (inputs and outputs)

JG Connection for external switches (pretrip,high airflow, continuous run, test board and door switches)

JH Option inputs/outputs for heat lockout, out–of–range and electric heat

JJ (Ribbon cable connection from analog interface board to relay board.) This cable controls functioning of the relay coils on the relay board.

JK (Ribbon cable connection from microprocessor display board to analog interface board)

c. Connection Descriptions

JA–1 Output to heat light on remote light bar

JA–2 Connection point for the electric fuel pump

JA–3 Not used

JA–4 Connection point for the starter solenoid relay. Note that the unit must be in "MANUAL" mode to manually crank starter motor.

JA–5 Connection point for fuel heater relay

JA–6 Main ground connection for relay board

JA–7 Output to the exciter circuit on the alternator voltage regulator

JA–8 Output to HP2 switch

JA–9 Not used

JA–10 Common with T3

JA–11 Open Not Used

JA–12 Connection point for SSR7 and arc suppression diode D53.

JA–13 Not used

JA–14 Not used

JA–15 Input to the positive side of the run relay. Input is present whenever HP1 is closed and the start–run–stop switch is in the run position.

JA–16 Not used

JB–1 (common with JB–2)

JB–2 Output to rear unloader (UR)

JB–3 Not used

JB–4 Output to TP2 which is common with the defrost air switch and defrost termination thermostats

JB–5 Input indicating the defrost termination thermostats are closed (common with JJ–3).

NOTE

Every time the defrost is initiated, a one hour clock is started in the microprocessor. After one hour the processor looks at the state of the defrost termination thermostats (DT). If the thermostats (DT) are still closed, the processor assumes that the thermostats have failed closed and the unit is placed in the defrost override mode.

Input is also used to start the timing function on the solid state defrost timer.

JB–6 Not used

JB–7 Output to defrost light on remote light bar

JB–8 Not used (common with T7)

JB–9 Output to the front unloader coil UF

JB–10 Not used

JB–11 Not used (common with T6)

JB–12 Output to SV1 – Refer to JJ–5

JB–13 Output to SV2

JB–14 Output to SV2/HP2; common with JB–13

JB–15 Output to cool light on remote light bar

JB–16 Output to SV3

JC–1 Main input to microprocessor. Power (12 vdc) should be present whenever the start–run–stop switch is in the run position. Also used to monitor battery voltage.

JC–2 Pin 2 provides the microprocessor with an input indication that the unit is being glowed for start–up.

NOTE

Oil pressure is not checked for 15 seconds after release of glow switch. For the run relay to energize for starting, the following conditions must be met: (a) coolant temperature must be less than 230°F (111°C), (b) HP1 must be closed, (c) battery voltage must be within specified minimum/maximum levels, (d) one probe must be functional and (e) a valid set point must be entered. If the above conditions are met, the run relay is energized when the glow plug switch is energized.

JC–3 Provides microprocessor with an input voltage for suction pressure transducer.

JC–4 Main ground connection pin for microprocessor and analog interface boards

JC–5 Input connector pin for water temperature sensor. This sensor provides six functions: (a) used to display coolant temperature, (b) used to shut down unit if coolant temperature is excessive, (c) used to illuminate LED if high coolant temperature exists, (d) used to determine proper glow time on auto start unit, (e) used to start unit on auto start if coolant temperature drops below 32°F (0°C) and (f) used to determine when engine can be placed in high speed after starting.

Sensor operates on an inversely proportional relationship. If coolant temperature is high, a low resistance reading will appear across sensor. To test unit for proper shutdown if coolant temperature is excessive, short sensor wire to ground.

JC–6 Not used

JC–7 Power supply to suction pressure transducer (5v)

JC–8 Alternator auxiliary input connection. This input serves three functions: (1) used to terminate cranking in the auto start mode; (2) signals the start of the 15 second oil pressure delay in manual and auto start modes; and (3) used for charging indicator for auto start shutdown.

NOTES

If the above signal (12 vdc) is not present after starting:

1. Unit will shut down in approximately 30 seconds with manual operation.

2. In auto start, the starter will be engaged for the maximum cranking time (10 seconds) and the unit will continue to run without 12 vdc at JC−8, but will not shut down automatically.

JC−9 Defrost switch input. If this pin has 12 vdc and the defrost termination switches (DT) are closed, the unit will initiate a defrost. The controller also senses this input when the defrost termination switches open. If the input still exists directly upon termination of defrost, the controller assumes the air switch is defective (stuck closed) and places the unit in defrost override. On override, the unit is alternately placed in defrost and normal control at one−hour intervals.

JC−10 Not used

JD−1 Return air sensor input connection

JD−2 Return air sensor input connection

JD−3 Ground for suction pressure transducer

JE−1 Supply air sensor input connection (optional)

JE−2 Supply air sensor input connection (optional)

JE−3 Not used

NOTE

Connections JF−1 through JF−6 are for auto start.

JF−1 Pin 1 is an input to the microprocessor indicating that the unit should be operating in auto start/stop mode.

JF−2 Pin 2 output controls the functioning of the starter solenoid relay during auto start operation. To energize the relay, the pin is pulled low by the microprocessor.

JF−3 In auto start ,the glow plug relay is controlled by output from pin 3. The pin is pulled low by the microprocessor to energize the relay.

JF−4 Output (12 vdc) for a remote bar mounted restart failure light.

JF−5 5 vdc input to the processor to indicate a 30 minute minimum off time is requested on auto start/stop. Fifteen minute minimum off time is the default value (no voltage at JF−5).

JF−6 Common 5 vdc output to the off time switch

CAUTION

Never apply 12 vdc to JD, JE, JF, or JG terminal blocks. These four items are low voltage (2.5 or 5.0 vdc). Damage to the microprocessor will result. (Refer to Note 4, Figure 5−1)

JG−1 Common output (2.5 vdc) to high airflow. Pre−trip and board test.

JG−2 Not used

JG−3 Not used

JG−4 Input (2.5 vdc) to the controller indicating the high airflow option is desired. In this mode the unit is prevented from running in low speed if the set point is set above 10°F (−12.2°C). Unloaders will function normally.

JG−5 Input (2.5 vdc) indicating pre−trip mode is desired. (Refer to section 1.12.2.e.4)

JG−6 Oil pressure switch connection used to shutdown unit if low oil pressure exists. Also controls the low oil pressure LED.

JH−2/JH−3 Not used

JH−4 Input for out−of−range light.

JH−5 Output for remote out−of−range light.

JJ−1 (Ribbon cable) If controller places potential at pin 1, run relay will not energize. If pin is pulled low, run relay will energize.

JJ−2 (Ribbon cable) Input (12 vdc) to the processor indicating electric standby mode is requested (not available)

JJ−3 (Ribbon cable) Input (12 vdc) to the processor indicating a closed defrost klixon

JJ−4 (Ribbon cable) Pin 4 controls the operation of heat relay HR2. HR2 controls the functioning of SV3 and the heat light on remote bar light. Pin 4 is pulled low to energize the relay.

JJ−5 (Ribbon cable) Pin 5 controls the operation of heat relay HR1. HR1 controls the functioning of SV2, SV1 and the cool light on a remote bar light. Pin 5 is pulled low to energize the relay.

NOTES

1. When the unit changes from cool to heat, heat relays HR1 and HR2 are energized simultaneously. Solenoid valve SV1 closes, SV3 opens, SV2 closes (if HP2 is open), the remote cool light de–energizes and the remote heat light is illuminated.

2. When the unit changes from heat to cool, heat relay HR2 de–energizes two seconds after heat relay HR1. This allows solenoid valve SV1 to open two seconds before SV3 closes. Also, note that on a remote light bar, the cool and heat lights will be on at the same time for this two–second period. Cool and heat LEDs on the processor will change immediately when HR1 de–energizes.

JJ–6 (Ribbon cable) Pin 6 controls the operation of the unloader front relay (UFR). Pin 6 is pulled low to energize the (UFR). The (UFR) is soldered into the relay board and is not replaceable.

JJ–7 (Ribbon cable) Pin 7 controls the operation of the unloader rear relay (URR). Pin 7 is pulled low to energize the (URR). The (URR) is soldered into the relay board and is not replaceable.

JJ–8 (Ribbon cable) Controls the functioning of the speed relay. Note: Speed relay is now energized for high speed operation.

JJ–9 (Ribbon cable) Controls the functioning of the defrost relay. Again, pin 9 would be pulled low to energize the relay.

JJ–10 (Ribbon cable) Interconnection for arc suppression diodes. (Connects the relay drivers on the processor to the relay coils on the relay board.)

NOTE

Main power for outputs is supplied to the relay board on the two 1/4 inch spade connections. These spade connections are independently fused and are labeled T1 & T2 .

d. Relay Board 1/4 Inch Connections

T1 Main 12 vdc power into the relay board. Supplies potential to the relay coils, defrost circuit and T3 protected by fuse F3 (20 amp).

T2 Main 12 vdc power into the relay board. Supplies potential to most of the relay contacts controlling load devices such as SV1, SV3, DDS, etc., protected by fuse F2 (30 amp).

T3 Common with T4 on diesel units.

T4 Connection common with JA–2,JA–3, JA–4,JA–5 (to electric fuel pump) and T5 .

T5 Output terminal (12 vdc) to run solenoid (RS).

T6 Output terminal (12 vdc) to speed control solenoid (SCS). This terminal is energized to place the engine in high speed .

T7 Output terminal (12 vdc) to defrost damper solenoid (DDS).

1.10.8 Remote Monitoring – Microlink(Optional)

The microprocessor controller is equipped with RS232 communication port. This port can be used to communicate unit operating data to a mobile satellite transmitter. This information will then be relayed back to the office via a modem to a computer.

1.11 AUTO START OPERATION

The automatic start/stop system is used to automatically cycle the engine off and on to save fuel, reduce wear, and, thus reduce operating costs. The system is contained in the analog interface board of the controller. It utilizes the controller sensors, glow plug and starter solenoid relays which are also used for normal operation.

This auto start system also has many of the same features as the original system such as minimum run time, low engine temperature protection, minimum off time, and three start attempts.

a. Variable Glow Time

During auto start/stop operation, glow time is automatically selected based on engine coolant temperature as follows:

Engine Coolant Temperature Glow Time	SECONDS FOR DI	TV
Less than 33°F (1°C)	30	15
33°F to 50°F (1°C to 10°C)	20	10
51°F to 77°F (11°C to 25°C)	10	5
Greater than 78°F (26°C)	5	0

b. Minimum Operating Time

A minimum operating time of seven minutes is programmed into the controller to prevent short cycling and ensure that air flows for a sufficient time to sample load temperature and prevent hot spots. In order to save fuel, if temperature requirements are not satisfied after this seven minute operating time, the controller automatically operates the unit as follows: High speed loaded cool for set points less than +10°F (–12.2°C). The controller locks unit in high speed loaded cool until set point is reached. Low or high speed loaded cool or heat for set points greater than +10°F (–12.2°C).

Short cycling is also prevented by the minimum off time switch found on the control panel. (Refer to section 1.12.2.e.6)

c. Coolant Temperature Override

The unit is prevented from stopping if coolant temperature is below 32°F (0°C). Likewise, if the unit has cycled off and coolant temperature drops below 32°F (0°C), the engine is automatically started. This feature insures proper engine starting even in cold ambient environments.

d. Battery Voltage Protection

The microprocessor controller continuously monitors battery voltage and will automatically start and stop the unit to maintain a proper voltage level. Shown in Table 1–5 is a summary of how this system operates.

e. Start Sequence

One of the features of the auto start system is the variable glow time before cranking. The glow time before cranking is dependent on the engine coolant temperature as sensed by the water temperature sensor. (Refer to paragraph a)

The engine cranking period is now a maximum of 10 seconds. If the engine starts before 10 seconds has elapsed, the alternator auxiliary signal will cause the processor to de–energize the starter solenoid relay.

Table 1–5. Battery Voltages

Condition	Message Display	Voltage Level	Description
Low battery	–Lb–	Less than 10	Unit is automatically stopped in manual or auto start/stop mode to prevent control error.
Intermediate battery	–No Display–	11.0–13.4	If the unit has cycled off in auto start/stop mode and battery voltage drops to11.0 volts, the unit is automatically started to charge battery. Unit will operate until a battery voltage of 13.4 volts is obtained at which level unit will stop if temperatures are satisfied.
High battery	–Hb–	Greater than 17	Unit is automatically stopped in manual or auto start/stop mode to prevent damaging components.

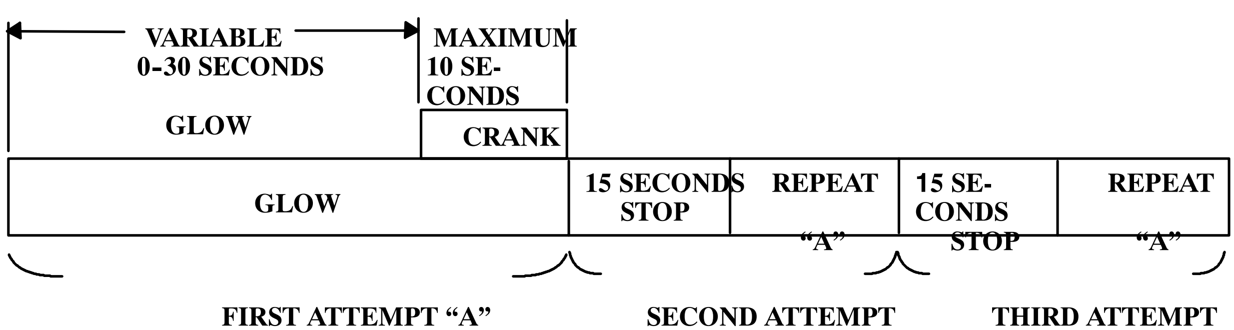


Figure 1–14. Auto Start Sequence

If the engine fails to start, after a 15 second stop period, a second start attempt identical to the first will begin. If this attempt fails, the processor will allow a third and final attempt to start. After the third failure, the processor will lock out unit operation and cause the AUTO START/STOP–ON LED to flash. The remote restart failure light will also energize. An attempt should then be made to manually start the unit. It should be noted that a restart failure indication will also be given if the unit fails to run for the 7 minute run time on three successive start attempts.

Once the unit has started automatically, the unit must run for a minimum of 7 minutes before it can consider shutting off. This minimum run time is to prevent short cycling and ensure adequate air flow through the load so that the controller can accurately sense load temperature. It also prevents hot spots in the trailer. During the minimum run time, the microprocessor will respond as required to bring trailer temperature to the desired set point.

After the minimum run time (7 minutes) the microprocessor will look at the remaining conditions that must be satisfied to allow a shutdown. These are:

1) Battery Condition – Battery voltage must be above 13.4 volts (measured at JC–1).

2) The trailer temperature must be within +1/2°F (0.3°C) of set point for both frozen and perishable range set points.

3) Engine coolant temperature must be above 32°F (0°C).

4) Alternator must be charging (12V at JC–8).

If ALL of the above four conditions are not satisfied, the engine will continue to run until they are. After the minimum run time, in order to save fuel and achieve a rapid shutdown, the microprocessor will only allow the unit to run in the modes as detailed in paragraph b (minimum operating time).

When all the shutdown conditions are satisfied, the processor breaks the run relay ground path at JJ–1. It also blanks the status LEDs to prevent battery drain. The display and caution LEDs remain activated.

Once the engine has cycled off, it will remain off for 15 or 30 minutes, depending upon the position of the off time switch. This prevents the engine from rapid cycling due to changes in air temperature. Air temperature in the trailer can change rapidly, but it takes time for the product temperature to change.

This auto start system does not include a 2 minute off time test position. The reason for this is that all timing functions of the microprocessor and the auto– start system are checked during the controller self–test when the unit is started.

After the off time is complete, the processor looks at the active probe temperature (trailer temperature). It must be at least 6°F (3.3°C) away from set point (out–of–range) for a restart to be initiated.

There are two conditions which can override the off time and trailer temperature for immediate restart. They are:

1) Coolant temperature below 32°F (0°C)

2) Battery voltage drops to 11.0 volts

Whenever the engine restarts, it must satisfy all shutdown conditions before it can again shut off.

To start the unit automatically, the engine auto start switch (EAS, Figure 5–1, coordinate H4 and P14) must be placed in AUTO position and start–run–stop switch (SRS, D2 and Q14) placed in the RUN position.

This gives the microprocessor full control of unit operation. Most of the auto start inputs/outputs to the processor are made through pins on the JF plug connector (E4).

Most of the preheat and cranking circuits are the same as manual starting except the way the glow plug and starter solenoid relays (G4 and O13) are energized with automatic starting.

The processor receives 12 vdc from SP4 (G3) to power up, and an input signal from the EAS switch at pin JF1 (E5) indicating that auto start operation is requested. If the trailer temperature is out–of–range, the processor will energize the glow plug relay (GPR) and run relay (RR) coils (located at G4 and K3) by pulling pins JF3 and JJ1 low (E5 and K2).

The GPR will energize to preheat the engine. The run relay will also energize to provide voltage to the remaining control circuits.

After 0 to 30 seconds, depending on engine type and temperature, the processor will energize the SSR coil (O13) by pulling pin JF2 (E4) low to energize the engine cranking circuit. The cranking period can last for a maximum of 10 seconds. If the engine starts sooner, a 12 vdc signal from the alternator auxiliary (ALT AUX) terminal at terminal JC8 (D5) will cause the processor to de–energize the SSR coil and terminate cranking.

The GPR will de–energized after cranking stops.

If the unit fails to start after 3 successive attempts, the remote restart failure light will turn on and the AUTO START/STOP–ON LED will flash.

It should also be noted that a restart failure indication will also be given if the unit fails to run for the 7 minute run time after three start attempts.

When all the shutdown conditions have been achieved, the processor will stop the engine by opening the ground circuit for the run relay. This removes the voltage from all the load circuits that are supplied by terminals T1 and T2 (L7 and M5) on the relay board. The processor also blanks the status LED's to conserve battery power.

During the off cycle, the processor continues to receive voltage from SP4 (G3) to JC1 and JF1 (E5). This allows the controller sensors, i.e. water temperature

(WTS) and trailer temperature (SAS or RAS) to remain active to monitor conditions for restart. The minimum off time timer is also timing. If the off time switch (D4) is in the 30 minute position as shown in Figure 5–1, 12 vdc will be placed at pin JF5 (D4). This input tells the processor to prevent starting for 30 minutes. If the off time switch is in the 15 minute position, no voltage will be present at JF5. The unit will then look at trailer temperature after 15 minutes has elapsed.

NOTE

This unit is not equipped with a 2 minute off time test position because the processor verifies proper timer function during initial self test.

After the off time has elapsed, the engine will restart when the trailer temperature deviates more than 6°F (3.3°C) from set point. In the *frozen range*, this must be a *rise* in temperature.

An immediate restart can occur for the following conditions:

1. Battery voltage drops below 11.0 volts
2. Engine coolant temperature drops to 32°F (0°C)

The above two items are called restart override conditions and are safeties to make sure that the unit will always be able to restart during automatic operation.

1.12 SWITCHES AND CONTROLS

1.12.1 Introduction

Components required for monitoring and controlling the diesel engine – refrigeration system are located in the control box and control panel. The water temperature sensor is located on top of the engine.

1.12.2 Control Panel and Related Components (See Figure 1–4 and Figure 1–5)

a. Air Filter Service Indicator – Optional With Dry Type Filter

The air filter indicator is connected to the engine air intake manifold and its function is to indicate when the air filter element requires replacing. In operation: When a plugged air cleaner element decreases intake manifold pressure to 20" (45 cm) WG, a red signal shows in the indicator. The filter element should be replaced and the indicator reset by pressing the reset button.

b. Defrost Test Points (TP1–TP2)

These terminals are used to bypass defrost termination thermostats (DTT) to allow defrost or pre–trip modes of operation when the evaporator temperature is above 35°F.

Located on the front of the control panel (see Figure 1–4), place bar across the two studs (TP1–TP2) to test defrost circuitry. After testing be sure to remove bar or the unit will remain in defrost and activate the defrost fault circuits.

c. Gauges

1. Ammeter Gauge (A)

The d–c ammeter indicates the rate of charge or discharge of the battery charging system (including batteries), battery charging alternator and the voltage regulator.

d. Sensor

1. Water Temperature Sensor (WTS)

This device senses engine water temperature and transmits a signal to the microprocessor. (Refer to JC–5)

e. Switches

1. Engine Auto Start Switch (EAS)

The switch is used to select automatic cycling of the engine, or normal continuous run operation. With the Start–Run–Stop (SRS) switch in the RUN position and the engine auto–start switch (EAS) in the AUTO position, the unit will start and stop as required to maintain cargo temperature (provided all conditions are met). (Refer to section 1.11)

The unit may be switched to continuous run by placing the EAS switch in the MANUAL position after the unit has started.

2. Glow–Plug Switch (GPS)

The glow–plug switch (momentary contact type), when held in the UP position (glow) permits battery current (approximately 7.5 amps per plug at 12 vdc) to flow to the glow plugs in the engine to pre–heat the combustion chamber. The glow plugs are located under the fuel injectors. When starting engine, it is necessary to continue to hold the glow–plug switch in the UP position until the engine has developed sufficient oil pressure to close the oil pressure safety switch (OP). (Refer to section 2.4.2)

3. Normal – High Air Flow Switch (NHS)

When hauling sensitive products that require constant high airflow, the high airflow switch may be selected. This switch prevents the unit from running in low speed in the perishable temperature range (set point greater than +10°F = –12.2.°C). Unloaders will function normally.

4. Pre–Trip Switch (PTS)

This switch is used to check the controller operating sequence through all modes of operation.

While the unit is running, place the switch in the UP position; this will initiate the pre–trip cycle through its modes as described in Table 1–6.

NOTE

To initiate PRE–TRIP, one defrost termination thermostat (DTT) must be closed (box temperature must be below 40°F =4.4°C) or a jumper placed between defrost test points (TP1–TP2) on the control panel. Then you must visually witness each mode and verify its proper operation as the controller will not record any occurring problems.

5. Off–Time Switch (OTS)

During auto start/stop operation, off time of fifteen (15) minutes or thirty (30) minutes may be selected with this bar. (See Figure 1–4)

6. Start–Run–Stop Switch (SRS)

When placed in the RUN position, this switch provides power to the processor. A self–test is initiated whenever power is first supplied to the controller. During self–test, (1) all display segments will light and show "888.8" and (2) all LED indicators will illuminate.

The controller is also checked internally. After five seconds, the controller will display the current set point entered in memory for five seconds. Box temperature will then appear.

To stop the unit or remove power from the processor, place the stop–run–start switch in the STOP position. The START position of the switch is used to manually crank the engine. (Refer to section 2.2)

If the switch is left in the RUN position, the run relay and status LEDs will be de–energized to prevent accidental draining of the battery. The display and caution lights will remain functional. The controller can be reactivated by energizing the glow plug switch.

1.12.3 Location of Engine Safety Devices

a. Oil Pressure Safety Switch (OP)

This switch, set to open below 15 ± 3 psig (1.0 ± 0.2 kg/cm^2), will automatically stop the engine upon loss of oil pressure. See Figure 1–3 for location. When the switch opens, the run relay (RR) coil is de–energized and the RR contacts open to de–energize the run solenoid (RS); thus stopping the engine.

b. Water Temperature Sensor (WTS)

This sensor, set to open at 230 ± 5°F (110 ± 3°C), will automatically stop the engine upon high water temperature. The sensor is located near the thermostat housing in the cylinder head. When the sensor opens, the run relay (RR) coil is de–energized and the RR contacts open to de–energize the run solenoid (RS); thus stopping the engine.

For auto start/stop mode see section 1.11.c.

1.13 CONDENSER SHUTTERS AND COVERS (Optional)

The primary function of the shutters and covers is to maintain higher condenser pressures for the refrigeration unit heating and defrost cycles when the unit is operating in low ambient temperatures.

The shutters and covers also help to maintain a warm engine. A thermal device located inside the top shutter (right hand side) controls the opening and closing of the shutters. The front and top shutters open or close simultaneously at a preset temperature. The shutters start to open at 70°F (21°C) condensing air temperature and are fully open at 90°F (32°C). (Refer to section 4.30)

Table 1–6. Pre–Trip Sequence Chart

Mode	Time Duration (Seconds)	Display Message*	Status LED's
High Speed Cool	30	PPPP–20 seconds Suction Pressure/10 seconds	Cool
Low Speed Loaded Cool	30	PPPP	Cool
Low Speed Unloaded Cool	30	PPPP	Cool, Fuel Miser
Low Speed Unloaded Heat	30	PPPP	Heat, Fuel Miser
Low Speed Loaded Heat	30	PPPP	Heat
High Speed Heat	30	Coolant Temperature	Heat
High Speed Cool	30	Defrost Interval	Cool
Defrost	Variable**	–dF–	Heat, Defrost

* The display message can be overridden at any time by depressing any keypad functions.

** When defrost has been initiated, it will remain in defrost until the defrost termination thermostats open or the jumper wire is removed from the defrost test points (TP1 and TP2).

1.14 REFRIGERANT CIRCUIT DURING COOLING (Refer to Figure 1−15)

When cooling, the unit operates as a vapor compression refrigeration system. The main components of the system are the (1) reciprocating compressor, (2) air−cooled condenser, (3) expansion valve, and (4) direct expansion evaporator.

The compressor raises the pressure and the temperature of the refrigerant and forces it into the condenser tubes. The condenser fan circulates surrounding air over the outside of the condenser tubes. The tubes have fins designed to improve the transfer of heat from the refrigerant gas to the air. This removal of heat causes the refrigerant to liquefy; thus liquid refrigerant leaves the condenser and flows through the solenoid valve SV−1 (normally open) and to the receiver.

The receiver stores the additional charge necessary for low ambient operation and for the heating and defrost modes. The receiver is equipped with a fusible plug which melts if the refrigerant temperature is abnormally high and releases the refrigerant charge.

The refrigerant leaves the receiver and flows through the manual receiver shutoff valve (King valve) and through a filter−drier where an absorbent keeps the refrigerant clean and dry; the refrigerant then flows through the electrically controlled liquid line solenoid valve (SV−2) which starts or stops the flow of liquid refrigerant.

On the Xtra model the refrigerant then flows through the subcooler. The subcooler occupies a portion of the main condensing coil surface and gives off further heat to the passing air.

The liquid then flows to an externally equalized thermostatic expansion valve which reduces the pressure of the liquid and meters the flow of liquid refrigerant to the evaporator to obtain maximum use of the evaporator heat transfer surface.

The refrigerant pressure drop caused by the expansion valve is accompanied by a drop in temperature; thus, the low pressure, low temperature fluid that flows into the evaporator tubes is colder than the air that is circulated over the evaporator tubes by the evaporator fan. The evaporator tubes have aluminum fins to increase heat transfer; therefore heat is removed from the air circulated over the evaporator. This cold air is circulated throughout the trailer to maintain the cargo at the desired temperature.

The transfer of heat from the air to the low temperature liquid refrigerant causes the liquid to vaporize. This low temperature, low pressure vapor passes through the "suction line−liquid line" heat exchanger where it absorbs more heat from the high pressure high temperature liquid and then returns to the compressor.

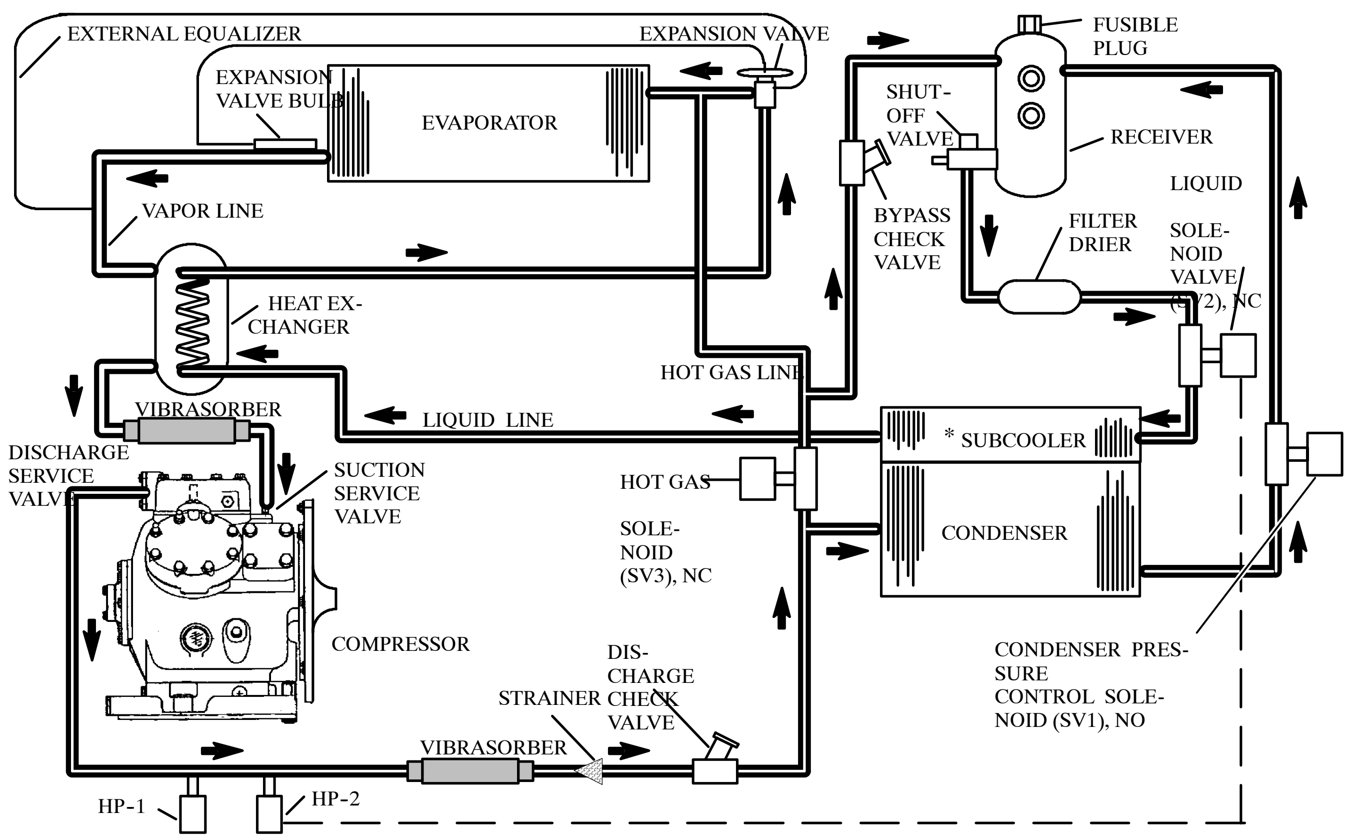


Figure 1−15. Refrigerant Circuit − Cooling

1.15 REFRIGERANT CIRCUIT DURING HEATING AND DEFROSTING (Refer to Figure 1–16)

The unit will only heat when the controller is set above +10°F (–12.2°C) as the heat relays are electronically locked out with set points below +10°F (–12.2°C).

When vapor refrigerant is compressed to a high pressure and temperature in a reciprocating compressor, the mechanical energy necessary to operate the compressor is transferred to the gas as it is being compressed. This energy is referred to as the "heat of compression" and is used as the source of heat during the heating cycle.

NOTE

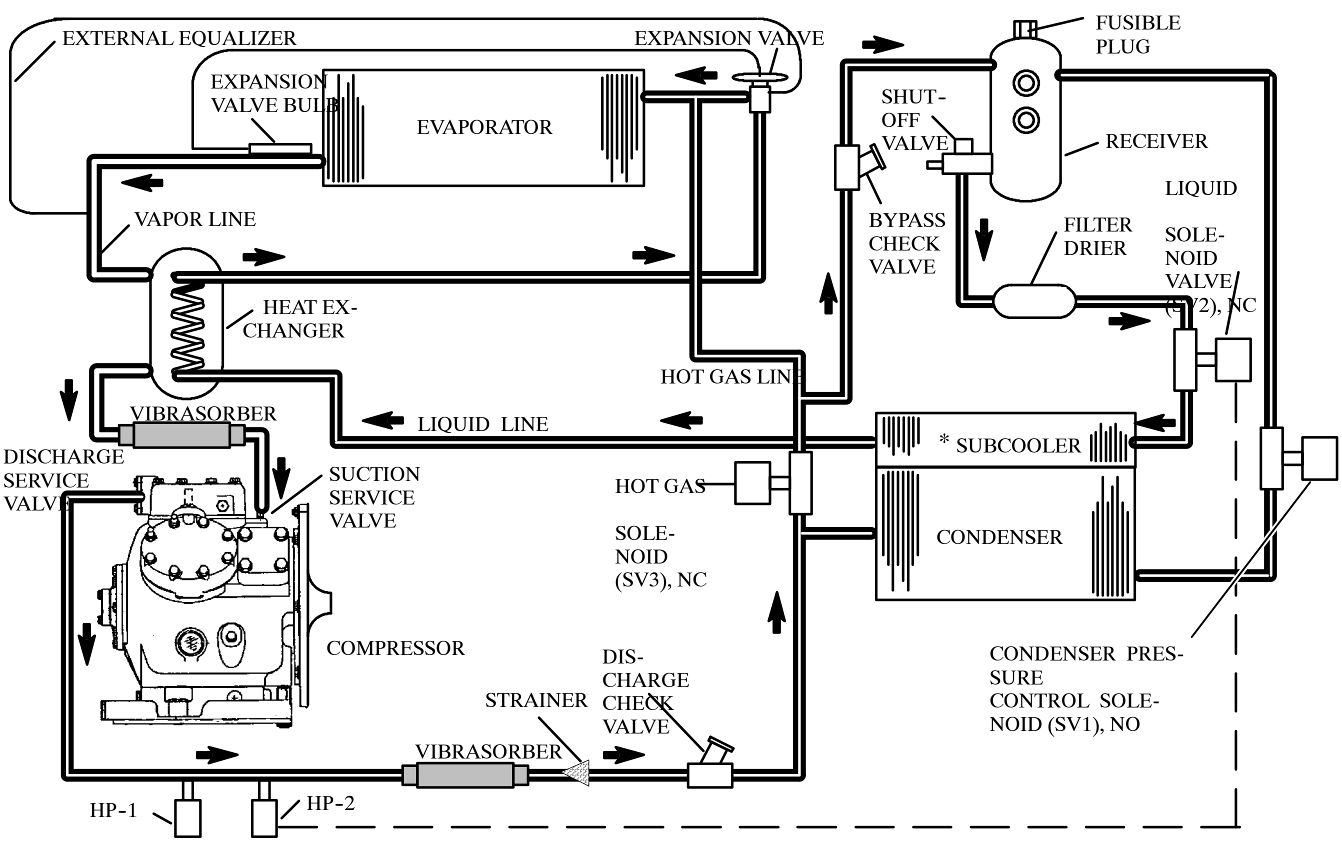
Solenoid valve (SV–2) remains open during heating or defrosting to allow additional refrigerant to be metered into the hot gas cycle (through the expansion valve) providing additional heating capacity until de–energized by head pressure control switch HP–2.

When the controller calls for heating, hot gas solenoid valve (SV–3) opens and the condenser pressure control solenoid valve (SV–1) closes. The condenser coil then fills with refrigerant, and hot gas from the compressor enters the evaporator. Also the liquid line solenoid valve (SV–2) will remain energized (valve open) as the head pressure control switch (HP–2) will remain closed until the compressor discharge pressure increases to 350 psig (24.6 kg/cm^2).

Switch HP–2 opens to de–energize the liquid line solenoid valve (SV–2) and the valve closes to stop the flow of refrigerant to the expansion valve.

When the compressor discharge pressure falls to 235 psig (16.45kg/cm^2), pressure switch (HP–2) closes and in turn energizes the normally closed solenoid valve (SV–2) which opens, allowing refrigerant from the receiver to enter the evaporator through the expansion valve.

When in engine operation and the discharge pressure exceeds pressure settings detailed in section 1.3.l., pressure cutout switch (HP–1) opens to de–energize the run relay coil (RR). When the RR coil is de–energized, the RR contacts open to de–energize the run solenoid (RS); thus stopping the engine. The function of the condenser coil bypass line is to raise the receiver pressure when the ambient temperature is low (below 0°F = –17.8°C) so that refrigerant flows from the receiver to the evaporator when needed.



* **NOTE:** SUBCOOLER ON XTRA ONLY

Figure 1–16. Refrigerant Circuit – Heating and Defrosting

SECTION 2

OPERATION

2.1 PRE–TRIP INSPECTION

a. Before Starting Engine

1. Drain water and foreign objects from fuel tank sump. Then fill tank with diesel fuel. (Refer to section 1.2.g)
2. Check radiator coolant level. (Add pre–mixed 50/50 permanent antifreeze–water as required.) USE ETHYLENE GLYCOL ONLY. (Refer to section 1.2.c)
3. Check condenser coil for cleanliness. (Refer to section 4.3.1)
4. Check engine lubrication and fuel oil filter cases, oil lines, and connections for leaks. (Tighten connections and/or replace gaskets.)
5. Check engine lubrication oil level. (Refer to section 1.2.m)
6. Check V–belts for proper tension, fraying or cracks. Adjust belt or replace.
7. Check jackshaft bearings for excessive play.
8. Check battery liquid level. (Fill per battery instructions.)
9. Check battery terminals for cleanliness and securement. Clean and coat with a mineral type grease (such as vaseline).
10. Check condenser/evaporator fan shaft bearing for excessive play.
11. Check engine air cleaner for cleanliness and condition of air cleaner hose.
12. Check oil level in compressor sight glass.
13. Check defrost drain pan hoses. (Should be clear of debris.)
14. Check evaporator and condenser coil for cleanliness.
15. Check defrost air switch tubes and connections for breaks or air leaks.
16. Check defrost damper blade and bearings.

b. After Starting Refrigeration Unit

1. After start–up, check control panel for caution light (LED).
2. Check water temperature. (Should be 170 to 210°F = 77 to 99°C.)
3. Check ammeter. (Should indicate 2 to 10 amps after start–up.)
4. Check engine speed. (Refer to section 4.3.4)
5. Listen for abnormal noises. (Refer to section 3.3.7)
6. Check compressor oil level. (Refer to section 4.13)
7. Observe any signs of lube or fuel oil leaks.
8. Check radiator hoses for leaks.
9. Check refrigerant level. (Refer to section 4.9.f)
10. Check manual defrost operation. (Refer to section 2.4.5)
11. Check operation – determine if unit responds properly to setting of controller, cycling from heat to cool, and high to low speed. (Refer to section 2.4)
12. Feel filter–drier. Excessive temperature drop across drier indicates restriction. (Refer to section 4.16)

2.2 STARTING AND STOPPING INSTRUCTIONS – ENGINE DRIVE

a. Starting Instructions (Manual Starting)

WARNING

Under no circumstances should ether or any other unauthorized starting aids be used in conjunction with the glow plugs.

NOTE

Whenever starting the engine, in order to reduce starter cranking and engine loads, the microprocessor always starts and operates in low speed, unloaded cool for the first 15 seconds. Upon completion of this period, the microprocessor will allow the unit to operate normally, providing the coolant temperature is above 77°F (26°C). In order to prolong engine life, the microprocessor will prevent operation in high speed until coolant temperature reaches this temperature.

1. Place engine auto start switch (EAS) in MANUAL position.
2. Place start–run–stop switch in RUN position. A self–test sequence will begin. All display segments and lights will illuminate for five seconds. The current set point will then be displayed for five seconds.
3. Place the glow plug switch in GLOW position as follows:

Ambient Temperature	Glow Time
Below 0°F (–17.8°C)	30 seconds
0 to 32°F (–17.8 to 0°C)	20 seconds
Above 32°F (0°C)	10 seconds

4. While holding glow plug switch in GLOW, place the start–run–stop switch in START. After starting, release start switch, then the glow plug switch. If the engine does not start after cranking 15 seconds, release start switch and repeat starting procedure.

5. Set controller at desired set point. Make sure to depress ENTER key.
6. Check defrost interval by pressing DEFROST INTERVAL key. Adjust as desired.

b. Stopping Instructions

Place start–run–stop switch (SRS) in the STOP position.

2.3 STARTING AND STOPPING INSTRUCTIONS – AUTO START

a. Starting Instructions

1. Place engine auto start switch in AUTO.
2. Place start–run–stop switch in the RUN position. During auto–start–stop operation, unit will automatically start and stop in response to changing box temperature. (With engine auto start switch in MANUAL, unit will operate continuously after starting.)

b. Stopping Instructions

Place start–run–stop switch in the STOP position.

2.4 CONTROL CIRCUIT OPERATION

2.4.1 Introduction

The electrical schematic (figure 5–1) for units equipped with the microprocessor controller is basically the same as other Carrier Transicold equipment. The schematic is read from top to bottom and left to right, with switches on the left and load devices on the right. There are several exceptions to this, however, due to the layout of the controller. The controller boards shown on the schematic that interface with unit components are the analog interface or processor board on the left and the relay board on the right.

Connections to these boards are made through several multiple–pin plug connectors. These connectors are labeled JA to JJ. JA and JB are located on the relay board while JC to JJ are on the analog interface board.

The analog interface board connections are mainly inputs and outputs for control switches, temperature sensors, safety, and auto start functions that control the operation of the unit. The processor board also controls the operation of the relay board through the ribbon cable connected to the JJ plug connection.

The relay board, which contains five plug–in interchangeable relays provides the microprocessor with a means for switching the unit components to achieve a desired operating mode. On the relay board, the heavy lines represent printed circuit traces, not actual wires. Most circuits will be traced on the relay board from left to right. The main 12 vdc power for all outputs enters the board at spade terminals T1 and T2. All relay outputs through the plug connectors JA and JB leave from the right of the board to the appropriate load device.

NOTE

To make it easier to locate the schematic components referred to in the written text, the schematic in this manual has map coordinates added to the margins. For example, to locate the ammeter (A) on the schematic, it would follow the component designation by the designation (E2). This would indicate that it is closest to lines E and 2 on the schematic. These locations have also been added to the legend.

2.4.2 Engine Preheat and Start–up

To preheat the engine, the start–run–stop switch must be placed in the RUN position. This allows current to flow from the battery (figure 5–1), coordinates G2, through the fusible link, ammeter, 30A fuse and the 5A fuse to the start–run–stop switch (figure 5–1, D2).

When the SRS is in the run position, voltage is placed at splice point SP4 (G3). From SP4, current is fed to terminal JC–1 (E5) on the processor. *This is the main power input to the controller. The main processor ground connection is made from pin* JC–4 (E6). The processor will now go through a 5 second self–test to check logic circuits and timing functions.

If any problems exist within the processor, it will not allow the unit to start. An error message will then be displayed. (Refer to section 1.10.5.)

Splice point SP4 also supplies potential through HP1 (O–11) to JA–15 (O–11). From JA–15 it passes through a printed circuit containing diode D68 (K4) to the run relay coil (RR, K3). The processor will allow the run relay to energize when the glow plug switch is energized, providing the following conditions are met:

1. Engine coolant temperature is below 230°F (110°C).
2. The controller probe is functional.
3. Battery voltage is within prescribed limits (see table 1–5).

Placing the glow plug switch (GPS, located at F5) in the GLOW position completes a ground path for the glow plug relay coil (GPR, also located at F5). The coil energizes and the GPR normally open (N.O.) contacts (B2) close supplying voltage to the glow plugs (G3).

When the run relay (K3) energizes, the normally open RR contacts (L6, L8, and M10) close, supplying potential to the remaining refrigeration and engine control circuits. Voltage is supplied to the heat, unloader, and speed relays through diode D54 (L4) on the relay board.

The processor will allow only the unloader relays to energize by pulling terminals JJ–6 & JJ–7 (L2) low (allowing a ground path). This enables the unit to start in low speed unloaded cool to reduce engine loading. Voltage is also supplied through printed circuits to terminals JB–13 and JB–15 (N4) to energize SV–2 and the remote cool light.

The same circuit also supplies power to test point TP2, defrost air switch and the defrost termination thermostats.

Through the second set of RR contacts (L8), current will flow through diode D58 (M11) and JA–7 to the voltage regulator. It will also flow to JA–10 and to T3 , T4 , T5 and JA–5 to energize the run solenoid, fuel pump and to supply voltage to the starter solenoid relay coil (SSR) circuit (O–13).

To start the engine, placing the start–run–stop switch (D2, momentary contact) in the START position completes the ground path for the starter solenoid relay coil which energizes. The normally open (N.O.) SSR contacts (F1) close to energize the starter solenoid (located in the starter). When the solenoid pulls in, its N.O. contacts (G2) close to energize the starter motor.

Once the engine has started, the start and glow plug switches can be released.

For the unit to remain running, the engine must maintain at least 15 psig (1.0 kg/cm^2) oil pressure.

The microprocessor will always place the unit in low speed unloaded cool for 15 seconds after starting.

2.4.3 Cooling

The controller automatically selects the mode(s) necessary to maintain box temperature at set point. The modes are as follows with descending temperatures:

(a) High speed loaded cool, (b) low speed loaded cool, (c) low speed unloaded cool, (d) low speed unloaded heat, (e) low speed loaded heat, and, (f) high speed loaded heat.

If the unit is in high speed loaded cool, the microprocessor will pull terminal JJ–8 (M2) low to energize the speed relay (M3). A set of normally open contacts (SR, N7) close to energize the speed control solenoid (SCS, located at O7). The engine will be in high speed.

When the unit is running in high speed loaded cool and with the evaporator coil temperature below 35°F (1.7°C) to close at least one defrost termination thermostat (O3) , a pretrip may be initiated at this time by depressing the pretrip switch (PTS, F9). The operator now may verify the pretrip sequence.
(Refer to table 1–6)

As the trailer temperature falls toward set point, the microprocessor will place the unit in low speed loaded cool (compressor in six cylinder operation). The temperature at which this occurs is not fixed but depends upon the rate at which the trailer temperature is approaching set point.

The speed relay (SR, located at M3) de–energizes to open the circuit to the speed control solenoid (SCS, located at O7). Engine speed decreases from high speed to low speed and the compressor remains in six cylinder operation.

If the trailer temperature falls closer to set point, the controller will shift the operation from low speed loaded cool to low speed unloaded cool to further reduce cooling capacity. To do this, the microprocessor will pull terminals JJ–6 & JJ–7 (M2) low, completing the ground path for the unloader relays (UFR & URR, located at M3). The coils energizes to close the UFR & URR contacts. This in turn supplies voltage to terminals JB–1, JB–2 & JB–9. Both unloaders (UF and UR) energize to unload the compressor (compressor in two cylinder operation, center bank loaded).

For set points above +10°F (12.2°C) and with decreasing temperature, the unit will shift to low speed unloaded heat.

Unit will remain in various stages of heating until the box temperature increases enough to place the unit in the low speed unloaded cool mode. As the box temperature increases, the unit will shift to low speed loaded cool, and then to high speed cool mode (speed relay energizes).

2.4.4 Heating

Refer to section 1.15 for description on heating cycle and to JJ–5 connection in section 1.10.7.c.

The unit will only heat when the controller is set above +10°F (–12.2°C) as the heat relays are electronically locked out with set points below +10°F (–12.2°C).

The controller automatically selects the mode(s) necessary to maintain box temperatures at set point. The heating modes are as follows with descending temperatures:

(a) Low speed unloaded heating, (b) low speed loaded heating, and, (c) high speed loaded heating.

The controller will shift the unit into low speed unloaded heat if the trailer temperature falls toward set point (compressor in four cylinder heating). The microprocessor pulls terminals JJ–4, JJ–5 and JJ–7 (L2) low to complete the ground paths for the heat relays (HR1 and HR2, located at L3) and unloader rear relay (URR, also at L3). When these relays energize, several things happen. HR1 will open the two normally closed (N.C.) HR1 contacts (M4) to the cool light and solenoid valve (SV2). SV2 now operates in conjunction with the head pressure control switch (HP2 located at P5). (Refer to section 1.15)

Also, HR1 closes a set of normally open contacts (M7) to energize solenoid valve SV1 to close the condenser outlet line.

When the unloader front relay (UFR at L3) energizes, a set of N.O. contacts (UFR at N9) close to energize the compressor front unloader (UF, located at O8). Compressor will be in four cylinder heating.

Energizing HR2 closes two sets of N.O. contacts (JB–16 and JA–1, located at N8 and N9). Solenoid SV3 energizes and mechanically opens to supply hot refrigerant vapor to enter the evaporator (section 1.15). The other set of HR2 contacts supply power to the heat light.

If more heating capacity is required, the unit will shift to low speed loaded heating. The microprocessor will break the ground path to JJ–7 to de–energize the unloader relay (M3), which in turn, de–energizes the compressor unloaders (compressor shifts from four cylinder to six cylinder operation).

When maximum heating capacity is required, the unit will shift to high speed loaded heat. The microprocessor energizes the HR1, HR2, and speed relay (SR) coils. Terminals JJ–4, JJ–5 and JJ–8 (L2) will be pulled low. The only change from the low speed loaded heat mode is that the speed relay is now energized. (SR contacts at N6 close to energize the speed control solenoid (SCS). The engine will be in high speed.

NOTE

Whenever the unit shifts to heat or defrost, HR1 and HR2 energize simultaneously. When switching from heat (or defrost) to cool, HR1 de−energizes 2 seconds before HR2. This allows time for SV−1 to open and clear the condenser of liquid before SV3 closes. This will eliminate any high pressure buildup which could occur. During this time, only on the remote light bar, the heat and cool lights will be on together. The heat and cool LED on the control panel change immediately.

2.4.5 Defrost

Refer to sections 1.10.2.f and 1.15 for the heat and defrost cycle.

NOTE

The unit will be in high speed in the defrost mode.

The defrost mode may be initiated by three different ways if the evaporator coil is below 35°F (1.7°C). (Refer to section 1.3.)

Method one to initiate defrost is by pressing the MANUAL DEFROST and ENTER keys simultaneously.

Method two is that defrost may be initiated automatically at preset intervals by the defrost timer built into the controller. (Refer to section 1.10.2.f). The manual defrost key and defrost timer are part of the microprocessor and are not shown on the schematic.

The third means of defrost initiation is by the defrost air switch (DA). The switch (located at P2) is a differential pressure air switch which measures differential air pressure across the evaporator coil and initiates the defrost cycle when the air pressure increases enough to close the DA contacts, such as would happen when excessive frost builds up on the evaporator coil surface. (Refer to section 1.3.e.)

When the air switch contacts close, a 12 vdc potential to terminal JC−9 (E6) on the microprocessor. The processor looks for voltage at terminal JJ−3 (N2). Voltage at JJ−3 indicates that at least one defrost termination thermostat (O3) is closed. The unit will shift to the defrost mode if voltage is present at JJ−3.

If both thermostats (klixons) are open (no voltage at JJ−3), defrost cannot be initiated by any means.

In defrost the processor pulls terminals JJ−4, JJ−5, and JJ−8 low (L2 & M2) to shift the unit into high speed heat. The processor also pulls terminal JJ−9 (N2) low to energize the defrost relay coil (N3). This closes the defrost relay contacts (two sets of N.O. contacts JB−7, and T7) to energize the damper solenoid (DDS) and the defrost light on the remote light bar. The defrost and heat light emitting diodes (LED) will also be illuminated.

The unit will remain in defrost until both defrost termination thermostats (O3) open to remove voltage from the defrost relay. If the thermostats fail to open in one hour, the processor will terminate defrost and shift between normal control and defrost at one hour intervals. This will also occur if the defrost air switch is stuck closed. Also, refer to JC−9 and JJ−3 in section 1.10.7.c.

If the problem corrects itself, (thermostats or damper opens for example), the unit will automatically resume its normal functions and the DEFROST LED will stop flashing (on STATUS board).

Table 2–1. Electrical Control Positions – Set Point Below +10°F (–12.2°C)

CONTROL CIRCUIT	HIGH SPEED COOLING	LOW SPEED COOLING	LOW SPEED HEATING	HIGH SPEED HEATING	DEFROST
Compressor Unloaders (UF & UR)	De–energized	See Note 1	Not Applicable	Not Applicable	De–energized
Condenser Pressure Control Valve (SV–1)	De–energized	De–energized	Not Applicable	Not Applicable	Energized
Defrost Relay (DR) and Solenoid (DDS)	De–energized	De–energized	Not Applicable	Not Applicable	Energized
Heat Relay (HR1 and HR2)	De–energized	De–energized	See Note 2	See Note 2	Energized
Hot Gas Solenoid Valve (SV–3)	De–energized	De–energized	Not Applicable	Not Applicable	Energized
Light Emitting Diodes (LED)					
Cool (CL)	ON	ON	OFF	OFF	OFF
Heat (HL)	OFF	OFF	Not Applicable	Not Applicable	ON
Defrost (DL)	OFF	OFF	OFF	OFF	ON
Liquid Line Solenoid Valve (SV–2)	Energized	Energized	Not Applicable	Not Applicable	See Note 3
Speed Control Solenoid (SCS)	Energized	De–Energized Applicable	Not Applicable	Not	Energized
Speed Relay (SR)	Energized	De–energized	Not Applicable	Not Applicable	Energized

NOTES:
1. Unit will operate with energized or de–energized unloaders. (Refer to section 1.8)
2. The heat relay is prevented from energizing with set points below +10°F (–12.2°C).
3. Solenoid Valve SV–2 opens or closes in response to head pressure control switch HP–2 (Refer to section 1.15)

Table 2–2. Electrical Control Positions – Set Point Above +10°F (–12.2°C)

CONTROL CIRCUIT	HIGH SPEED COOLING	LOW SPEED COOLING	LOW SPEED HEATING	HIGH SPEED HEATING	DEFROST
Compressor Unloaders (UF & UR)	De–energized	See Note 1	See Note 1	De–energized	De–energized
Condenser Pressure Control Valve (SV–1)	De–energized	De–energized	Energized	Energized	Energized
Defrost Relay (DR) and Solenoid (DDS)	De–energized	De–energized	De–energized	De–energized	Energized
Heat Relay (HR1 and HR2)	De–energized	De–energized	Energized	Energized	Energized
Hot Gas Solenoid Valve (SV–3)	De–energized	De–energized	De–energized	Energized	Energized
Light Emitting Diodes (LED)					
Cool (CL)	ON	ON	OFF	OFF	OFF
Heat (HL)	OFF	OFF	ON	ON	ON
Defrost (DL)	OFF	OFF	OFF	OFF	ON
Liquid Line Solenoid Valve (SV–2)	Energized	Energized	See Note 2	See Note 2	See Note 2
Speed Control Solenoid (SCS)	Energized	De–energized	De–energized	Energized	Energized
Speed Relay (SR)	Energized	De–energized	De–energized	Energized	Energized

NOTES:
1. Unit will operate with energized or de–energized unloaders. (Refer to section 1.8)
2. Solenoid Valve SV–2 opens or closes in response to head pressure control switch HP–2 (Refer to section 1.15)

SECTION 3
TROUBLESHOOTING

CAUTION

Under no circumstances should anyone attempt to service the microprocessor!(see section 4.27) Should a problem develop with the microprocessor, contact your nearest Carrier Transicold dealer for replacement.

3.1 DIESEL ENGINE

INDICATION/ TROUBLE	POSSIBLE CAUSES	REFERENCE PARAGRAPH
3.1.1 Engine Will Not Start		
Starter motor will not crank or low cranking speed	Battery insufficiently charged	Check
	Battery terminal post dirty or defective	Check
	Bad electrical connections at starter	Check
	Starter motor malfunctions	3.1.3
	Starter motor solenoid defective	Engine Manual
	Open starting circuit	3.1.4
	Incorrect grade of lubricating oil	1.2.m
Starter motor cranks but engine fails to start	No fuel in tank	1.2.g & 1.3.n
	Air in fuel system	4.2
	Water in fuel system	Drain Sump
	Plugged fuel filter	Replace
	Plugged fuel lines to injector (s)	Check
	Fuel control operation erratic	4.3.3
	Glow plug(s) defective	4.3.8
	Run solenoid (RS) defective	4.3.3
	Fuel pump (FP) malfunction	4.2
Starter cranks, engages, but dies after a few seconds	Engine lube oil too heavy	1.2.m
	Voltage drop in starter cable(s)	Check
3.1.2 Engine Starts Then Stops		
Engine stops after several rotations	Fuel supply restricted	Check
	No fuel in tank	1.2.g
	Leak in fuel system	Check
	Faulty fuel control operation	4.3.3
	Fuel filter restricted	Replace
	Injector nozzle(s) defective	Engine Manual
	Injection pump defective	Engine Manual
	Air cleaner or hose restricted	4.3.5
	Safety device open	1.4
	Open wiring circuit to run solenoid (RS)	Check
	Fuel pump (FP) malfunction	4.2
3.1.3 Starter Motor Malfunction		
Starter motor will not crank or turns slowly	Battery insufficiently charged	Check
	Battery cable connections loose or oxidized	Check
	Battery cables defective	Replace
	Starter brushes shorted out	Engine Manual
	Starter brushes hang up or have no contact	Engine Manual
	Starter solenoid damaged	Engine Manual
	Start–Run–Stop switch defective	Replace
	Engine lube oil too heavy	1.2.m

INDICATION/ TROUBLE	POSSIBLE CAUSES	REFERENCE PARAGRAPH
3.1.3 Starter Motor Malfunction (CONTINUED)		
Starter motor turns but pinion does not engage	Pinion or ring gear obstructed or worn	Clean both, remove burrs, or replace; apply grease
Starter motor does not disengage after switch was depressed	Start–Run–Stop switch defective	Replace
	Starter motor solenoid defective	Engine Manual
Pinion does not disengage after engine is running	Defective starter	Engine Manual
3.1.4 Malfunction In the Engine Starting Circuit		
No power to starter motor solenoid (SS)	Battery defective	Check
	Loose electrical connections	Tighten
Run solenoid (RS) does not energize or does not remain energized	Battery defective	Check
	Loose electrical connections	Tighten
	Oil pressure safety switch (OP) defective	Replace
	Run relay (RR) defective	Replace
	Water temperature safety switch (WT) open	1.2.c
	Water temperature sensor (WTS) defective	Replace
	Run solenoid (RS) defective	4.3.3
	Start–Run–Stop switch (SRS) defective	Replace
3.2 ALTERNATOR (AUTOMOTIVE TYPE)		
Alternator fails to charge	Limited charging system operating time	Check
	Battery condition	Check
	Alternator belt loose/broken	4.5
	Loose, dirty, corroded terminals, plugs or broken leads	Check/Repair
	Excessively worn, open or defective brushes	4.4.5
	Open blocking diode	Check D58
	Regulator faulty	4.4.4
	Open isolation diode	4.4.4
	Open rotor (field coil)	Replace
Low or unsteady charging rate	Alternator belt loose	4.5
	Loose, dirty, corroded terminals, plugs or broken leads	Check/Repair
	Excessively worn, sticky or intermittent brushes	4.4.5
	Faulty regulator	4.4.4
	Grounded or shorted turns in rotor	4.4
	Open, grounded or shorted turns in stator	Replace
Excessive charging rate (as evidenced by battery requiring too frequent refilling) or charge indicator shows constant “charge with engine idling”	Regulator leads loose, dirty, corroded terminals, plugs or wires broken	Clean/Repair or Replace
	Defective regulator	4.4.4
Noisy alternator	Defective or badly worn V–belt	4.5
	Worn bearing(s)	Replace alternator
	Misaligned belt or pulley	4.5
	Loose pulley	Tighten

INDICATION/ TROUBLE	POSSIBLE CAUSES	REFERENCE PARAGRAPH
3.3 REFRIGERATION		
3.3.1 Unit Will Not Cool		
Diesel engine	Malfunction(s)	3.1
Compressor malfunction	Compressor drive defective	4.12
	Compressor defective	4.12
Refrigeration system	Defrost cycle did not terminate	3.3.5
	Abnormal pressure	3.3.6
	Solenoid valve malfunction	3.3.11
3.3.2 Unit Runs But Has Insufficient Cooling		
Compressor	Compressor valves defective	4.12
	Unloader malfunction	4.14
Refrigeration system	Abnormal pressure	3.3.6
	Unloader malfunction	4.14
	Expansion valve malfunction	3.3.10
	No or restricted evaporator airflow	3.3.9
Engine does not develop full rpm	Speed control linkage	4.3.4
	Engine malfunction	3.1
3.3.3 Unit Operates Long or Continuously in Cooling		
Container	Hot Load	Allow time to pull down
	Defective box insulation or air leak	Correct
Refrigeration system	Abnormal pressure	3.3.6
	Temperature controller malfunction	3.3.8
Compressor	Defective	4.12
3.3.4 Unit Will Not Heat or Has Insufficient Heating		
Refrigeration	Head pressure control switch (HP−2) defective	4.17
	Abnormal pressure	3.3.6
	Temperature controller malfunction	3.3.8
	Condenser shutter malfunction	3.3.12
	Solenoid valve malfunction	3.3.11
	1/4” check valve (bypass) defective	4.15
Compressor	Compressor drive defective	4.12
	Compressor defective	4.12
Engine does not develop full rpm	Speed control linkage	4.3.4
	Engine malfunction	3.1

INDICATION/ TROUBLE	POSSIBLE CAUSES	REFERENCE PARAGRAPH
3.3.5 Defrost Cycle Malfunction		
Will not initiate defrost automatically	Defrost air switch (DA) out of calibration	4.22
	Defrost thermostats open or defective	4.21
	Defrost air switch (DA) defective	4.21 & 4.22
	Loose terminal connections	Tighten
	Damper solenoid relay (DDS) defective	4.24
	Air sensing tubes defective or disconnected	Check
Will not initiate defrost manually	Manual defrost switch defective	Replace
	Loose terminal connections	Tighten
	Damper solenoid relay (DDS) defective	Replace
	Defrost thermostats (DT) open or defective	Replace
Initiates but does not defrost	Solenoid valve malfunction	3.3.11
	Defrost relay (DR) defective	Replace
	Defrost damper solenoid (DDS) or linkage defective	4.24
	Damper open or defective	4.24
Frequent defrost	Defrost air switch (DA) out of adjustment	4.21 & 4.22
	Wet load	Normal
Damper blade does not close	Defrost damper solenoid (DDS) defective	4.24
	Damper defective	4.24
Does not terminate or cycles on defrost	Defrost damper linkage disconnected	4.24
	Defrost thermostats (DT) shorted closed	4.21
	Manual defrost switch shorted closed	Replace
	Head pressure control switch (HP−2) defective	4.17
	Low refrigerant charge	4.10
	Defrost air switch (DA) out of adjustment	4.21 & 4.22
3.3.6 Abnormal Pressure		
3.3.6.1 Cooling		
High discharge pressure	Condenser shutter malfunction	3.3.12
	Condenser coil dirty	4.3.1
	Condenser fan defective	4.23
	V−belt broken or loose	4.5
	Discharge check valve restricted	4.15
	Noncondensibles or refrigerant overcharge	4.11
	Solenoid valve (SV−1) malfunction	4.20
Low discharge pressure	Compressor valves(s) worn or broken	4.12
High suction pressure	Compressor valves(s) worn or broken	4.12
	Compressor gasket(s) defective	4.12
Low suction pressure	Suction service valve partially closed	Open
	Receiver outlet valve partially closed	Open
	Filter−drier partially plugged	4.16
	Low refrigerant charge	4.10
	Solenoid valve (SV−2) defective	4.19
	Expansion valve malfunction	3.3.10
	No evaporator air flow or restricted air flow	3.3.9
	Excessive frost on coil	4.21
Suction and discharge pressures tend to equalize when unit is operating	Compressor valves defective	4.21

INDICATION/ TROUBLE	POSSIBLE CAUSES	REFERENCE PARAGRAPH
3.3.6.2 Heating		
High discharge pressure	Solenoid valves (SV−1 or SV−3) malfunction	3.3.11
	Condenser fan defective	4.23
	V−belts broken or loose	4.5
	Noncondensibles in system	4.11
	Head pressure control switch (HP−2) defective (closed)	4.17
	Condenser shutter malfunction	3.3.12
Low discharge pressure	Compressor valve(s) worn or broken	4.12
	Head pressure control switch (HP−2) defective(open)	4.17
	Solenoid valve (SV−1) malfunction	3.3.11
	Low refrigerant charge	4.10
	Condenser shutter malfunction	3.3.12
Low suction pressure	Refrigerant shortage	4.10
	Solenoid (SV−1) open	3.3.11
	Defective HP−2	4.17
3.3.7 Abnormal Noise		
Compressor	Loose mounting bolts	Tighten
	Worn bearings	4.12
	Worn or broken valves	4.12
	Liquid slugging	3.3.10
	Insufficient oil	4.13
Condenser or evaporator fan	Loose or striking shroud	Check
	Bearings defective	4.23
	Bent shaft	4.23
Jackshaft	Bearings defective	4.5
V−belts	Cracked or worn	4.5
3.3.8 Solid State Control System Malfunction		
Will not control	Sensor defective	4.28
	Relay(s) defective	Check
	Microprocessor malfunction	4.27
3.3.9 No Evaporator Air Flow or Restricted Air Flow		
Evaporator coil blocked	Frost on coil	4.21
	Dirty coil	4.3.1
No or partial evaporator air flow	V−belt broken or loose	4.5
	Jackshaft defective	Replace
	Evaporator fan loose or defective	4.23
	Evaporator fan rotating backwards	4.5
	Evaporator air flow blocked in trailer (box)	Check
	Defrost damper in the closed position	4.24

INDICATION/ TROUBLE	POSSIBLE CAUSES	REFERENCE PARAGRAPH
3.3.10 Expansion Valve Malfunction		
Low suction pressure with high superheat	Low refrigerant charge	4.7/4.10
	External equalizer line plugged	Clean
	Ice formation at valve seat	4.8
	Wax, oil or dirt plugging valve or orifice	4.26
	Broken capillary	4.26
	Power assembly failure or partial	Replace
	Loss of element/bulb charge	Replace
	Superheat setting too high	4.26.c
Low superheat and liquid slugging in compressor	Superheat setting too low	4.26.c
	External equalizer line plugged	Open
	Ice holding valve open	4.11
	Foreign material in valve	4.11
	Pin and seat of expansion valve eroded or held open by foreign material	4.26
Fluctuating suction pressure	Improper bulb location or installation	4.26
	Low superheat setting	4.26.c
High superheat	Broken capillary	4.26
3.3.11 Solenoid Valve Malfunction		
Solenoid valve does not function properly	No power to valve	Check
	Improper wiring or loose connections	Check
	Coil defective	4.19
	Valve improperly assembled	4.19
	Coil or coil sleeve improperly assembled	4.19
	Movement of plunger restricted due to:	
	a. Corroded or worn parts	4.19
	b. Foreign material lodged in valve	4.19
	c. Bent or dented enclosing tub	4.19
Solenoid valve closes but refrigerant continues to flow	Foreign material lodged under seat	Clean
	Defective seat	Replace
3.3.12 Condenser Shutter Malfunction (OPTIONAL)		
Shutters will not open	Bearing(s) seized	4.30.e & f
	Shutters seized	4.30.c & f
	Element (thermostat) malfunction	4.30.a
	Linkage disconnected	4.30.c
Shutters will not close	Return springs broken	Replace
	Linkage disconnected	4.30.c
	Bearing(s) seized	4.30.e & f
Air leakage	Linkage out of adjustment	4.30.c
	Vane seals worn	4.30.d
	Improper shutter installation	4.30.b

SECTION 4

SERVICE

WARNING

Beware of V–belts and belt driven components as the unit may start automatically. Before servicing unit, make sure the start–run stop switch is in the OFF position. Also disconnect the negative battery cable.

NOTE

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

4.1 MAINTENANCE SCHEDULE

Unit ON	Unit OFF		Operation	Reference Section
4.1.1			**Daily Maintenance**	
	X	1.	Pre–Trip Inspection – before starting	2.1.a
X		2.	Pre–Trip Inspection – after starting	2.1.b
X		3.	Check engine hours	Run 10 min.
4.1.2			**First 400 Hour Maintenance**	
	X	1.	Pre–Trip Inspection – before starting	2.1.a
X	X	2.	Change lube oil and filter	4.3.2
X		3.	Pre–Trip Inspection – after starting	2.1.b
		4.	Check engine hours	Run 10 min.
4.1.3			**Every 1000 Hour Maintenance (Normal Operating Conditions)**	
X	X	1.	Complete 400 Hour Maintenance (Refer to paragraph 1.2.m. for oil change intervals)	4.1.2
	X	2.	Tighten engine, compressor and unit mounting bolts	None
	X	3.	Tighten all electrical connection in control box	Tighten
	X	4.	Calibrate defrost air switch	4.22
	X	5.	Clean air cleaner, check hose and connections	4.3.5
	X	6.	Check water pump bearing end play	None
	X	7.	Check alternator slip rings and brushes	4.4.5/4.4.6
	X	8.	Clean evaporator and condenser coils	4.3.1/4.26
	X	9.	Check fuel pump (FP) filter	4.3.7
	X	10.	Replace fuel filter	4.3.7
4.1.4			**Every 3000 to 6000 Hour Maintenance**	
X	X	1.	Complete a 1000 Hour Maintenance	4.1.3
	X	2.	Clean crankcase breather	4.3.6
X	X	3.	Clean and flush cooling system	4.3.1
	X	4.	Replace all V–belts	4.5
	X	5.	Check engine compression	Engine Manual
	X	6.	Check starter condition	Engine Manual
	X	7.	Check and adjust injector nozzles	Engine Manual

4.2 PRIMING THE FUEL SYSTEM

a. Mechanical Fuel Pump

The unit is equipped with a mechanical fuel lift pump, it is mounted on the engine next to the injection pump.(also see section 4.3.7) This pump has a manual plunger for bleeding fuel when the fuel tank has been run dry.

Since the unit employs a closed fuel circuit, it is recommended to use the following steps:

1. Turn bleed valve (Red) counter–clockwise until fully opened (See Figure 1–3).

2. Turn the top of the manual plunger counter–clockwise to unlock it. (See Figure 1–3) Then, rapidly hand pump the manual plunger until a positive pressure (resistance) is felt, which will indicate fuel flow.

3. Depress and turn the top of the manual plunger clockwise to lock in place.

4. Start engine. (Refer to section 2.2 and 2.3)

5. When engine is running properly, turn bleed valve clockwise until fully closed.

b. Electrical Fuel Pump (Optional)

If the unit is equipped with electrical fuel pumps, they are mounted on the fuel tank mounting bracket.(also see section 4.3.7) It is recommended to use the following steps:

1. Open bleed valve located on top of the injection pump. (See Figure 1–3)

2. Energize the fuel pump by holding glow plug switch in the *PREHEAT* position. This will complete the circuit to the fuel pump.

3. Start engine. (Refer to section 2.2 and 2.3)

4. When engine is running properly, turn bleed valve clockwise until fully closed.

4.3 ENGINE SERVICE AND COMPONENTS

4.3.1 Cooling System

The condenser and radiator assembly is designed with the radiator located alongside of the condenser coil. Air flows through the radiator by using the condenser fan. The condenser and radiator may be cleaned at the same time.

The radiator, externally and internally, must be clean for adequate cooling. The condenser fan belt must be adjusted periodically to provide maximum air flow. (Refer to section 4.5.3)

Do the following to service the cooling system:

a. Remove all foreign material from the radiator–condenser coil by reversing the normal air flow. (Air is pulled in through the front and discharges over the engine.) Compressed air or water may be used as a cleaning agent. It may be necessary to use warm water mixed with any good commercial dishwasher detergent. Rinse coil(s) with fresh water if a detergent is used.

b. Drain coolant completely by opening drain–cock and removing radiator cap.

CAUTION

Use only ethylene glycol anti–freeze (with inhibitants) in system as glycol by itself will damage the cooling system.
Always add pre–mixed 50/50 anti–freeze and water to radiator/engine. Never exceed more than a 50% concentration of anti–freeze. Use a low silicate anti–freeze meeting GM specifications GM 6038M or equal.

c. Close drain–cock and fill system with clean, untreated water to which three to five percent of an akalined based radiator cleaner should be added (six ounces – dry 151 grams to one gallon = 3.78 litres) of water.

d. Run engine 6 to 12 hours and drain system while warm. Rinse system three times after it has cooled down. Refill system with water.

e. Run engine to operating temperature. Drain system again and fill with treated water/anti–freeze. (see Caution Note and refer to section 1.2.c) NEVER POUR COLD WATER INTO A HOT ENGINE, however hot water can always be added to a cold engine.

4.3.2 Lube Oil Filters

After warming up the engine, stop engine, remove drain plug from oil reservoir and drain engine lube oil. Lightly oil gasket on filter before installing.

CAUTION

When changing oil filters, the new filters should be primed with clean oil. if the filters are not primed, the engine may operate for a period with no oil supplied to the bearings.

Replace filter(s) and add lube oil. (Refer to section 1.2.m) Warm up engine and check for leaks.

4.3.3 Run Solenoid Linkage Adjustment

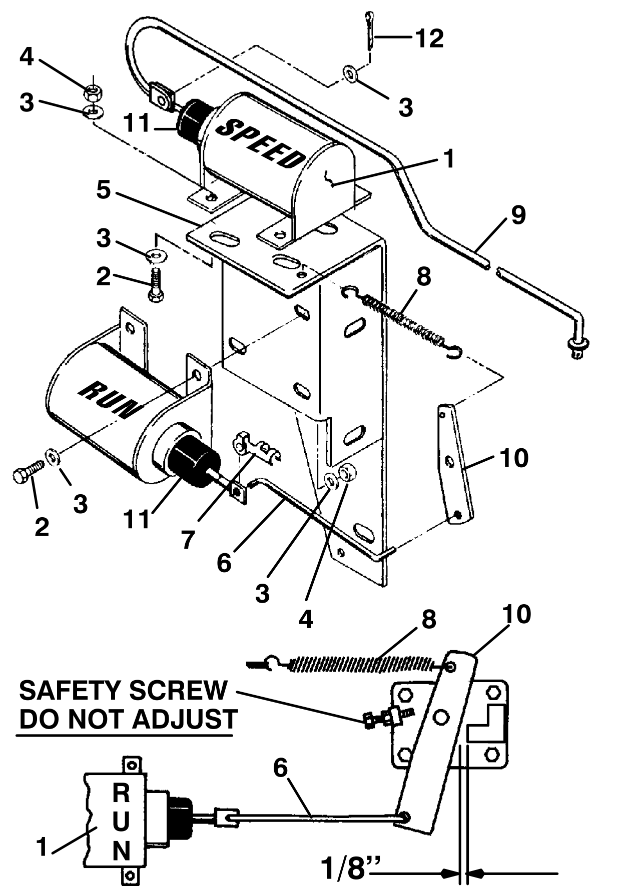
a. Remove spring from injection pump run lever (items 8 and 10, Figure 4–1).

b. Loosen the solenoid mounting bolts.

c. Holding the run lever (item 10) against the full open stop, slide the solenoid (item 1) as far toward the lever as the linkage (item 6) will allow and tighten the mounting bolts. DO NOT ADJUST SAFETY SCREW as it is factory set.

d. Connect run control spring (item 8).

e. Energize run solenoid and check for approximately 1/8 inch clearance between the run control lever and the stop. If clearance is in excess of 1/8 inch, repeat the above steps.



1. Solenoid
2. Capscrew
3. Flat Washer
4. Locknut, 1/4–20
5. Solenoid Bracket
6. Linkage (Run Control)
7. Clip
8. Spring (Run Control)
9. Linkage (Speed Control)
10. Run Control Lever
11. Boot
12. Cotter Pin

Figure 4–1. Speed and Run Control Solenoids

4.3.4 Servicing the Speed Control Solenoid and Linkage

a. Disconnect linkage arm (item 9, Figure 4–1) from solenoid. Disconnect wiring to solenoid. Remove mounting hardware from solenoid and then remove solenoid.

b. Install replacement solenoid and mounting hardware. Do not tighten at this time.

c. Attach linkage to solenoid and install the clip to the linkage rod. Push injection pump speed lever counterclockwise (away from solenoid) until lever rests against pump stop and hold in this position (high–speed position). Solenoid plunger should bottom out.

d. Tighten solenoid mounting hardware. Connect wiring to solenoid.

e. Check engine speed. With the engine stopped, place a mark on the crankshaft sheave (white paint for example). Speed may be verified by a Strobette model 964 (strobe–tachometer) Carrier Transicold P/N 07–00206.

f. Set controller at trailer temperature and then start engine. Engine should be in low speed (Refer to Table 1–1). Set the controller 10°F (5.5°C) below trailer temperature. Engine should be in high speed (Refer to Table 1–1). If engine speed is not correct (pump lever against stop), loosen mounting hardware and move solenoid toward the pump lever (bracket has slotted holes).

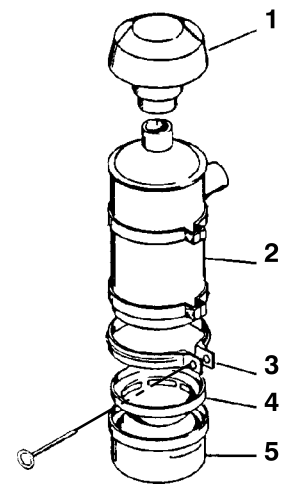
g. If adjustment is not achieved by doing step f, stop engine and remove linkage from solenoid. Remove boot (item 11) from solenoid and pull solenoid shaft out (far enough to loosen jam nut on solenoid shaft). Energize solenoid for maximum force (pull) and then turn shaft clockwise to shorten.

NOTE

It may be necessary to apply heat to adjusting “I” bolt to be able to turn it because Loctite is used .

h. De–energize solenoid, tighten shaft jam nut and replace boot. Connect linkage and repeat steps 5 and 6.

4.3.5 Engine Air Cleaner (See Figure 4–2)



1. Air Inlet Hood
2. Air Cleaner Body
3. Clamp
4. Inner Cup(Oil bath)
5. Oil or Dust Cup

Figure 4–2. Air Filter

a. Inspection

The oil bath or dry type air cleaner should be inspected regularly for leaks. A damaged air cleaner or hose can seriously affect the performance and life of the engine. The air cleaner is designed to effectively remove contaminants from the air stream entering the engine. An excessive accumulation of these contaminants in the air cleaner will impair its operation, therefore, a service schedule must be set up and followed. Remember that the air cleaner cleans the air, but the air cleaner requires cleaning. The following simple service steps are easily made while the engine is being serviced in the field.

The simple service steps are as follows:

1. Watch all connections for mechanical tightness. Be sure cleaner outlet pipe is not fractured.

2. If cleaner has been dented or damaged, check all connections immediately.

3. In case of leakage and if adjustment does not correct the trouble, replace necessary parts or gaskets. *Swelled or distorted gaskets must always be renewed.*

b. Service Procedure (Oil Type)

CAUTION

Always cover the engine inlet tube while the air cleaner is being serviced.

1. Oil Cups

When to Service:

Remove the oil cup at regular intervals. Initially inspect daily or as often as conditions require. Never allow more than 1/2 inch (12.7 mm) of dirt deposit in either cup. More than 1/2 inch accumulation could result in oil and dirt to carry over into the engine causing accelerated engine wear. Heavily contaminated oil will not allow the air cleaner to function properly.

How to Service:

Stop the engine and remove the oil cup from the air cleaner. Remove the oil from the oil cups. Remove the inner cup from the oil cup and clean both cups of sludge.

Reassemble and fill both oil cups to the *indicated level* with SAE #10 oil for temperatures below freezing or SAE #30 for temperatures above freezing. It is generally a recommended practice to use the same oil as required in the engine crankcase. (Refer to section 1.2.m)

CAUTION

Do not underfill or overfill the cups. Overfilling of cups means loss of capacity and underfilling means lack of efficiency.

2. Body Assembly

When to Service:

The lower portion of the fixed element should be inspected each time the oil cup is inspected or serviced. If there is any sign of contaminant buildup or plugging, the body assembly should be removed and back flushed. At least one a year or at regular engine service periods remove the entire air cleaner and perform the following:

(a) Remove oil cup. Check and clean center tube. *DO NOT USE GASOLINE.*

(b) Pump solvent through the air outlet with sufficient force and volume to produce a hard, even stream out the bottom of the body assembly. Reverse flush until all foreign material is removed.

c. Service Procedure (Dry Type)

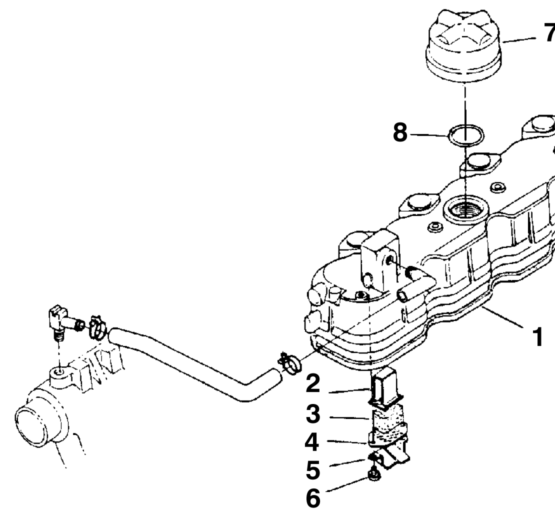
1. Stop the engine, remove and clean the dust cup. Check for damage or if plugged. Remove the dirty element (filter) from the air cleaner.(Refer to section 4.1.3) Install new element.

2. Reinstall dust cup, making sure it seals 360° around the air cleaner body and tighten wing nut securely. Check all connections between the air cleaner and the engine to be certain that they are tight and leak–free.

4.3.6 Engine Crankcase Breather

The engine uses a closed type breather with the breather line attached to the cylinder head cover. (See Figure 4–3)

The breather assembly should be cleaned once a year or at every 3000 hours maintenance interval (whichever comes first).



1. Cylinder Head Cover
2. Breather Cover
3. Breather Element
4. Plate
5. Breather Oil Shield
6. Capscrew
7. Breather Assembly
8. O–Ring

Figure 4–3. Engine Crankcase Breather

4.3.7 Servicing Fuel Pump

a. Mechanical Pump (See Figure 4–4)

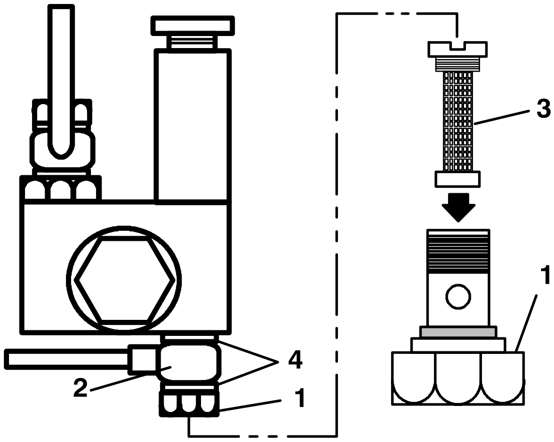
Due to foreign particles in the fuel and wax as a result of using the wrong grade of fuel or untreated fuel in cold weather. The fuel filter may become plugged or restricted, and the engine will loose capacity. The filter must be cleaned on a regular schedule such as unit pre–trip or when the oil and fuel filters are changed (Refer to section 4.1).

1. Turn nut counter–clockwise to loosen and remove (item 1).

2. Remove banjo fitting (item 2) and let it hang loose, making sure to keep copper rings (item 4) for replacement.

3. Turn filter (item 3) counter–clockwise and remove. Check and clean.

4. To install reverse steps 1 through 3.



1. Nut
2. Banjo
3. Filter
4. Copper Rings

Figure 4–4. Mechanical Fuel Pump

b. Electrical Pump (See Figure 4–5) (Optional)

1. To Check or Replace Filter

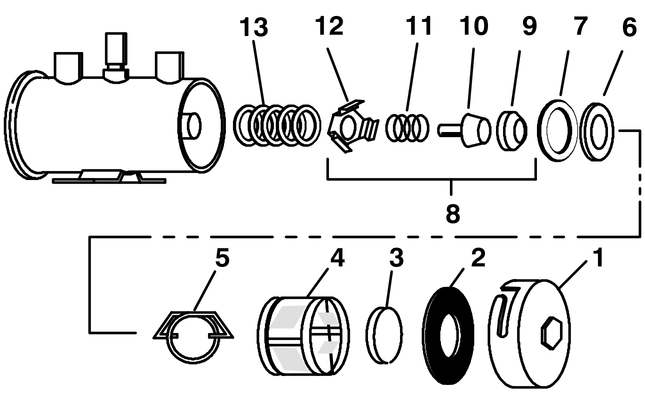
Place box wrench on hex portion of cover, item 1, Figure 4–5 and rotate cover counterclockwise (the magnet and gasket, items 2 and 3, should stay with the cover). Remove filter for inspection or replacement.

2. To Replace Spring

Using your finger, depress check valve assembly, item 8. With a screwdriver, snap wire retaining clip out of the two holes in the check valve housing. Slowly release spring pressure and remove items 6 through 13.

3. To Install

Reverse steps 1 and 2.



1. Cover
2. Gasket
3. Magnet
4. Filter
5. Retainer Clip
6. Flat Washer
7. O–Ring
8. Check Valve Assy.
9. Seat
10. Plunger
11. Plunger Spring
12. Retainer
13. Spring – 10 psi ($0.7 kg/cm^2$)

Figure 4–5. Electric Fuel Pump (Optional)

4.3.8 Servicing Glow Plugs

The glow plugs, when energized, draw a nominal 7.0 amps at 10.5 vdc. When servicing, the glow plug is to be fitted carefully into the cylinder head to prevent damage to glow plug. Torque value for the glow plug is 14 to 18 ft–lb (1.9 to 2.5 mkg).

Checking for a Defective Glow Plug

a. One method is to remove the injector and then energize the glow plug. The glowing tip may then be observed.

b. Another method is to place an ammeter (or clip–on ammeter) in series with each glow plug and energize the plugs. Each plug (if good) should show amperage draw.

4.4 SERVICING THE ALTERNATOR

4.4.1 Preliminary Checks and Tests

NOTE

Before starting the actual electrical test procedure, the charging system, battery and wiring should be checked to eliminate possible problem areas. Figure 1–12 identifies the terminals on the rear of the alternator.

a. Check the condition and adjustment of belts.

1. Check belt adjustment (Refer to section 4.5).
2. Replace any worn or glazed belts.

b. Check to see that all terminals, connectors and plugs are clean and tight.

1. Loose or corroded connections cause high resistance and this could cause overcharging, undercharging or damage to the charging system.

2. Badly corroded battery cables could prevent the battery from reaching a fully charged condition.

c. Check battery condition and charge if necessary. A low or discharged battery may cause false or misleading readings when conducting in–unit tests.

4.4.2 Test Tools

A list of the following tools is provided to perform tests on the alternator and its components.

a. Volt–ohm meter

b. Single–pole, single throw switch

c. 12 vdc lamp

d. Insulated 12 gauge stranded wire

e. Alligator clamp terminals

4.4.3 Problem Area Determination

CONDITIONS: Engine running for all tests (unless otherwise specified).

a. Battery Undercharged

1. Perform open diode–trio test. (Refer to section 4.4.4)

2. Perform regulator tests. (Refer to section 4.4.4) If regulator is O.K., the cause is probably an open field circuit, and alternator must be removed for repair.

3. Further investigation requires alternator removal and repair (diodes).

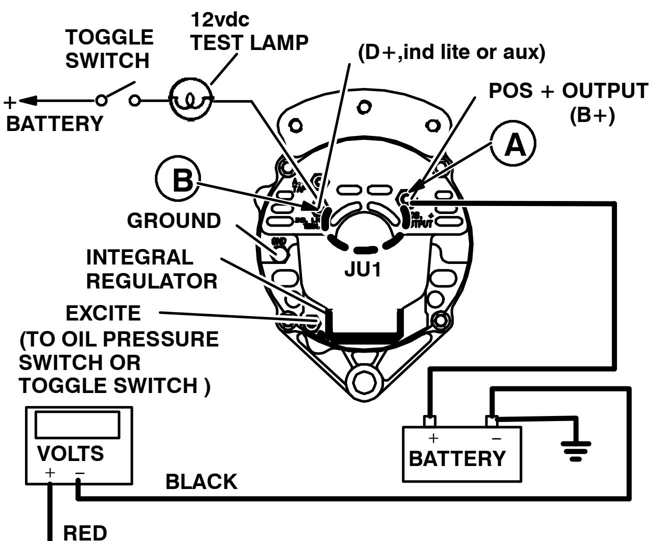
b. Battery Overcharged

1. Perform alternator output test.
(Refer to section 4.4.4)

2. Regulator shorted. Replace regulator.

4.4.4 In−Unit Alternator/Regulator Tests

Test No. 1 − Open Diode−Trio Test



STEP	TEST POINT	INDICATION
1 *	A (B+)	BATTERY VOLTAGE
2 *	B (REG)	1.5 TO 3.0 VOLTS WITH TEST LAMP ON
3	A (B+)	13.5 TO15.0 VOLTS (JUMPER ATTACHED ENGINE RUNNING)

* JUMPER NOT ATTACHED

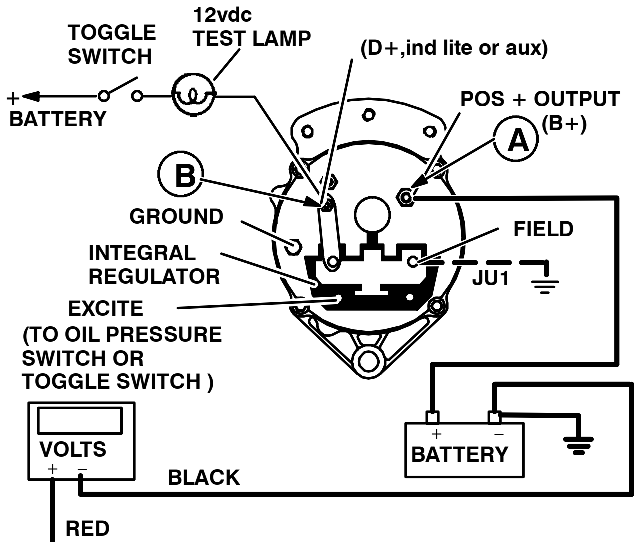
Figure 4−6. Open Diode−Trio Test

CONDITIONS: Start−run−stop switch (SRS) in RUN position and engine stopped (after proper hook−up is made and test leads connected). No electrical loads.

a. With jumper not attached. Check for battery voltage at terminal A and for 1.5 to 3.0 volts at terminal B. (See Figure 4−6)

b. Add jumper JU1 between terminals A and B. Start engine and run with no load. If the test lamp now goes off, and charging voltage is present at terminal A (more than battery voltage), the diode−trio is open. Alternator should be removed for repair. If the voltmeter indication is not in this range, remove the jumper and proceed to the regulator test
(test no. 2).

Test No. 2 − Open Regulator Test



STEP	TEST POINT	INDICATION
1 *	A (B+)	BATTERY VOLTAGE
2 *	B (REG)	BATTERY VOLTAGE WITH TEST LAMP OFF
3	B (D+)	JUMPER ATTACHED. 1.5 TO 3.0 VOLTS. TEST LAMP ON

* JUMPER NOT ATTACHED

Figure 4−7. Open Regulator Test

CONDITIONS: Engine stopped (start−run−stop switch in the RUN position) and voltmeter set−up as shown in Figure 4−7.

NOTE

Before performing test, removal of back cover is required. To remove, disconnect wires from terminals extending through back cover. Remove back cover (two screws) and reconnect all wires.

a. With jumper not attached, check for battery voltage at terminals A and B. Test lamp will be off.

b. Add jumper JU1 between field and ground. (See Figure 4−7) If 1.5 to 3.0 volts is present at terminal B and the test lamp is on, the regulator is open. Alternator should be removed for repair.

Test No. 3. Alternator Output Test

CONDITIONS: Engine running (after voltmeter is connected as shown in Figure 4−8).

a. Start unit and run engine with load. With the unit operating (placing a load on charging circuit) check for nominal system output voltage of between 13.8 − 14.8 volts for a properly operating charging system. (Voltages may vary a few tenths of a volt, higher or lower, due to ambient temperature variations.)

b. If the alternator output voltage does not fall within the proper range, the alternator should be removed for further inspection and tests. (refer to Motorola manual)

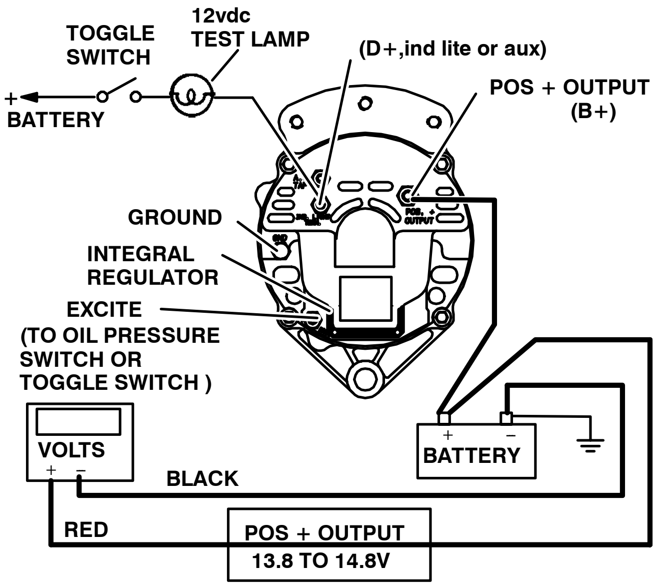


Figure 4–8. Alternator Output Test

4.4.5 Alternator Brush Test Procedure

NOTE

Before performing test, removal of back cover is required. To remove, disconnect wires from terminals extending through back cover. Remove two screws securing back cover to rear housing and remove cover.

a. Removing Brush Set

1. Remove two locknuts securing brush holder and remove brush assembly.

2. Check brush assembly for cracked, chipped or oil soaked brushes. Remaining brush length should be at least 3/16 inch (4.76 mm) long.

3. Check slip rings for carbon build–up.

4. Using a 12 vdc test lamp or ohmmeter, test brush assembly for continuity and insulation (See Figure 4–9) Replace brush assembly if necessary.

b. Brush Continuity Check (See Figure 4–9)

Using a 12 vdc test lamp or ohmmeter, test brush assembly for continuity and insulation as shown. Remove brush assembly if necessary.

CONTINUITY CHECK

Continuity	A to B	OK
Continuity	C to D	OK
No Circuit	A to C	OK
No Circuit	A to D	OK
No Circuit	B to C	OK
No Circuit	B to D	OK

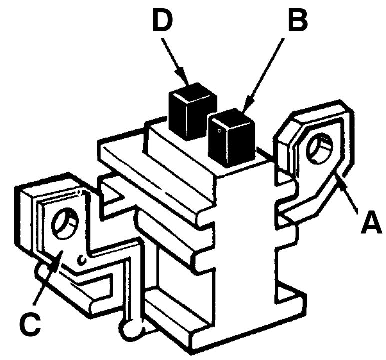


Figure 4–9. Alternator Brush Assembly

4.4.6 Slip Ring Servicing

Clean brush contacting surfaces with fine crocus cloth. Wipe dust and residue away.

If surfaces are worn beyond this restoration, replace entire rotor assembly.

4.4.7 Alternator Installation

a. Make sure negative battery terminal is disconnected.

b. Place V–belt on alternator sheave and then install alternator with two bolts loosely in position.

c. Check the center alignment of the jackshaft driving pulley and alternator pulley, to ensure proper drive. Pulley misalignment will create excess belt wear and limit alternator bearing life. The center line of the alternator sheave, and the driving sheave must be in line.

d. Pivot alternator to place tension on belt using hand force only. *Do not use pry bar or excessive force as it may cause bearing failure.* For correct belt tension see table 4–1. Tighten pivot and adjustment bolts.

e. Connect wiring to alternator.

f. Connect battery cable. Start unit and check for output per section 4.4.4.

4.5 SERVICING AND ADJUSTING V–BELTS

WARNING

Beware of V–belts and belt driven components as the unit may start automatically.

4.5.1 Belt Tension Gauge

It is recommended using a belt tension gauge (tester) P/N 07–00253, shown in Figure 4–10 whenever V–belts are adjusted or replaced.

A belt tension gauge provides an accurate and easy method of adjusting belts to their proper tension. Properly adjusted belts give long lasting and efficient service. Too much tension SHORTENS belt and bearing life, and too little tension causes slippage and excessive belt wear. It is also important to keep belts and sheaves free of any foreign material which may cause the belts to slip.

The belt tension gauge can be used to adjust all belts. The readings which we specify for Carrier Transicold units are applicable only for our belts and application, as the tension is dependent on the size of the belt and distance between sheaves. When using this gauge, it should be placed as close as possible to the midpoint between two sheaves. (See Figure 4–11)

The V–belts must be kept in good condition with the proper tension to provide adequate air movement across the coils.

Table 4–1. Belt Tension (Part No. 07–00253) (See Figure 4–10)

Initial Tension (New Belt)		Retention Value
Water pump to Crankshaft	65–75	65–75
Jackshaft to Fanshaft	140	80–90
Jackshaft to Compressor	*	65–75
Jackshaft to Alternator	65–75	65–75

* This tension will automatically be set when the jackshaft to fanshaft belt is tensioned. Tension will be approximately the same as the jackshaft to fanshaft belt.

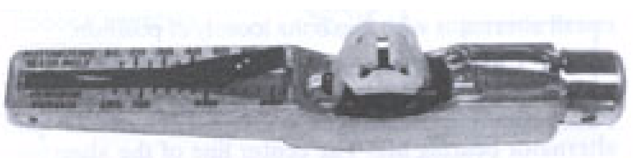


Figure 4–10. Belt Tension Gauge (Part No. 07–00253)

4.5.2 Water Pump V–Belt

The water pump V–belt is driven by a sheave on the engine crankshaft. Frayed, cracked or worn belts must be replaced. Adjustment is achieved by altering the position of the frontside idler.

When replacing V–belt, avoid excessive force when applying tension to the V–belt to prevent damage to the water pump bearings. (Refer to Table 4–1)

4.5.3 Driveshaft to Jackshaft and Jackshaft To Evaporator/Condenser Fans

a. Jackshaft to Fan Shaft V–Belt

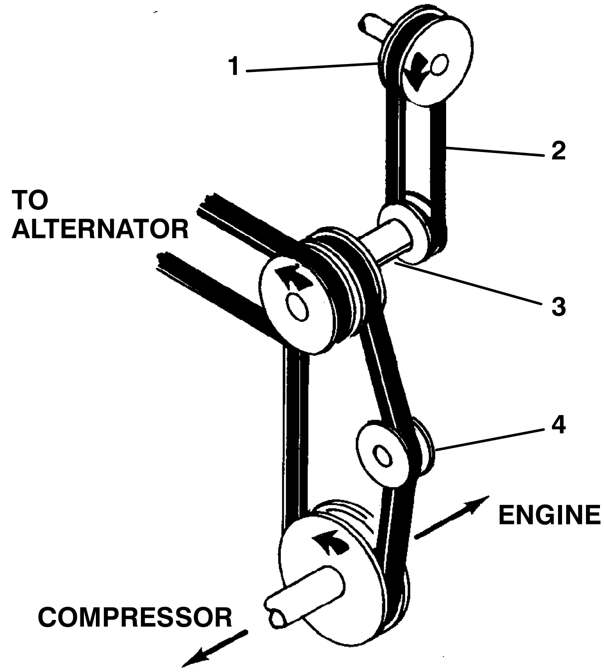
To Replace V–belt:

1. Remove V–belt guard. (See Figure 4–12)

2. Loosen capscrews (5) and carriage bolt (3) so that swing arm (4) is free to move.

3. Loosen frontside idler (7).

4. Note direction of upper belt twist. Remove old belt and replace with new belt in exactly the same way. (See Figure 4–11)



1. Evaporator/Condenser Fan Shaft Sheave
2. Midpoint of Belt
3. Jackshaft
4. Frontside Idler

Figure 4–11. V–Belt Arrangement

5. Using a belt tension gauge (Figure 4–10) on the upper belt, rotate frontside idler so that the gauge reads correct tension. (Refer to Table 4–1) Lower belt will automatically be tensioned to approximately the same value.

6. Tighten frontside idler, carriage bolt, and capscrews.

NOTE

Both belts must be checked and retensioned, if necessary, after a brief run–in period. (see step 7)

7. Operate unit in high speed for 5 to 10 minutes. Repeat steps 5 and 6. And then rotate idler as necessary to adjust upper belt to a tension indicated in Table 4–1. Once again, lower belt will be automatically tensioned to approximately the same value.

8. Repeat step 6 and then replace belt guard.

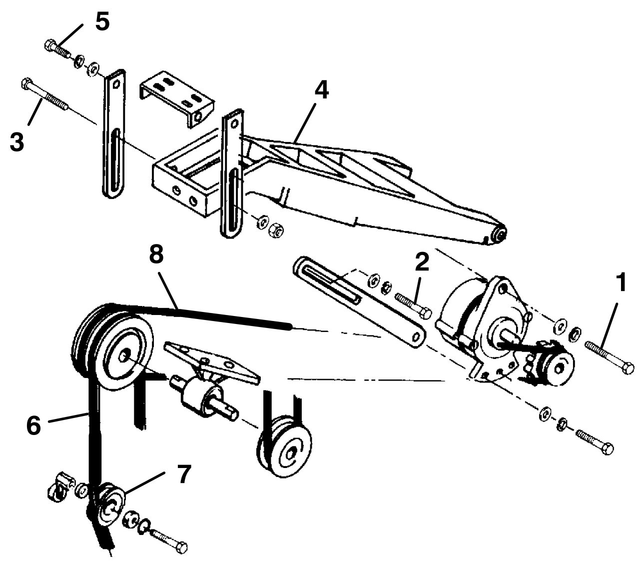
b. Driveshaft to Jackshaft

1. Remove V–belt guard and then loosen frontside idler bolt.

2. Match mark adapter to engine flywheel (See Figure 4–13A) for ease of assembly.

3. Remove six bolts (5/16–18 x 1 lg) securing adapter drive sheave to engine flywheel, Figure 4–13A.

4. Insert three of the six bolts (5/16–18 x 1 lg) into three threaded holes (jacking holes) provided on engine adapter. Jack adapter from engine flywheel. Remove the three screws from adapter. Insert a pry bar between engine flywheel and adapter, Figure 4–13A and slide the adapter–sheave toward the compressor enough to change the V–belt as shown in Figure 4–13B. Replace V–belt.



1. Alternator Pivot Bolt
2. Alternator Adjustment Bolt
3. Carriage Bolt
4. Swing Arm
5. Capscrews
6. Drive V–Belt
7. Frontside Idler
8. Alternator V–Belt

Figure 4–12. Alternator, Jackshaft and V–Belts

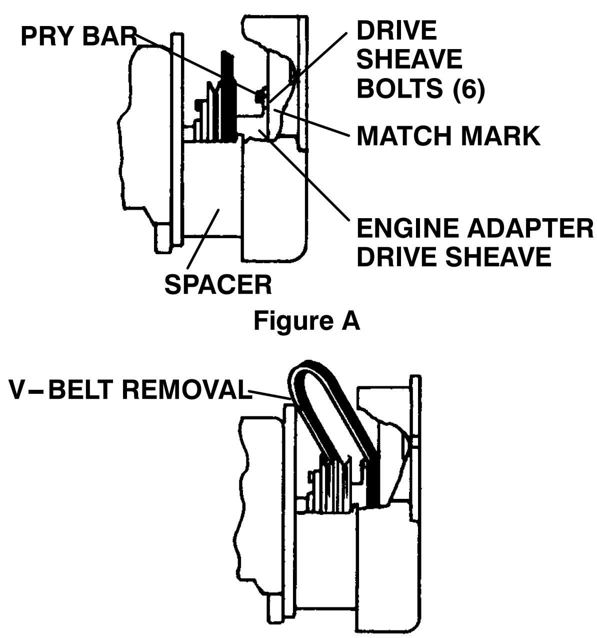


Figure A

Figure B

Figure 4–13. Engine Adapter Drive Sheave to Jackshaft V–Belt

5. Pry the adapter back toward the engine flywheel or use 5/16–18 x 2–1/2 lg bolts (3) in every other hole of adapter and take up evenly on the bolts until the 5/16–18 x 1 lg bolts will start in the engine flywheel. Apply thread sealer (Loctite #262) to the bolts used to secure adapter to flywheel. Take up on all bolts evenly and then torque to a value of 28 ft–lb (3.87 mkg).

6. Place V–belt on the jackshaft sheave and adjust belt tension as indicated in Table 4–1. Install V–belt guard. DO NOT START UNIT UNTIL V–BELT GUARD IS INSTALLED.

7. Start unit and run for 10 minutes to allow for belt stretch.

8. Turn unit off and recheck belt tension.

4.6 PUMPING THE UNIT DOWN OR REMOVING THE REFRIGERANT CHARGE

NOTE

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

a. Pumping the Unit Down

To service the filter–drier, liquid line solenoid valve (SV–2), expansion valve, or evaporator coil, pump most of refrigerant into condenser coil and receiver as follows:

1. Backseat suction and discharge service valve (turn counterclockwise) to close off gauge connection and attach manifold gauges to valves.

2. Open valves two turns (clockwise). Purge gauge line.

3. Close valve at the receiver outlet by turning clockwise. Start unit and run in high speed cooling. Place start–run–stop switch in the STOP position when unit reaches 1 psig (0.1 kg/cm^2).

4. Frontseat (close) suction service valve and the refrigerant will be trapped between the compressor suction service valve and the receiver manual shutoff valve.

5. Before opening up any part of the system, a slight positive pressure should be indicated on the pressure gauge. If a vacuum is indicated, emit refrigerant by cracking receiver outlet valve momentarily and opening the liquid solenoid valve electrically to build up a slight positive pressure. Place the start–run–stop in the RUN position and place the glow plug switch in the GLOW position for the solenoid valve SV–2 to energize.

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

7. After repairs have been made, be sure to perform a refrigerant leak check, section 4.7, and to evacuate and dehydrate the system, section 4.8.

8. Start the unit in cooling and check for noncondensibles. (Refer to section 4.11)

9. Check the refrigerant charge. (Refer to section 4.9.f)

b. Removing the Refrigerant Charge

NOTE

Store the refrigerant charge in an evacuated container if the system must be opened between the compressor discharge valve and receiver.

Whenever the system is opened, it must be evacuated and dehydrated. (Refer to section 4.8)

WARNING

Do not use a disposable refrigerant container to store the charge as an explosion may occur.

1. Equipment Required

(a) Appropriate returnable refrigerant cylinder, preferably 125 lb (57 kg) net capacity. Also, a 50 lb (23 kg) capacity returnable cylinder may be used. Refrigerant removal will be faster and more complete with the larger cylinder.

(b) Refrigerant service gauge manifold.

(c) Vacuum pump, preferably 5 cfm (8 m^3H), P/N 07–00176–01.

(d) Weight scales (0–300 lb = 0 to 91 kg range, minimum).

(e) A 12–foot length of 3/8 inch (I.D.) evacuation hose or 3/8 inch copper tubing with 3/8 inch female flare adapter on each end. Do not use hose or tubing of smaller diameter or the removal process will take considerably longer.

2. Procedure

To service the condenser coil, receiver, solenoid valves SV–1, SV–3, and check valves, store the refrigerant in an evacuated container as follows:

(a) Evacuate and dehydrate returnable refrigerant cylinder to 29 inches (74 cm) Hg vacuum (minimum). A 5 cfm (8 m^3H) vacuum pump will pull down the cylinder in three to five minutes. After cylinder has been evacuated, close cylinder valve, shut off vacuum pump, and remove pump.

(b) Backseat compressor service valves and connect a gauge manifold. Tighten connections at compressor service valves. Attach lines loosely to manifold. Be sure manifold valves are frontseated. One at a time, crack open compressor service valves to purge lines with refrigerant and tighten connections at manifold. Midseat service valves after purging.

(c) Connect evacuated refrigerant cylinder to the manual receiver outlet valve. Tighten line at receiver valve and attach loosely to cylinder valve. Crack open receiver outlet valve to purge line with refrigerant and tighten connection at cylinder.

NOTE

If cylinder has two valves, be sure to connect drain line to liquid valve.

(d) Place evacuated refrigerant cylinder on scales and note weight of empty cylinder. Leave cylinder on scales.

(e) Midseat receiver outlet valve. (Starting from the fully backseated position, turn valve in four or five turns.)

(f) Run the unit in high speed cooling with the condenser coil completely blocked off. Head pressure will quickly rise. Stop the unit when it reaches 260 psig (18 kg/cm^2). This will take three or four minutes in a 70 to 80°F (21to 27°C) ambient.

(g) Fully open cylinder valve. Liquid refrigerant will flow from receiver into cylinder and head (discharge) pressure will drop.

NOTE

Refrigerant will flow from system into cylinder until system pressure is equivalent to container temperature. For example, if cylinder is at 90°F (32.2°C), given a system containing R–502 the system pressure reaches 187 psig (13 kg/cm^2) no further transfer will take place. (For this reason, it is possible to remove more than 77 to 83 percent of refrigerant by this method if the refrigerant cylinder can be cooled such as by packing in ice.)

(h) Monitor head pressure and weight of refrigerant cylinder to determine how much refrigerant is being removed. (Assuming a trailer unit properly charged with refrigerant, 77 to 83 percent of refrigerant will drain into cylinder in four to five minutes).

Shut off cylinder valve when the head pressure holds steady (unit and cylinder pressures have equalized). At this time, all the refrigerant that can be removed quickly is in the cylinder.

(i) Connect a refrigerant recovery system to the unit to remove remaining charge.

(j) After repairs have been made, be sure to perform a refrigerant leak check, section 4.7, and to evacuate and dehydrate the system, section 4.8, before recharging refrigerant as detailed in section 4.9.

NOTE

1. It is good practice to place a USED REFRIGERANT tag on cylinder.

4.7 REFRIGERANT LEAK CHECKING

a. If system was opened and repairs completed, leak check the unit.

b. The recommended procedure for finding leaks in a system is with a halide torch or electronic leak detector. Testing joints with soapsuds is satisfactory only for locating large leaks.

c. If system is without refrigerant, charge system with refrigerant to build up pressure between 30 to 50 psig (2.1 to 3.5 kg/cm^2). Remove refrigerant drum and leak check all connections.

NOTE

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

d. Remove refrigerant using a refrigerant recovery system and repair any leaks. Evacuate and dehydrate the unit. (Refer to section 4.8) Charge unit with refrigerant. (Refer to section 4.9)

4.8 EVACUATION AND DEHYDRATION

4.8.1 General

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

4.8.2 Preparation

a. Evacuate and dehydrate only after pressure leak test. (Refer to section 4.7)

b. Essential tools to properly evacuate and dehydrate any system include a good vacuum pump (5 cfm = 8m3H volume displacement, P/N 07−00176−01) and a good vacuum indicator such as a thermocouple vacuum gauge (vacuum indicator). (Available through Robinair Manufacturing, Montpelier, Ohio, Part Number 14010.)

NOTE

It is not recommended using a compound gauge because of its inherent inaccuracy.

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

4.8.3 Procedure for Evacuation and Dehydrating System

a. Remove refrigerant using a refrigerant recovery system.

b. The recommended method to evacuate and dehydrate the system is to connect three lines (3/8" OD copper tubing or larger) to manifold. Attach one line to the receiver, compressor suction and discharge service valves. (See Figure 4−14)

c. Connect lines to unit and manifold and make sure vacuum gauge valve is closed and vacuum pump valve is open.

d. Start vacuum pump, open all valves half way. Then open vacuum gauge valve. Evacuate unit until vacuum gauge indicates 2000 microns. Close vacuum gauge valve, vacuum pump valve and stop vacuum pump.

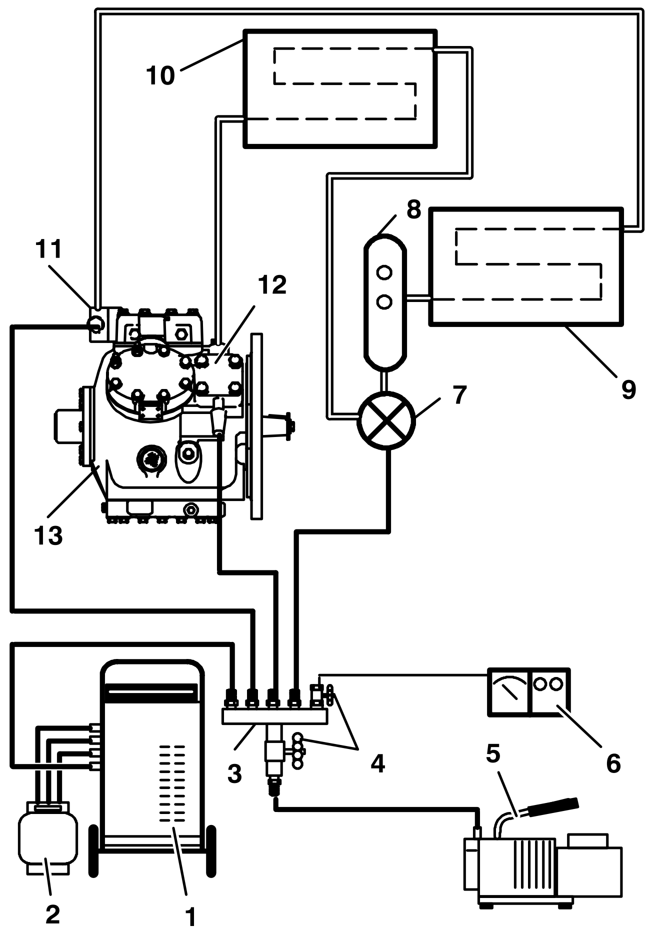
e. Break the vacuum with clean dry refrigerant. Use refrigerant that the unit calls for. Raise system pressure to approximately 2 psig.

f. Remove refrigerant using a refrigerant recovery system.

g. Repeat steps d, e and f one time.

h. Evacuate unit to 500 microns. Close off vacuum pump valve and stop pump. Wait five minutes to see if vacuum holds. This 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 4.9)



1. Refrigerant Recovery Unit
2. Refrigerant Cylinder
3. Evacuation Manifold
4. Valve
5. Vacuum Pump
6. Vacuum Gauge
7. Receiver Outlet Valve
8. Receiver
9. Condenser
10. Evaporator
11. Discharge Valve
12. Suction Valve
13. Compressor

Figure 4−14. Vacuum Pump Connection

4.9 ADDING REFRIGERANT TO SYSTEM (FULL CHARGE)

a. Dehydrate unit and leave in deep vacuum. (Refer to section 4.8)

b. Place drum of refrigerant on scale and connect charging line from drum to receiver outlet valve. Purge charging line at outlet valve.

c. Note weight of drum and refrigerant.

d. Open liquid valve on drum. Open receiver outlet valve half way and allow the liquid refrigerant to flow into the unit until the correct weight of refrigerant has been added as indicated by scales. Correct charge will be found in section 1.3.m.

NOTE

It is possible that all liquid may not be pulled into the receiver, as outlined in step d. In this case, frontseat the receiver outlet valve (king valve) and the liquid will be pulled into the system. Unit must be operating in the cooling mode.

e. When drum weight (scale) indicates that the correct charge has been added, close liquid line valve on drum and backseat the receiver outlet valve.

f. Start unit in cooling mode. Run approximately ten minutes. Partially block off air flow to condenser coil so discharge pressure rises to 230 psig (16 kg/cm^2).

Refrigerant should appear at center line of lower receiver sight glass. If charge is inadequate, add refrigerant charge (per section 4.10).

4.10 ADDING REFRIGERANT TO SYSTEM (PARTIAL CHARGE)

a. Place drum of refrigerant on scale and note weight. Backseat suction service valve and connect charging line between suction valve port and drum. Open VAPOR valve on drum and purge charging line.

b. Run the unit in cooling for ten minutes and then partially block off air flow to condenser coil so discharge pressure will rise 10 psig (0.7 kg/cm^2). Refrigerant should appear at center line of the lower receiver sight glass . If charge is inadequate, add refrigerant charge with condenser coil still blocked. (Refer to section 4.10.c)

c. Open suction service valve three turns. Add charge until level appears at center line of the lower receiver sight glass (white pill will be floating).

d. Backseat (open) suction service valve. Close vapor valve on refrigerant drum, noting weight. Vent charging line and replace all caps.

e. Start unit and check for noncondensibles. (Refer to section 4.11)

4.11 PURGING NONCONDENSIBLES

A leak in the suction side of a system operating in a vacuum will pull air into system. The presence of noncondensibles in the system is usually indicated by excessive head pressure. The noncondensibles accumulate at the top of the condenser coil or receiver because they are lighter than refrigerant vapor.

WARNING

Do not purge unit without protection for face and eyes. Refrigerant charge should not be released to the atmosphere.

a. Perform a low side pumpdown to isolate noncondensible gases in the condenser side of system. (Refer to section 4.6.a)

b. Allow system to sit for a minimum of fifteen minutes for gases to separate.

c. Open purge cock located on top of condenser coil for ten to fifteen seconds and then close tightly.

d. Backseat receiver outlet valve and run unit. If discharge pressure is still abnormally high, repeat procedure one more time.

e. If discharge pressure is still high, remove refrigerant from system to empty charging cylinder. (Refer to section 4.6.b) Evacuate and charge system following directions in section 4.9.

4.12 REPLACING THE COMPRESSOR

If compressor is inoperative and unit still has refrigerant pressure, frontseat suction and discharge service valves to trap most of the refrigerant in the unit.

If compressor runs, pump down the unit. (Refer to section 4.6.a)

a. Remove the two rear compressor bracket mounting bolts (compressor shockmount end).

b. Block up engine.

c. Slowly release compressor pressure.

d. Remove bolts from suction and discharge service valve flanges.

e. Remove oil filter and bracket from compressor.

f. Disconnect wiring to unloader valve assemblies, suction pressure transducer and the wiring to the high pressure cutout switches (HP-1 and HP-2). Identify wiring and switches if necessary. (See Figure 4-16)

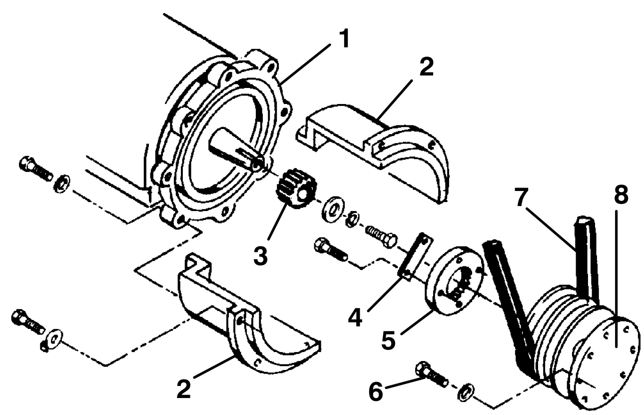
g. Remove four bolts from the two engine-compressor spacers.

h. Disconnect ground strap from frame.

i. Disconnect suction pressure transducer from compressor .

j. Attach sling or other device to the compressor. The O5G compressor weighs 137 pounds (62 kg).

k. Slide compressor enough to remove spacers. Then slide compressor enough to clear nylon drive gear, Figure 4-15, and remove compressor from unit.



1. Compressor
2. Spacer
3. Compressor Drive Gear
4. Locking Tab
5. Nylon Drive Gear
6. Drive Sheave Bolts
7. Jackshaft V–Belt
8. Engine adapter–Drive Sheave

Figure 4–15. Compressor Drive Assembly

l. Drain oil from defective compressor before shipping. (Oil drain plug is located at the bottom plate, oil pump end of compressor.) (See Figure 4–17)

m. The original unloader valves must be transferred to the replacement compressor. The plug arrangement removed from the replacement is installed in the original compressor as a seal. If piston is stuck, it may be extracted by threading socket head cap screw into top of piston. A small teflon seat ring at bottom of piston must be removed.

NOTES

The service replacement compressor is sold without shutoff valves (but with valve pads). Customer should retain the original capacity control valves for use on replacement compressor. Check oil level in service replacement compressor. If none add 8 U.S. Pints (3.7 Litres).(Refer to sections 1.3.c, and 4.13.c)

n. Remove the complete high pressure switch assembly (HP–1 and HP–2) (See Figure 4–16) and install on new compressor after checking switch settings. Remove suction pressure transducer and install on new compressor. Install compressor frame to new compressor (if removed with defective compressor).

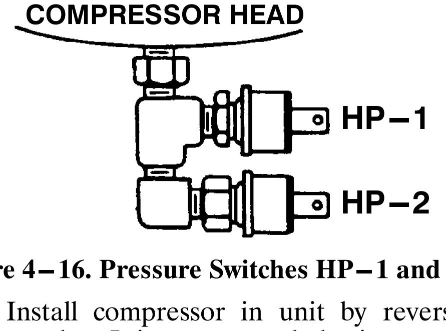


Figure 4–16. Pressure Switches HP–1 and HP–2

o. Install compressor in unit by reversing step 4.12.c through n. It is recommended using new locknuts when replacing compressor. Torque bolts to a value of 46 ft/lb (6.4 mkg). Install new gaskets on service valves and tighten bolts uniformly.

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

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

r. Remove vacuum pump lines and install manifold gauges.

s. Start unit and check for noncondensibles. (Refer to section 4.11)

t. Check refrigerant level (section 4.10.b.)

u. Check compressor oil level. (Refer to section 4.13) Add oil if necessary.

v. Check compressor unloader operation. (Refer to section 4.14)

w. Check refrigerant cycles. (Refer to section 2)

4.13 CHECKING THE COMPRESSOR OIL LEVEL

a. To Check the Oil Level in the Compressor:

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

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

3. Check the level of the oil in the front sight glass with the compressor operating. The correct level should be between bottom and 1/4 of the sight glass. If the level is above 1/4, oil must be removed from the compressor. To remove oil from the compressor, follow step d. If the level is below sight glass, add oil to the compressor following step b.

b. Adding Oil with Compressor in System

Two methods for adding oil are the oil pump method and closed system method.

1. Oil Pump Method

One compressor oil pump that may be purchased is a Robinair, part no. 14388. This oil pump adapts to a one U.S. gallon (3.785 litres) metal refrigeration oil container and pumps 2–1/2 ounces (0.0725 litres) per stroke when connected to the suction service valve port. Also there is no need to remove pump from can after each use.

When the compressor is in operation, the pump check valve prevents the loss of refrigerant, while allowing servicemen to develop sufficient pressure to overcome the operating suction pressure to add oil as necessary.

Backseat suction service valve and connect oil charging hose to port. Crack the service valve and purge the oil hose at oil pump. Add oil as necessary.

2. Closed System Method

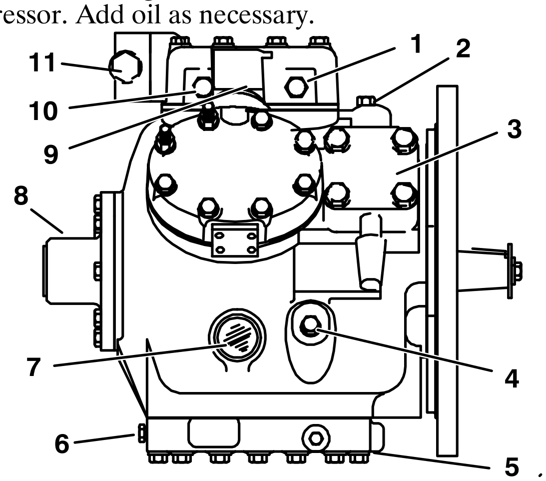
In an emergency where an oil pump is not available, oil may be drawn into the compressor through the suction service valve.

CAUTION

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

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

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



1. High Pressure Switch Connection
2. Suction Pressure Transducer Connection
3. Suction Service Valve
4. Oil Fill Plug
5. Bottom Plate
6. Oil Drain Plug
7. Oil Level Sight Glass
8. Oil Pump
9. Unloader Solenoid
10. Discharge Thermistor Connection
11. Discharge Service Valve

Figure 4−17. Compressor − Model O5G

c. Adding Oil to Service Replacement Compressor

NOTE

The correct oil charge is 8 U.S. Pints (3.8 litres).

Service replacement compressors may or may not be shipped with oil.

If compressor is without oil:

Add oil, (section 1.3.c) through the suction service valve flange cavity or by removing the oil fill plug (See Figure 4−17)

d. To remove oil from the compressor:

1. Close suction service valve (frontseat) and pump unit down to 2 to 4 psig (0.1 to 0.3 kg/cm2). Frontseat discharge service valve and slowly bleed remaining refrigerant.

2. Remove the oil drain plug on the bottom plate of the compressor and drain the proper amount of oil from the compressor. Replace the plug securely back into the compressor.

3. Open service valves and run unit to check oil level, repeat as required to ensure proper oil level.

4.14 COMPRESSOR UNLOADER VALVE

The compressor suction cutoff unloaders (located on the compressor cylinder heads) are controlled by relays UFR,URR and the temperature controller. (Refer to section 1.8)

a. Checkout Procedure

1. Connect manifold gauges to the compressor suction and discharge service valves and start unit in cooling with the container temperature at least 5°F (2.8°C) above set point and the compressor will be fully loaded (both unloader coils are de−energized). Note suction pressure.

2. Remove wiring from the front unloader coil. Place electrical tape over wire terminals.

3. Set controller upscale (cooler to warmer). This mechanically simulates falling temperature. Approximately 2°F (1.1°C) below box temperature the unloader coils will energize, but only the rear unloader valve will unload. Note suction pressure, a rise of approximately 3 psig (0.2 kg/cm2) will be noted on the suction pressure gauge.

4. Reconnect wiring on the front unloader. The front unloader will retract and an additional 3 psig (0.2 kg/cm2) rise on the suction gauge will be noted. Compressor is now fully unloaded and only the top bank is loaded (two cylinders).

5. Reverse the above procedure to check out compressor loading. Suction pressure will drop with this test.

NOTE

If either unloader coil energizes and the suction pressure does not change, the unloader assembly must be checked. (Refer to section 4.14.b)

b. Replacing the Unloader

WARNING

Make sure power to unit is OFF and negative battery cable is disconnected before servicing the compressor unloader.

1. Close off suction and discharge service valve to trap most of the refrigerant in the unit (this will prevent moisture from entering the system and save most of the refrigerant charge).

2. *Slowly* release compressor pressure through the service valve gauge ports.

3. Remove cylinder head and unloader from compressor. Have on hand valve plate gasket, cylinder head gasket, suction and discharge service valve gaskets.

4. Proceed to step 11 if not rebuilding unloader at this time.

CAUTION

Care must be exercised when handling valve body and enclosing tube as a dent in the enclosing tube could mean failure to unload the compressor.

5. Remove valve body and enclosing tube assembly and gasket. (Items 1, 2, and 3, Figure 4–18).

6. Remove cover and gasket (items 9,10 & 11) from bottom of cylinder head. Then remove spring and valve body (items 7 and 8).

7. From the top of the cylinder head, push piston (item 6) out of piston cavity.

8. On the replacement piston, place ring seal in position on piston by positioning in place (using two thumbs). Make sure seal is firmly in place.

9. From bottom of cylinder head, insert seal and piston in cylinder head. Using piston driver, push piston into cylinder head cavity.

10. Re–assemble rest of unloader.

11. Install new valve plate gasket and cylinder head gasket before installing cylinder head.

12. After installing cylinder head, torque bolts to a value of 35 to 40 ft/lb (4.84 to 5.53 mkg).

13. Place unloader coil and snap cap on unloader valve enclosing tube.

14. Install compressor and mounting plate in unit.

15. Install new gaskets on service valves and then install mounting bolts in service valves and torque to a value of 16 to 20 ft/lb (2.21 to 2.77 mkg).

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

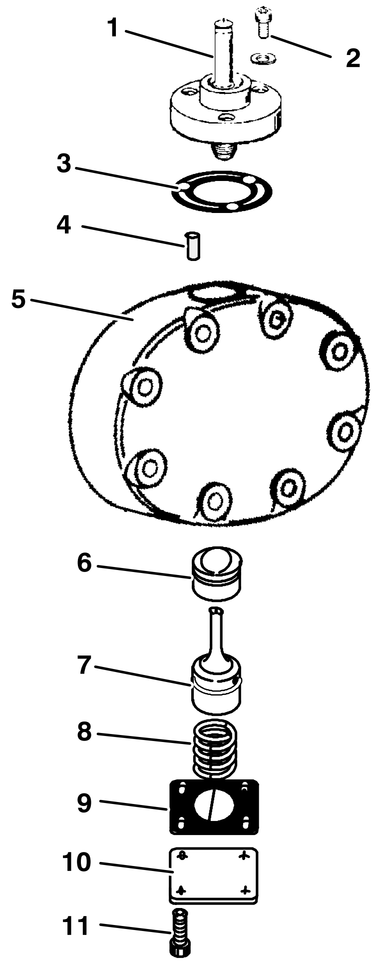
17. Fully backseat (open) both suction and discharge service valves.

18. Remove vacuum pump lines.

19. Start unit and check refrigerant charge. (Refer to section 4.9.f)

20. Check system for wetness. Change filter–drier if necessary. (Refer to section 4.16)

21. Check compressor oil level per section 4.13.a. Add oil if necessary. (Refer to section 4.13.b.)



1. Valve Body and Enclosing Tube
2. Capscrew and Gaskets
3. Gasket
4. Strainer
5. Cylinder Head
6. Piston and Ring Seal
7. Valve Body
8. Spring
9. Cover Gasket
10. Cover
11. Capscrews

Figure 4–18. Compressor Unloader Valve – Suction Cutoff

c. Solenoid Coil Replacement

NOTE

The coil may be removed without pumping the unit down.

1. Disconnect leads. Remove snap cap. Lift off coil. (See Figure 4–19)

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

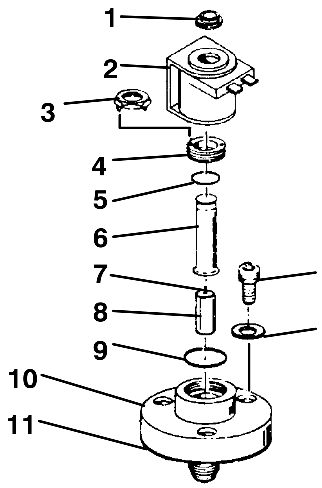
d. Replacing Solenoid Valve Internal Parts (See Figure 4–19)

1. Pump down the unit. Frontseat both service valves to isolate the compressor.

2. Remove coil snap cap, and coil.

3. Remove enclosing tube collar (item 4, Figure 4–19) using installation/removal tool supplied with repair kit (item 3).

4. Check plunger for restriction due to: (a) Corroded or worn parts; (b) Foreign material lodged in valve; (c) Bent or dented enclosing tube.



1.	Snap Cap	7.	Plunger Spring
2.	Coil Assembly	8.	Plunger Assembly
3.	Installation/Removal Tool	9.	Gasket
		10.	Valve Body
4.	Enclosing Tube Collar	11.	Gasket
		12.	Capscrew
5.	"O" Ring	13.	Gasket, Capscrew
6.	Enclosing Tube		

Figure 4–19. Unloader Solenoid Valve – Suction Cutoff

5. Install new parts. Do not overtighten enclosing tube assembly. Torque to a value of 100 inch pounds (1.15 mkg).

6. Remove supplied installation/removal tool. Install coil, voltage plate, and snap cap.

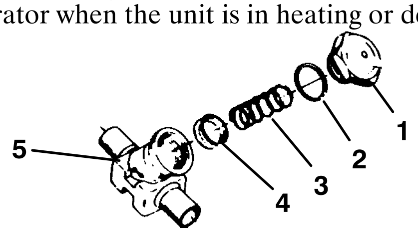
7. Evacuate and dehydrate the compressor. (Refer to section 4.12.p through 4.12.w.)

8. Start unit and check unloader operation (Refer to section 4.14.a).

4.15 SERVICING THE CHECK VALVE – SERVICEABLE TYPE

The check valve allows the hot gas to travel in one direction only.

The function of the condenser coil bypass is to raise the receiver pressure when the ambient temperature is low so that refrigerant can flow from the receiver to the evaporator when the unit is in heating or defrost.



1.	Cap	4.	Brass/Teflon Seat
2.	Copper Washer	5.	Body
3.	Spring		

Figure 4–20. Check Valve – Serviceable Type

a. To replace check valve, store the refrigerant into an evacuated container. (Refer to section 4.6)

b. Replace necessary parts.

c. Evacuate and dehydrate unit. (Refer to section 4.8)

d. Add refrigerant charge. (Refer to section 4.9)

4.16 CHECKING AND REPLACING FILTER–DRIER

To Check Filter–Drier

Check 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.

To Replace Filter–Drier

a. Pump down the unit per section 4.6. Remove U–bolt and nuts from clamp, then replace drier.

b. Check refrigerant level. (Refer to section 4.10.b)

4.17 CHECKING AND REPLACING HIGH PRESSURE CUTOUT SWITCH

4.17.1 Replacing High Pressure Switch

a. Pump down the unit. (Refer to section 4.6.a) Frontseat both suction and discharge service valves to isolate compressor. Then slowly release compressor refrigerant charge.

b. Disconnect wiring from defective switch. The high pressure switches are located on the top cylinder head. (See Figure 4–17)

c. Install new cutout switch after verifying switch settings. (Refer to section 4.17.2)

d. Evacuate and dehydrate the compressor. (Refer to section 4.12.p through 4.12.w)

4.17.2 Checking High Pressure Switch (HP–1 or HP–2)

WARNING

Do not use a nitrogen cylinder without a pressure regulator. Cylinder pressure is approximately 2350 psi (165 kg/cm^2).Do not use oxygen in or near a refrigerant system as an explosion may occur.
(See Figure 4–21)

a. Remove switch as outlined in section 4.17.1.

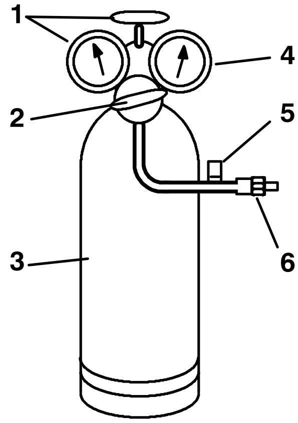
b. Connect ohmmeter or continuity light across switch terminals. Ohmmeter will indicate resistance and continuity light will be lighted if switch closed after relieving pressure.

c. Connect switch to a cylinder of dry nitrogen. (See Figure 4–21)

d. Set nitrogen pressure regulator higher than cutout point on switch being tested. Pressure switch cutout and cut–in points are shown in sections 1.3.k. and 1.3.l.

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

f. Open cylinder valve. Slowly close bleed–off valve and increase pressure until the switch opens. If light is used, light will go out and if an ohmmeter is used, the meter will indicate open. Open pressure on gauge. Slowly open bleed–off valve (to decrease pressure) until switch closes (light will light or ohmmeter will move).



1. Cylinder Valve and Gauge
2. Pressure Regulator
3. Nitrogen Cylinder
4. Pressure Gauge (0 to 400 psig = 0 to 28 kg/cm2)
5. Bleed–Off Valve
6. 1/4 inch Connection

Figure 4–21. Typical Setup for Testing High Pressure Switch

4.18 REPLACING RECEIVER SIGHT GLASS ASSEMBLY

NOTE

There are two types of receiver sight glasses. One is the floating ball type (P/N 14–00111), and the second is the prism type (P/N 14–50023–00); both are interchangeable.

a. Store the refrigerant in an evacuated container. (Refer to section 4.6.b)

b. Unscrew the sight glass assembly. Spread some sealing compound on pipe threads of new sight glass assembly and install.

c. Leak check receiver sight glass per section 4.7.

d. After leak checking unit, evacuate and dehydrate as outlined in section 4.8.

e. Add refrigerant charge. (Refer to section 4.9)

f. Check for noncondensibles. (Refer to section 4.11)

4.19 SERVICING SOLENOID VALVES

4.19.1 Solenoid Valves SV2 – Alco

CAUTION

Do not damage or overtighten the enclosing tube assembly. Torque to 200–inch pounds (2.3 mkg). Also make sure all parts are placed on the enclosing tube in proper sequence to avoid premature coil burnout.

a. Replacing the Coil

NOTE

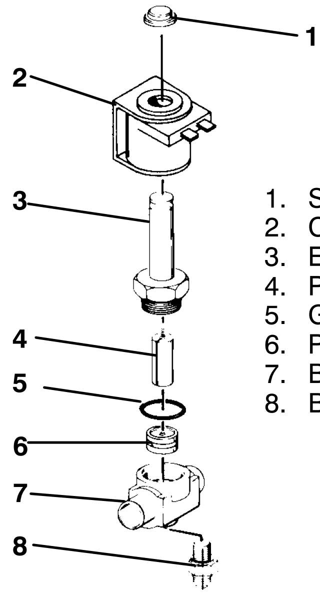
The coil may be replaced without removing the refrigerant or pumping the unit down.

1. Disconnect leads, remove coil snap cap and coil assembly.

2. Verify coil type, voltage and frequency. This information appears on the coil housing.

3. Place new coil over enclosing tube, snap cap and connect wiring.

b. Replacing Solenoid Valve Internal Parts (See Figure 4–22)



1. Snap Cap
2. Coil Assembly
3. Enclosing Tube Assembly
4. Plunger Assembly
5. Gasket
6. Piston Assembly
7. Body
8. Bracket Adapter

Figure 4–22. Solenoid Valves SV2 – Alco

The liquid line solenoid valve (SV2) may be serviced by pumping the unit down. (Refer to section 4.6.a)

1. Remove coil snap cap and coil assembly from valve. Remove enclosing tube assembly and related items.

2. Check for foreign material in valve body.

3. Install new parts. Do not completely tighten enclosing tube down. Purge line by emitting small amount of refrigerant per section 4.6.a.5.

4. Tighten enclosing tube assembly to a torque value of 200 inch pounds (2.3 mkg) and leak check the valve. (Refer to section 4.7)

5. Install coil assembly and snap cap.

6. Start unit and check refrigerant charge per section 4.9.f.

7. Check refrigeration cycles.(Refer to section 2)

4.19.2 Solenoid Valve SV1/SV3 – Sporlan

a. Replacing the Coil

NOTE

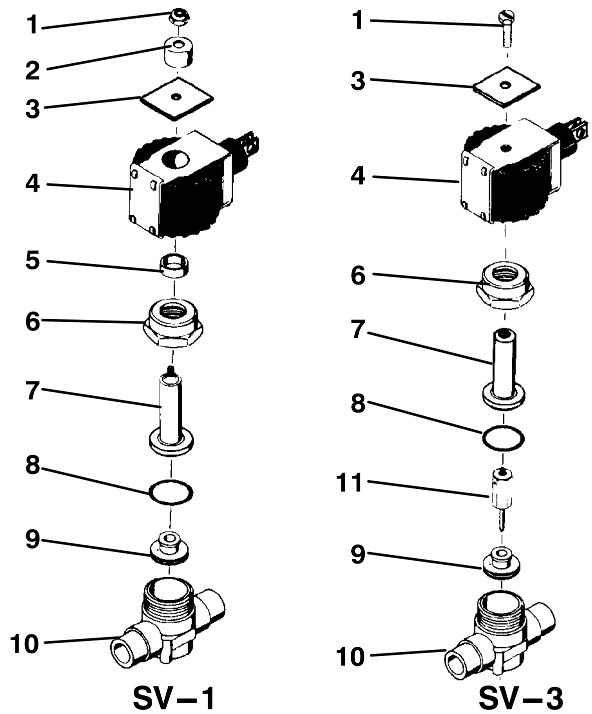
The coil may be replaced without removing the refrigerant or pumping the unit down.

1. Remove top locknut, spacer cup and nameplate (SV1). For SV3, remove screw and nameplate.

2. Disconnect wiring and remove coil.

3. Replace coil by reversing steps 1 and 2.

b. Replacing Internal Components (See Figure 4–23)



1. Locknut/Screw
2. Spacer Cup
3. Nameplate
4. Coil
5. Spacer
6. Enclosing Tube Locknut
7. Enclosing Tube
8. Gasket
9. Seat Disc
10. Body
11. Stem and Plunger

Figure 4–23. Solenoid Valves SV1/SV3–Sporlan

1. Remove and store the refrigerant charge in an evacuated container. (Refer to section 4.6.b)

2. Remove the top locknut, spacer cup, nameplate, coil assembly and spacer (SV1). For SV3, remove screw and nameplate.

3. Using a 12 point, 1–3/8 inch box wrench, loosen the enclosing tube locknut and bleed off remaining refrigerant.

4. Remove enclosing tube and locknut assembly. The gasket is inside the enclosing tube.

5. Remove seat disc from inside of body and check for obstructions and foreign material.

6. Place the seat disc into the valve body with the smaller diameter end facing up.

7. For SV3 install stem and plunger (item 11, Figure 4–23)

8. Place the enclosing tube locknut over the enclosing tube. Install spacer over enclosing tube making sure it is seated properly in the enclosing tube locknut. Tighten enclosing tube locknut to a torque value of 20 ft–lb (2.78 mkg). Do not overtighten.

9. Install coil assembly, nameplate and top locknut or screw.

10. Dehydrate and evacuate the system. (Refer to section 4.8) Charge unit with refrigerant per sections 4.9 and 4.10.

11. Start unit and check operation. (Refer to section 2)

4.20 SOLENOID VALVE SV–1 CHECKOUT PROCEDURE

To obtain proper heating and defrost, the normally open (N.O.) SV–1 solenoid valve must energize and close tightly during the heat and defrost cycles. If the valve does not close tightly due to physical damage, foreign material or wear, refrigerant leakage through the valve can reduce heating capacity.

a. During normal heat or defrost cycles the following conditions will be observed when the valve is operating properly:

(1) Receiver refrigerant level will drop quickly at the initiation of heating or defrost mode.

(2) Suction pressure will rise slowly to 25–30 psig (1.8 to 2.1 kg/cm^2).

(3) Discharge pressure will drop quickly, but begin to rise to a minimum of 250 psig (17.5 kg/cm^2) within 15 to 20 minutes.

b. If suction and discharge pressures remain low and the receiver level does not drop, the valve may be inoperative and can be checked by the following method.

(1) Verify the solenoid coil has proper voltage and is energized in heating and defrosting.

(2) Connect a discharge pressure gauge to the compressor discharge service valve and connect a gauge to the liquid line valve (king valve) leaving the receiver tank.

(3) With the trailer temperature at 35°F (1.7°C) or lower, operate the unit in high speed cool and remove or disconnect the "hot" wire leading to the SV–1 coil.

(4) With a separate 12 vdc positive voltage, energize SV–1 with the unit in high speed cooling and observe the discharge and receiver pressures. If the valve is closing properly, compressor discharge pressure will begin to rise and the receiver pressure will remain the same or begin to drop slowly. If the valve is not seating properly, both discharge and receiver pressure will rise slowly or remain the same.

Operate the unit until discharge pressure reaches 200 psig (14 kg/cm^2) and disconnect jumper wire to SV–1 valve. Discharge and receiver pressure should be within 5 to 15 psig (0.4 to 1.0 kg/cm^2) of each other.

4.21 CHECKING DEFROST OR HEATING CYCLE

NOTE

The evaporator temperature must be 35°F (1.7°C) (approximately 40°F = 4.4°C box temperature) or lower, before any checks can be made.

a. Hot Gas Solenoid Valve (SV–1 & SV–3) Heating and Defrosting

1. Connect a discharge pressure gauge to the receiver outlet valve and another gauge to the compressor discharge service valve. Connect a gauge to the compressor suction service valve.

2. Start unit with controller set at least 10°F = 5.5°C below indicated box temperature to obtain high speed cooling. Press the manual defrost and ENTER keys simultaneously to initiate defrost. (Box temperature must be below 40°F = 4.4°C.) The hot gas solenoid valve (SV3) will energize and the hot gas line will be hot to touch on either side of the valve. The condenser pressure control solenoid (SV1) closes and suction pressure will rise approximately 10 to 15 psig (0.70 to 1.05 kg/cm^2) after 15 to 20 minutes on unit operation. Refer to section 4.20 if unit does not heat properly.

The unit will remain in defrost until coil temperature increases to 50°F (10°C) where the defrost thermostats open and the unit resumes automatic operation.

b. Defrost Air Switch (DA)

1. To check air switch, run unit in high speed cooling and jump across the air switch terminals. This will start the defrost cycle as it simulates the action of the defrost air switch. Bypassing the switch in this manner operates all components involved in defrost.

2. Unit should remain in defrost until evaporator coil temperature reaches 50°F (10°C). At this point one of the two defrost thermostats should open to terminate the defrost cycle. Replace the defrost thermostats if unit fails to terminate defrost.

3. If the above test indicates satisfactory operation, test defrost air switch (DA) settings using a Dwyer Magnehelic gauge (P/N 07–00177) or similar instrument. (Refer to section 4.22)

c. Solid State Defrost Timer

Refer to section 1.10.2.f. for description.

4.22 CHECKING CALIBRATION OF THE DEFROST AIR SWITCH

a. Make sure magnehelic gauge is in proper calibration.

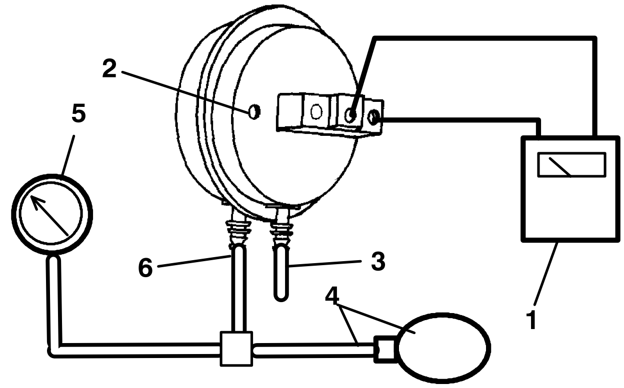
NOTE

The magnehelic gauge may be used in any position, but must be re–zeroed if position of gauge is changed from vertical to horizontal or vice versa. USE ONLY IN POSITION FOR WHICH IT IS CALIBRATED.

b. With air switch in vertical position, connect high pressure side of magnehelic gauge to high side connection of air switch. (See Figure 4–24)

c. Install tee in pressure line to high side connection. Tee should be approximately half–way between gauge and air switch or an improper reading may result.

d. Attach an ohmmeter to the air switch electrical contacts to check switch action.



1. Ohmmeter or Continuity Device
2. Adjustment Screw (0.050 socket head size)
3. Low Side Connection
4. Pressure Line or Aspirator Bulb (P/N 07–00177–01)
5. Magnehelic Gauge (P/N 07–00177)
6. High Side Connection

Figure 4–24. Defrost Air Switch Test Setup

NOTE

Use a hand aspirator (P/N 07–00177–01), since blowing into tube by mouth may cause an incorrect reading.

e. With the gauge reading at zero, apply air pressure very slowly to the air switch. An ohmmeter will indicate continuity when switch actuates.

f. Refer to section 1.3.e for switch settings. If switch fails to actuate at correct gauge reading, adjust switch by turning adjusting screw clockwise to increase setting or counterclockwise to decrease setting.

g. Repeat checkout procedure until switch actuates at correct gauge reading.

h. After switch is adjusted, place a small amount of paint or glycerol on the adjusting screw so that vibration will not change switch setting.

4.23 REPLACING THE CONDENSER/ EVAPORATOR FAN SHAFT OR BEARING

WARNING

Beware of unannounced starting of the evaporator and condenser fan.

a. To Remove the Fan Shaft

1. Remove two screws securing split tapered bushing to condenser fan hub (items 12 and 13, Figure 4–25). Place the two screws in the threaded holes of the fan hub and use screws as jacking bolts to remove bushing from fan.

2. Remove V–Belt. (Refer to section 4.5.3.)

3. Remove tapered bushing and sheave (items 10 and 11, Figure 4–25). Turn the two socket head screws (7/32 hex wrench) counterclockwise until the bushing clears the sheave and then remove sheave. At this time reassemble sheave and bushing by placing bushing into sheave and aligning the two half–moons of the bushing to the sheave. Place socket head screws in sheave and turn them in enough to catch the inner edge of bushing. Rotate bushing 90° and then the assembly is ready for installation.

4. Remove four 3/8–18 x 1 lg capscrews and washers (items 14, 15 and 16) from the bearing housing (item 8, Figure 4–25).

5. Remove evaporator panels.

6. Remove two screws securing split tapered bushing, to blower wheel (items 1 and 2, Figure 4–25). Place the two screws in the threaded holes of the fan hub and use screws as jacking bolts to remove bushing from blower wheel.

7. Remove venturi ring (item 3, Figure 4–25) by removing six 1/4–20 x 3/4 long capscrews.

8. Remove the shaft and bearing housing.

9. If necessary to replace bearings; remove locking collar from bearing (item 6, Figure 4–25). Remove fan shaft from bearing housing and then, using a bearing puller, remove bearings. Bearings cannot be driven through housing.

10. Inspect housing for casting number. The 48–00228–00 and 48–00228–02 casting use different bearings. Refer to your parts manual.

11. Inspect inner housing for rust or signs of water. Immediately discard any housing which cannot be reused after average cleaning in a "parts washer". Insure that housing is completely dry with no solvent residue before reusing.

12. Coat inside of bearing housing and outer bearing race with Beacon 325, or Mobil SHL 460 grease (or other lithium base equivalent – do not use WD–40 motor oil or other product which may have a solvent action).

13. Lubricate "O" ring with Beacon 325 or lithium base grease and install in grooves on shaft.

14. Press new bearings into housing and install shaft with the long keyway on the condenser side. The shaft extends 6 inches (152 mm) from the face of the bearing housing. Place locking collars on bearings and torque set screws to 6 foot/pounds.

CAUTION

Install one bearing into housing taking care to press bearing evenly into housing using both inner and outer race. DO NOT press against the seals. Install shaft with "O" ring into bearing. Install 2nd bearing onto shaft to complete assembly. "O" ring damage can be caused by sharp set screw holes in locking collar if shaft is inserted in a different manner.

15. Install bearing housing assembly into unit securing with four 3/8–16 x 1 inch long screws.

16. Install sheave with key and split taper bushing. The center line of the sheave is located 1–1/32 inch (33 mm) from the face of the bearing housing.

17. Install V–belt per section 4.5.3.

18. Install tapered hub on condenser fan loosely. Fan rotation is clockwise when viewing from front of unit. Air is pulled through the coil and discharges over the engine.

19. Locate the fan and key so that 1/3 of the condenser fan extends beyond the leaving edge of the fan shroud. Secure fan and hub to shaft.

20. Install evaporator fan venturi ring. Then install tapered hub and blower wheel loosely. Adjust blower wheel and tighten.

21. Install evaporator panels.

WARNING

Do not start unit without installing the evaporator panels as unit damage or body harm may result.

22. Start unit and check refrigeration cycle.

4.24 SERVICING DEFROST DAMPER SOLENOID (DDS) ASSEMBLY

WARNING

Beware of unannounced starting of the evaporator and condenser fan.

a. Replacing Solenoid or Adjusting Linkage (See Figure 4–26)

1. Remove six 1/4–20 capscrews securing evaporator panel to unit.

2. Disconnect wiring to solenoid.

3. Remove rod linkage clip (item 4, Figure 4–26) securing linkage rod (item 2).

4. Remove four 1/4–20 capscrews and locknuts securing solenoid.

5. Install new solenoid.

6. Install linkage and clip.

7. Connect solenoid wiring.

8. Energize the damper solenoid to close shutter blade.

9. If damper does not seal, remove boot (item 3) from solenoid and pull solenoid shaft out (far enough to loosen jam nut on solenoid shaft). Energize solenoid for maximum force (pull) and then shorten shaft by turning clockwise. De–energize solenoid, tighten shaft jam nut and replace boot. Connect linkage and energize solenoid.

NOTE

It may be necessary to apply heat to adjusting "I" bolt to be able to turn it because Loctite is used .

b. Replacing Bushings or Damper Blade

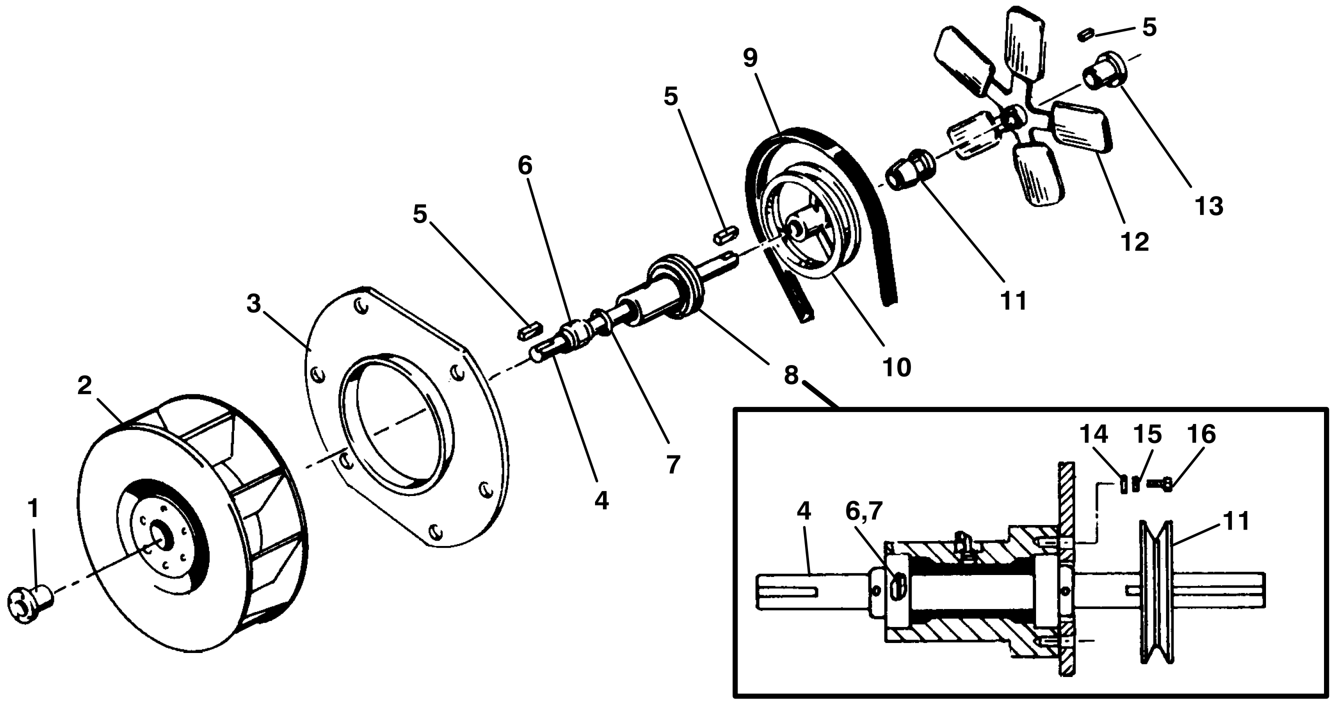
1. Remove damper return spring from damper (item 10, Figure 4–26).

2. Remove clip and cotter pin from linkage rod (items 2, 4, and 6, Figure 4–26).

3. Remove mounting hardware from damper plate assembly (item 7, Figure 4–26). Remove blade and bushing. Replace parts as necessary.

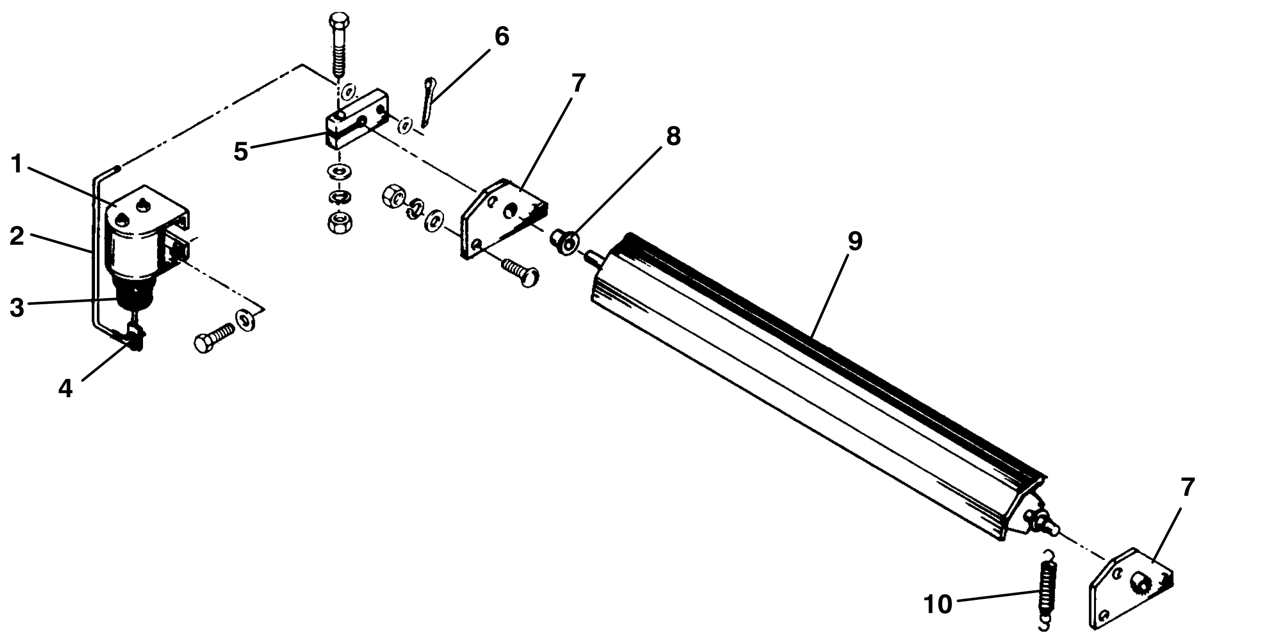
4. Reassemble parts by reversing steps 1 through 3.

5. Check linkage by following section 4.24.a. steps 8 and 9.



1. Split Tapered Bushing–2–1/2 Dia.
2. Blower Wheel
3. Venturi Ring
4. Shaft
5. Key
6. Bearing
7. O–Ring (Used with old style bearings)
8. Bearing Housing
9. V–Belt
10. Sheave
11. Split Tapered Bushing–1–13/16 Dia.
12. Condenser Fan
13. Condenser Fan Hub
14. Flat Washer, 3/8
15. Lock Washer, 3/8
16. Capscrew, 3/8–16 x 1 lg

Figure 4–25. Evaporator/Condenser Fan Shaft Assembly



1. Solenoid
2. Linkage Rod
3. Solenoid Boot
4. Clip, Linkage Rod
5. Linkage Adapter
6. Cotter Pin – 1/16 Dia.
7. Damper Plate Assembly
8. Bushing
9. Damper Blade Assembly
10. Return Spring

Figure 4–26. Defrost Damper Assembly

4.25 EVAPORATOR COIL CLEANLINESS

The use of recycled cardboard cartons is increasing across the country. The recycled cardboard cartons create much more fiber dust during transport than "new" cartons. The fiber dust and particles are drawn into the evaporator where they lodge between the evaporator fins. If the coil is not cleaned on a regular basis, sometimes as often as after each trip, the accumulation can be great enough to restrict air flow, cause coil icing, repetitive defrosts and loss of unit capacity. Due to the "washing" action of normal defrost the fiber dust and particles may not be visible on the face of the coil but may accumulate deep within.

It is recommended to clean the evaporator coil on a regular basis, not only to remove cardboard dust, but to remove any grease or oil film which sometimes coats the fins and prevents water from draining into the drain pan.

Cardboard fiber particles after being wetted and dried several times can be very hard to remove. Therefore, several washings may be necessary.

a. Remove rubber check valves (Kazoo) from drain lines (front of trailer).

b. Spray coil with a mild detergent solution such as Oakite 164 or any good commercial grade automatic dish washer detergent such as Electrosol or Cascade and let the solution stand for a few minutes and reverse flush (opposite normal air flow) with clean water at mild pressure. A garden hose with spray nozzle is usually sufficient. Make sure drain lines are clean.

c. Run unit until defrost mode can be initiated to check for proper draining from drain pan. (Refer to section 2)

4.26 THERMOSTATIC EXPANSION VALVE

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

There are two methods of replacing the expansion valve.

a. Preferred Method

Refer to section b. for alternate method.

1. Pump down the unit by closing the receiver outlet valve. (Refer to section 4.6.a)

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

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

4. Remove flange screws and lift off power assembly. Then remove the cage assembly. Check for foreign material in valve body.

5. The thermal bulb is located below the center of the suction line (4 or 7 o'clock position). This area must be clean to ensure positive bulb contact. Strap thermal bulb to suction line and insulate both with Presstite.

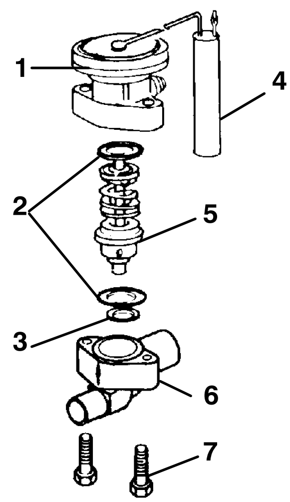
6. Install new gaskets and insert cage assembly and install power assembly.

7. Fasten equalizer tube to expansion valve.

8. Evacuate by placing vacuum pump on suction service valve.

9. Open receiver outlet valve and then check refrigerant level. (Refer to section 4.10.b)

10. Check superheat. (Refer to section 1.3.h)



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

Figure 4-27. Thermostatic Expansion Valve

b. Alternate Method

1. Pump down the unit by closing the receiver outlet valve and then closing the suction service valve

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

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

4. Remove flange screws and lift off power assembly. Then remove the cage assembly. Check for foreign material in valve body.

5. The thermal bulb is located below the center of the suction line (4 or 7 o'clock position). This area must be clean to ensure positive bulb contact. Strap thermal bulb to suction line and insulate both with "Presstite."

6. Install new gaskets and insert cage assembly. Install power assembly with flange screws loosely.

7. Fasten equalizer tube to expansion valve.

8. Tighten flange screws on expansion valve and then check the refrigerant charge per section 4.10.b.

9. Check superheat. (Refer to section 1.3.h)

c. Checking Superheat

NOTE

It is not recommended adjusting internal adjustable valves unless absolutely necessary.

If the valve came from the factory with the proper setting and the setting has changed, a mechanical malfunction has occurred and adjusting superheat will not correct the malfunction.

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

d. To Measure Superheat

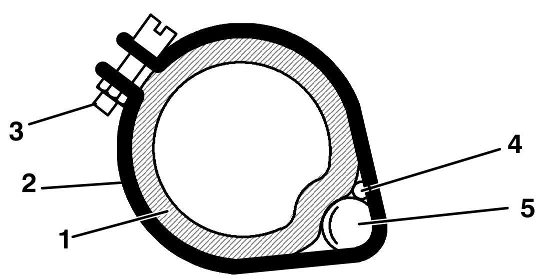
NOTE

The expansion valve and bulb location are shown in Figure 1–6.

1. Remove evaporator panel from rear of unit and then remove Presstite from expansion valve bulb and suction line.

2. Loosen one TXV bulb clamp and make sure area under clamp (above TXV bulb) is clean.

3. Place thermocouple above (parallel) TXV bulb and then secure loosened clamp making sure both bulbs are firmly secured to suction line as shown in Figure 4–28.



1. Suction Line (end view)
2. TXV Bulb Clamp
3. Nut and Bolt (clamp)
4. Thermocouple
5. TXV Bulb

Figure 4–28. Thermostatic Expansion Valve Bulb and Thermocouple

NOTE

When conducting this test the suction pressure must be 6 psig (0.4 kg/cm2) below expansion valve maximum operating pressure (MOP). For example: R–502 units use an expansion valve with a 30 MOP. The recommended test pressure should be below 24 psig(1.69 kg/cm2).

4. Connect an accurate gauge to the 1/4" port on the suction service valve.

5. Run unit until stabilized. Set controller 10°F (5.5°C) below box temperature.

6. From the temperature/pressure chart, determine the saturation temperature corresponding to the evaporator outlet pressure.

7. 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 7. The difference is the superheat of the suction gas.

e. Adjusting Superheat

1. Pump the unit down and remove the two bolts holding the valve body together. (Refer to sections 4.26.a or 4.26.b)

2. Remove the cage assembly and rotate the adjusting nut to increase or decrease the superheat. Turning the nut to compress the valve spring will increase the superheat and decrease refrigerant flow through the valve. Decompressing the spring will decrease the superheat and increase the refrigerant flow through the valve.

3. Reassemble the valve and then start the unit.

4. When the unit has stabilized operation for at least 20 minutes, recheck superheat setting.

5. If superheat setting is correct, remove gauge and thermocouple. Insulate bulb and suction line.

4.27 MICROPROCESSOR

NOTE

The erasable, programmable, read only memory (EPROM) chip (component U9 on the microprocessor display board) has a window on it which is covered with a label listing the revision level of the software. The window is used to erase the chip's memory with the use of ultraviolet light. the label prevents light from entering the chip and erasing the memory. Under NO circumstances should this label be removed.

CAUTION

Under no circumstances should a technician electrically probe the processor at any point, other than the connector terminals where the harness attaches. Microprocessor components operate at different voltage levels and at extremely low current levels. Improper use of voltmeters, jumper wires, continuity testers, etc. could permanently damage the processor.

As mentioned above, some microprocessor inputs operate at voltage levels other than the conventional 12 vdc. Connector points and the associated approximate voltage levels are listed below for reference only. Under no circumstances should 12 vdc be applied at these connection points.

Grounded wrist cuffs are available at most radio, computer and electronic supply stores. It is recommended that these be worn whenever handling a microprocessor.

CONNECTION POINT

Connection Point	Approximate Voltage Range
JG1, JG3, JG4, JG5 NHS1, NHS2,CRS2, CRS1 PTS1,and PTS2	2.5 vdc
JD1, JD2, JE1, JE2, RAS, SAS	2.5 vdc (Variable)
JF5, JF6, OTS1, OTS2	5.0 vdc
JC5, WTS	2.5 vdc (Variable)
JC6, CDT	2.5 vdc (Variable)

CAUTION

Most electronic components are susceptible to damage caused by electrical static discharge (ESD). In certain cases, the human body can have enough static electricity to cause resultant damage to the components by touch. This is especially true of the integrated circuits found on the truck/trailer microprocessor.

Although there is less danger of electical static discharge ESD damage in the outdoor environment, where the processor is likely to be handled, proper board handling techniques should always be stressed. Boards should always be handled by their edges, in much the same way one would handle a photograph. This not only precludes the possibility of ESD damage, but also lowers the possibility of physical damage to the electronic components. Although the microprocessor boards are fairly rugged when assembled, they are more fragile when separated and should always be handled carefully.

During emergency situations, the five switch test board may be used to keep a unit running and prevent a critical load from spoiling. Since the microprocessor is totally disconnected from the unit, it cannot monitor the engine's safety switches for oil pressure and coolant temperature. *Since the engine is running unprotected when the five switch board is used,* it is imperative that should a problem develop with the microprocessor, it be replaced immediately. *The five switch board is intended to be a trouble–shooting tool only.*

When using the five switch board to troubleshoot, the unit should be started in low speed, unloaded cool in the same way as the processor would start the unit. *Good judgment should also be used when cycling any unit with the five switch board. Rapid cycling should be avoided.*

When welding is required on the unit frame, or on the front area of the trailer, ALL wiring to the Microprocessor MUST be disconnected. When welding is performed on other areas of the trailer, the welder ground connection MUST be in close proximity to the area being welded. It is also a good practice to remove both battery cables before welding on either the unit frame or the trailer to prevent possible damage to other components such as the alternator and voltage regulator.

Should damage to the Key Board of the Microprocessor occur, it is possible to replace only the Key Board.

It is absolutely imperative that whenever a Microprocessor is removed from a unit for any reason, that the old Key Board gasket be removed, and a new one be installed.

The tightening sequence shown below should be adhered to when tightening the retaining bolts or nuts. The recommended torque for securing nuts or bolts is 20 inch–lbs. Over tightening the nuts or bolts, or using a tightening sequence other than the one shown, may cause warping of the Key Board.

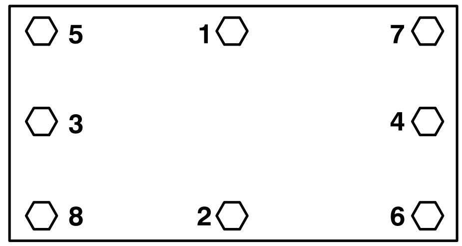


Figure 4–29. Tightening Sequence for Microprocessor

4.28 CONTROLLER SENSOR CHECKOUT

An accurate ohmmeter must be used to check resistance values shown in Table 4–2.

Due to 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 bad, the resistance reading will usually be much higher or lower than the resistance values given in Table 4–2.

At least one lead from the sensor (RAS, terminals JD1 and 2 or SAS, terminals JE1 and 2) must be disconnected from the unit electrical system before any reading is taken. Not doing so will result in a false reading. Two preferred methods of determining the actual test temperature at the sensor, is an ice bath at 32°F (0°C) or a calibrated temperature tester.

4.29 SUCTION PRESSURE TRANSDUCER

Before installing a new suction pressure transducer it must be calibrated.

1. Connect wiring to new suction pressure transducer. Before installing suction pressure transducer into compressor, press SUCTION PRESSURE key on control panel. If display reads "0" on control panel install suction pressure transducer into compressor. If it does not reads "0" go to step 2.

2. Press Carrier Transicold oval, SUCTION PRESSURE and ENTER keys at the same time to calibrate suction pressure transducer. Display should read "0". (See Figure 1–13)

4.30 SERVICING CONDENSER SHUTTER (OPTIONAL)

a. Replacing the Vernatherm Power Unit (Element)

The Vernatherm power unit assembly (item 1, Figure 4–30) is pre–set and will start to open at 70°F (21°C) condensing air temperature. *It is not adjustable* for various temperature settings. The temperature must be below 68°F (20°C) when replacing the Vernatherm power unit (element).

To replace power unit (item 1), remove old power unit (item 1) and jam nut (item 2). Assemble jam nut to new power element. Turn power element into body casting until the push pin (item 3) is firmly positioned against the push rod (item 6). Then tighten jam nut.

b. Air Leakage

With the shutter closed and unit running, place a piece of paper on the surface of the shutter. If the paper is held in place by fan suction, the shutter is improperly adjusted. Air leakage may be caused by one or more of the following:

1. Bearings (Refer to section 4.30.e.)
2. Shutters need adjusting. (Refer to section 4.30.c.)
3. Vernatherm power unit needs adjusting. (Refer to section 4.30.a.)
4. Worn vane seals (Refer to section 4.30.d.)
5. Improper shutter installation on unit. (There must be an air–tight seal all around shutter to ensure that air enters the shutter only.)

c. Shutter Linkage Adjustment

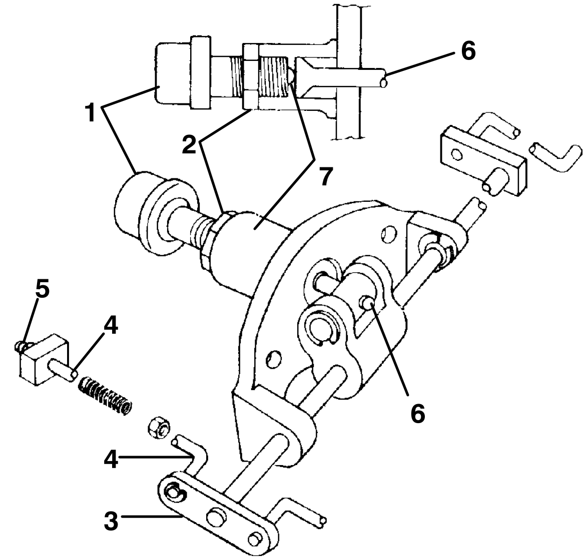
Check condition of vane seals before making adjustments to the shutter linkage (Refer to section 4.30.d.) Also, the temperature must be below 68°F (20°C) and the vanes firmly closed before making adjustments.

If the vane seals appear to be in good condition, place a piece of cardboard, or feeler gauge, approximately .015 inch (0.381 mm) thick between the vanes. If there is a drag on the gauge when removing, the adjustment is correct. If the gauge is loose between the vanes, the shutter must be adjusted by doing the following:

1. Loosen lock nuts (item 5) on both control rods. The shutters will be held closed by the return springs and the vanes should now be sealing properly.
2. Press actuating lever (item 3) and shaft assembly to its full “in” position.
3. Tighten lock nuts (item 5) on both control rods. When adjustment is completed, the push rod (item 6) must be against Vernatherm push pin (item 7).

d. Checking and Replacing Vane Seals

To inspect the vane seals, start unit and when shutters open, check seals for damage or a worn condition.



1. Vernatherm Power Unit
2. Jam Nut
3. Actuating Lever
4. Control Rod
5. Lock Nut
6. Push Rod
7. Push Pin

Figure 4–30. Condenser Shutter Adjustment

Replacing Vane Seals

1. Remove shutters from unit and disconnect shutter return spring from both shutters. Shutter may now be opened.
2. When replacing seals, do not let them extend beyond the vanes. This will eliminate any possibility of binding of the shutter. Use a soap solution in the vane channel and stretch the seal when assembling to the channel. The seal, being elastic, will return to its natural shape.

e. Bearing Seizure

When shutters are not adjusted correctly and sufficient air leakage through the vanes occur, the shutters will not operate and will stay in a static position (partially opened). This will, in some instances, especially where salt conditions exist, cause the vane pins and bearings to seize, making the shutters inoperative.

When this occurs, remove the shutter from the unit and apply liberal amounts of penetrating oil to all bearing surfaces, including the control bar and let stand for a period of time. Disconnect the return spring and then, operate the vanes by hand, until they move freely. Remove excess oil with a solvent.

f. Lubrication

Lubricate all pivot points with rust inhibitor and lubricant, LPS–2 or equal.

1. Run unit until shutters open (warm weather operation). Attach applicator (plastic tube) to aerosol can and lubricate all pivot points. Do not spray directly into radiator and condenser coil.
2. If shutters are seized or do not open because of low ambient temperature:

Remove shutters from unit and disconnect shutter return spring from both shutters. Lubricate all pivot points and manually move shutters until satisfactory operation is achieved.

4.31 UNIDRIVE TORQUE REQUIREMENTS (See Figure 4−31)

Extensive damage may occur if the proper hardware and procedures are not followed. Periodic inspection of hardware and bolt torque is recommended to insure the integrity of the unidrive.

NOTE

Earlier units used locking tabs to retain the bolts between the compressor mounting flange and the adapter spacers. If the locking tabs are not replaced, or on new units without locking tabs, a thread locking sealant, 5/16 flatwasher and 5/16 lockwasher *must* be used. The recommended sealant is Loctite screw lock no. 262.

The figure below shows the torque value, size and grade of the hardware to be used when reassembling the unidrive assembly.

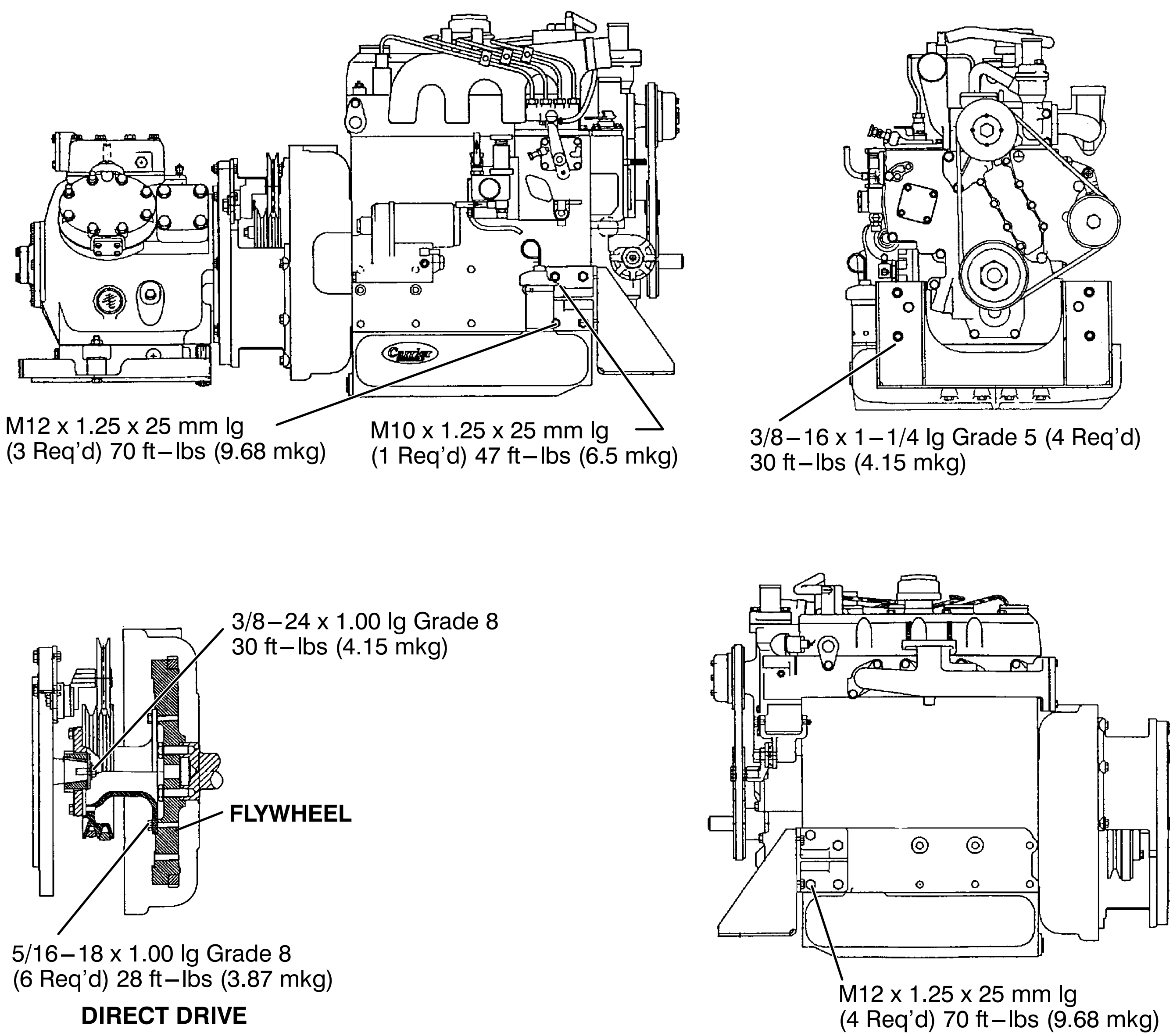


Figure 4−31. Unidrive Torque Requirements

Table 4–2. Sensor Resistance (RAS and SAS)

Temperature °F	°C	Resistance In Ohms	Temperature °F	°C	Resistance In Ohms	Temperature °F	°C	Resistance In Ohms
−20	−28.9	165,000	+14	−10.0	55,300	+48	+ 8.9	21,000
−18	−27.8	154,000	+16	− 8.9	52,100	+50	+10.0	19,900
−16	−26.7	144,300	+18	− 7.8	49,100	+52	+11.1	18,900
−14	−25.6	134,400	+20	− 6.7	46,300	+54	+12.2	18,000
−12	−24.4	126,100	+22	− 5.5	43,600	+56	+13.3	17,000
−10	−23.3	118,300	+24	− 4.4	41,100	+58	+14.4	16,100
− 8	−22.2	110,500	+26	− 3.3	38,800	+60	+15.6	15,300
− 6	−21.1	103,700	+28	− 2.2	36,600	+62	+16.7	14,500
− 4	−20.0	97,100	+30	− 1.1	34,600	+64	+17.8	13,800
− 2	−18.9	91,000	+32	0	32,700	+66	+18.9	13,200
0	−17.8	82.800	+34	+ 1.1	30,800	+68	+20.0	12,500
+ 2	−16.7	80,200	+36	+ 2.2	29,200	+70	+21.1	11,800
+ 4	−15.6	75,300	+38	+ 3.3	27,600	+72	+22.2	11,300
+ 6	−14.4	70,800	+40	+ 4.4	26,100	+74	+23.3	10,600
+ 8	−13.3	66,500	+42	+ 5.5	24,700	+76	+24.4	10,300
+10	−12.2	62,500	+44	+ 6.7	23,400	+78	+25.6	9,800
+12	−11.1	58,800	+46	+ 7.8	22,100	+80	+26.7	9,300

Table 4–3. R–502 Pressure – Temperature Chart

TEMPERATURE °F	°C	PRESSURE Psig	Kg/cm2	Bar	TEMPERATURE °F	°C	PRESSURE Psig	Kg/cm2	Bar
−40	−40	4.1	.29	.28	28	− 2	62.8	4.42	4.33
−35	−37	6.5	.46	.45	30	− 1	65.6	4.61	4.52
−30	−34	9.2	.65	.63	32	0	68.4	4.81	4.72
−28	−33	10.3	.72	.71	34	1	71.3	5.01	4.92
−26	−32	11.5	.81	.79	36	2	74.3	5.22	5.12
−24	−31	12.7	.89	.88	38	3	77.4	5.44	5.34
−22	−30	14.0	.98	.97	40	4	80.5	5.66	5.55
−20	−29	15.3	1.08	1.05	45	7	88.7	6.24	6.12
−18	−28	16.7	1.17	1.15	50	10	97.4	6.85	6.72
−16	−27	18.1	1.27	1.25	55	13	106.6	7.49	7.35
−14	−26	19.5	1.37	1.34	60	16	116.4	8.18	8.03
−12	−24	21.0	1.48	1.45	65	18	126.7	8.91	8.74
−10	−23	22.6	1.59	1.61	70	21	137.6	9.67	9.49
− 8	−22	24.2	1.70	1.67	75	24	149.1	10.48	10.28
− 6	−21	25.8	1.81	1.78	80	27	161.2	11.33	11.11
− 4	−20	27.5	1.93	1.90	85	29	174.0	12.23	12.00
− 2	−19	29.3	2.06	2.02	90	32	187.4	13.18	12.92
0	−18	31.1	2.19	2.14	95	35	201.4	14.16	13.89
2	−17	32.9	2.31	2.27	100	38	216.2	15.20	14.91
4	−16	34.9	2.45	2.44	105	41	231.7	16.29	15.98
6	−14	36.9	2.59	2.54	110	43	247.9	17.43	17.09
8	−13	38.9	2.73	2.68	115	46	264.9	18.62	18.26
10	−12	41.0	2.88	2.83	120	49	282.7	19.88	19.49
12	−11	43.2	3.04	2.98	125	52	301.4	21.19	20.78
14	−10	45.4	3.19	3.13	130	54	320.8	22.55	22.12
16	− 9	47.7	3.35	3.29	135	57	341.2	23.99	23.52
18	− 8	50.0	3.52	3.45	140	60	362.6	25.49	25.00
20	− 7	52.5	3.69	3.62	145	63	385.0	27.07	26.54
22	− 6	54.9	3.86	3.89	150	66	408.4	28.71	28.16
24	− 4	57.5	4.04	3.96	155	68	432.9	30.44	29.85
26	− 3	60.1	4.23	4.14	160	71	458.7	32.25	31.63

SECTION 5
ELECTRICAL SCHEMATIC WIRING DIAGRAM

5.1 INTRODUCTION

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

WARNING

Beware of V–belts and belt driven components as the unit may start automatically. Before servicing unit, make sure the start–run stop switch is in the OFF position. Also disconnect the negative battery cable.

WARNING

Beware of unannounced starting of the evaporator and condenser fan.

WARNING

Make sure power to unit is OFF and negative battery cable is disconnected before servicing the compressor unloader.

WARNING

Do not use a disposable refrigerant container to store the charge as an explosion may occur.

WARNING

Under no circumstances should ether or any other unauthorized starting aids be used in conjunction with the glow plugs.

CAUTION

Under no circumstances should anyone attempt to service the microprocessor! Should a problem develop with the microprocessor, contact your nearest Carrier Transicold dealer for replacement.

CAUTION

Under no circumstances should a technician electrically probe the processor at any point, other than the connector terminals where the harness attaches. Microprocessor components operate at different voltage levels and at extremely low current levels. Improper use of voltmeters, jumper wires, continuity testers, etc. could permanently damage the processor.

CAUTION

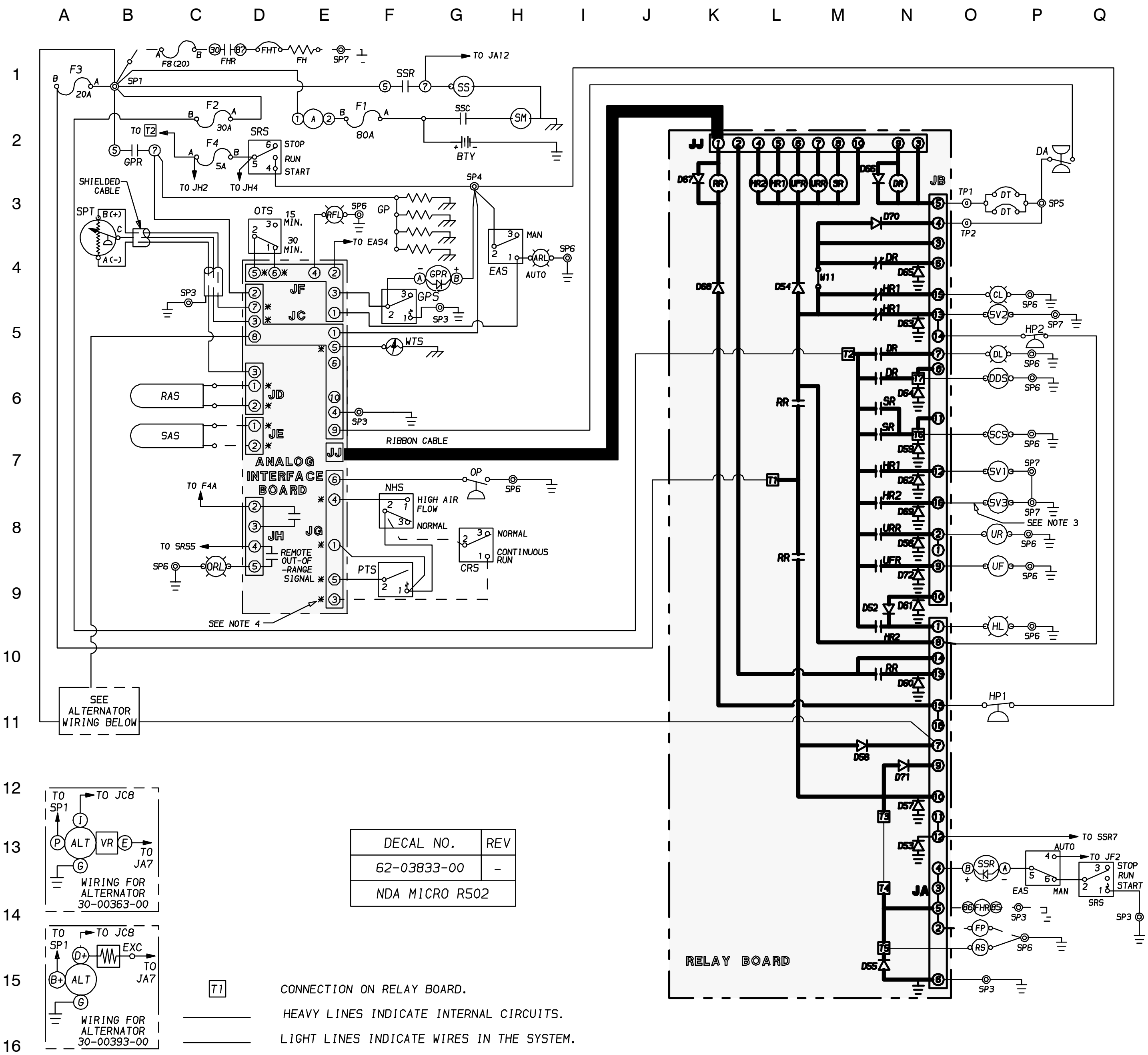
Never apply 12 vdc to JD, JE, JF, or JG terminal blocks. These four items are low voltage (2.5 or 5.0 vdc). Damage to the microprocessor will result. (Refer to Note 4, Figure 5–1)

CAUTION

Observe proper polarity when installing battery, negative battery terminal must be grounded. Reverse polarity will destroy the rectifier diodes in alternator. As a precautionary measure, disconnect positive battery terminal when charging battery in unit. Connecting charger in reverse will destroy the rectifier diodes in alternator.

LEGEND

Figure 5-1. Electrical Schematic Wiring Diagram - Dwg. No. 62-03833
(Sheet 1 of 2)



DECAL NO.	REV
62-03833-00	-
NDA MICRO R502	

T1 CONNECTION ON RELAY BOARD.

HEAVY LINES INDICATE INTERNAL CIRCUITS.

LIGHT LINES INDICATE WIRES IN THE SYSTEM.

NORMALLY CLOSED CONTACTS.

NORMALLY OPEN CONTACTS.

INDICATES A SOLDERED SPLICE POINT.

COMPONENT OR A MULTIPLE PLUG CONNECTION NUMBER.

SWITCH SYMBOL INDICATES MOMENTARY CONTACTS.

INDICATES A WIRE GROUND.

INDICATES A CHASSIS GROUND (NO WIRE).

INDICATES STANDARD OPTIONS.

INDICATES A CONNECTION, WIRE, LUG, ETC.

NOTES:

1. UNIT SHOWN IN "OFF" POSITION.
2. WIRE IDENTIFICATION SYSTEM:
   COLOR: WHITE - DC CONTROL CIRCUITS
   BLACK - DC GROUNDS
3. ADDRESS SYSTEM: EXAMPLE, JB16-SV3 INDICATES A WIRE BETWEEN PLUG JB, PIN #16 ON RELAY BOARD AND THE SV3 SOLENOID VALVE.
4. * VOLTAGE BELOW 12 VOLTS. REFER TO OWNERS MANUAL FOR TROUBLESHOOTING PROCEDURE.

Figure 5-1. Electrical Schematic Wiring Diagram - Dwg. No. 62-03833 (Sheet 2 of 2)

SECTION 6

MULTI–TEMP OPERATION AND SERVICE

6.1 INTRODUCTION

a. System

The Phoenix Multi–Temp multiple compartment refrigeration system offers the versatility of two or three compartment temperature control. The Multi–Temp allows the shipper to ship frozen and perishable commodities in the same load under separate refrigeration control.

The Phoenix Multi–Temp unit is comprised of the basic Phoenix diesel nosemount unit with one or two remote evaporators for rear compartments .

The unit also is equipped with a 5–kilowatt, single phase, 230 v–ac generator in the nosemount to power the electric heaters in the rear evaporators.

b. Remote Evaporator and Control Box

The rear compartments of the Multi–Temp system is equipped with a separate evaporator and remote mounted control box.

The remote evaporators can be wall or ceiling mounted and includes evaporator coil and heaters, drain pan, evaporator fan and motor (12v–dc), defrost termination thermostat, liquid line solenoid, expansion valve, air switch and evaporator pressure regulator.

The control box includes a solid state controller, indicating lights, switches, circuit breakers and relays. CB4 is a circuit breaker which protects the evaporator fan motor and CB5 protects the control power circuit.

6.2 ELECTRICAL DATA

a. Generator (5kw)

Wattage	5000 Watts
Volts	230 v–ac
Phase	1
Speed	3600 rpm at 60 hz
Rotation	either direction

b. Remote Evaporator Fan Motor

Volts	12 v–dc
Horsepower	1/8 hp
Speed	3000 rpm
Rotation	Clockwise when viewed from shaft end

c. Remote Evaporator Defrost Heaters

1. Two Compartments

Number	2
Voltage	240 v–ac/1 ph/60hz
Wattage	2500 watts each

2. Three Compartments

Number	2
Voltage	240 v–ac/1 ph/60hz
Wattage	1250 watts each

6.3 SAFETY DEVICES

Safety Devices for protection of the Remote Evaporator are listed in Table 6–1.

Table 6–1. Safety Devices – Remote Evaporator

Unsafe Conditions	Safety Device	Device Setting
1. Excessive current draw by remote evaporator fan motor	1. Circuit breaker (CB4) automatic reset	1. Trips at 30 amps
2. Excessive current draw by remote evaporator control circuit	2. Circuit breaker (CB5) automatic reset	2. Refer to Wiring Diagram
3. Excessive current draw by 5 KW generator	3. Fuse (F6, F7)	3. Opens at 30 amps

6.4 REFRIGERANT CIRCUIT

The Multi−Temp refrigerant circuit is the same as the Phoenix but with the addition of a remote evaporator.

The remote evaporator refrigerant flows through the electrically controlled liquid line solenoid valve (LSV) which starts or stops the flow of liquid refrigerant.

The remote evaporator is fitted with an evaporator pressure regulating valve. This valve will automatically throttle flow from the evaporator in order to maintain the preset minimum evaporator pressure.

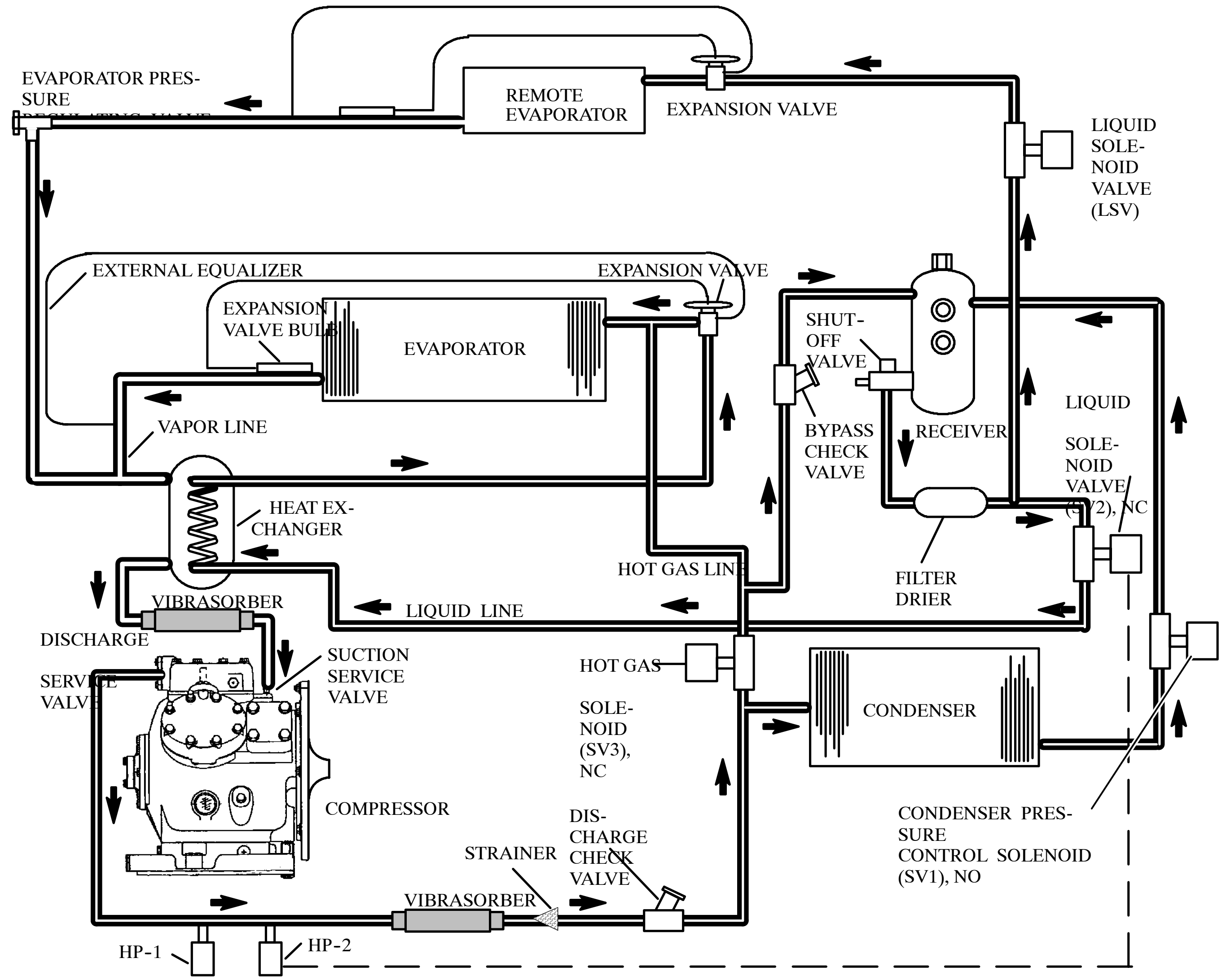


Figure 6−1. Refrigerant Circuit − Cooling

6.5 REMOTE COMPARTMENT OPERATION

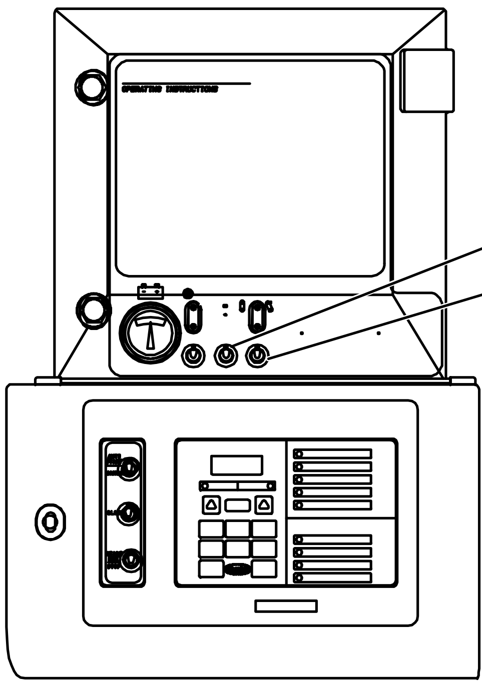
a. To start remote evaporator, place the remote compartment switch in the ON position (See Figure 6−2). Set desired temperature using the dial on the remote control box (See Figure 6−3).

b. The manual defrost switch and function lights for each compartment are on the remote control box.

c. Turn remote compartment switch OFF when remote evaporator is not required.

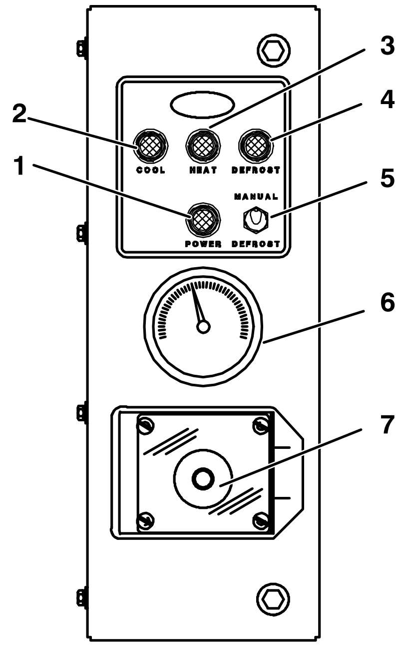
NOTE

For starting instructions on the nosemount unit refer to section 2.2.



1. Third Compartment ON−OFF Switch (3ST)
2. Second Compartment ON−OFF Switch (2ST)

Figure 6−2. Control Panel



1. Power Light
2. Cool Light
3. Heat Light
4. Defrost Light
5. Manual Defrost Switch
6. Thermometer
7. Temperature Selector

Figure 6−3. Remote Control Box

6.6 SERVICING THE REMOTE EVAPORATOR

WARNING

BEFORE SERVICING THE REMOTE EVAPORATOR, REMOVE NEGATIVE BATTERY CABLE AND TAG NOSEMOUNT START−RUN−STOP SWITCH TO PREVENT STARTING.

a. Fan Motor or Blade Replacement

1. Remove front panel.

2. Remove fan guard, loosen fan hub set screw (#10−32 x 1/2 lg − cone point) and remove fan. Remove fan motor hardware and fan wiring (if required).

3. Replace fan motor and fan blade before tightening fan setscrew, align fan with 1/3 of the fan blades extending beyond the leaving edge of the housing. Replace fan guard and front panel, test fan operation.

b. Replacing Tubular Heaters

1. Remove front panel.

2. Disconnect heater wiring from junction block and spiral wrap.

3. Release spring tension on heater and remove from attaching clip.

4. Replace and rewire heater. Reinstall front panel and test heater operation.

6.7 SERVICING LIQUID SOLENOID VALVE (LSV)

NOTE

The liquid solenoid valve (LSV) is the same valve as (SV2). Refer to section 4.19 for servicing.

6.8 EVAPORATOR PRESSURE REGULATING VALVE

Evaporator pressure regulating valves offer an efficient means of balancing the system capacity and the load requirements during periods of low loads and maintaining different evaporator conditions on multi–temperature systems. The primary function of this type of valve is to prevent the evaporator pressure from falling below a predetermined value at which the valve has been set.

The valves will automatically throttle the vapor flow from the evaporator in order to maintain the desired minimum evaporator pressure. As the load increases, the evaporating pressure will increase above the valve setting and the valve will open further.

Operation

Evaporator pressure regulating valves respond only to variations in their inlet pressure (evaporator pressure). The outlet pressure is exerted on the underside of the bellows and on top of the seat disc. Since the effective area of the bellows is equal to the area of the port, the outlet pressure cancels out and the inlet pressure acting on the bottom of the seat disc opposes the adjustable spring force. These two forces are the operating forces of the valve. When the evaporator load changes, the valve opens or closes in response to the change in evaporator pressure.

An increase in inlet pressure above the valve setting tends to open the valve. If the load drops, less refrigerant is boiled off in the evaporator and the evaporator pressure will decrease. The decrease in evaporator pressure tends to move the valve to a more closed position which in turn keeps the evaporator pressure up. The net result is that the evaporator pressure does change as the load changes.

The operation of a valve of this type is improved by an anti–chatter device built into the valve. Without this device, the valve would be susceptible to compressor pulsations that can greatly reduce the life of a bellows. This feature allows the valve to function at low load conditions without chattering or other operating difficulties.

6.9 ADJUSTING THE EVAPORATOR PRESSURE REGULATING VALVE

a. Adjustment

0°F (–17. 8°C) Front and 35°F (1. 7°C) Rear Compartment Operation

1. Connect gauge to evaporator pressure regulating valve (EPR) access valve. Remove the cap from the EPR.

NOTE

To adjust valve, place 1/4” hex wrench size in adjustment screw. A clockwise rotation increases the valve setting while a counterclockwise rotation decreases the setting. To obtain the desired setting, a pressure gauge should be utilized so the effects of any adjustment may be observed.

2. Set front and rear compartment controllers to above settings and start unit. When the front compartment suction Pressure reaches l0 to 12 Psig (0.7 to 0.8 kg/cm^2) , set rear evaporator EPR. valve at 17 Psig 1.2 kg/cm^2) . This setting will satisfy the operating requirements for most 2 compartment applications.

3. However, if the front compartment does not pull down to 0°F (–l7.8°C) within 2 hours, adjust the rear evaporator EPR to a higher pressure setting, increasing by 2 psig (0.1 kg/cm) increments. (Adjustment screw turned in a clockwise direction.) Allow temperature to stabilize after each new valve adjustment until the set compartment temperature is reached.

4. Conversely, if the front compartment reaches controller setting of 0°F (–17.8°C) but the rear compartment does not pull down to 35°F (l.7°C) within 1 hour, adjust the rear evaporator EPR. counterclockwise in 2 psig (0.1 kg/cm^2) increments until the set rear compartment temperature is reached. Allow stabilization of temperature after each new adjustment is recommended.

EPR adjustments should be made when the ambient temperature is near summer maximum Adjustments made in cooler ambients may require resetting when the summer maximum is reached.

For other temperature and respective valve pressure settings, contact Carrier Transicold.

b. Service

Since these valves are hermetic and cannot be disassembled for inspection and cleaning, they usually must be replaced if they become inoperative. However, if the valve fails to open, close properly, Or won’t adjust, it is probably due to solder or other foreign materials lodged in the port. It is sometimes possible to dislodge these materials. by turning the adjustment screw all the way out with the system running.

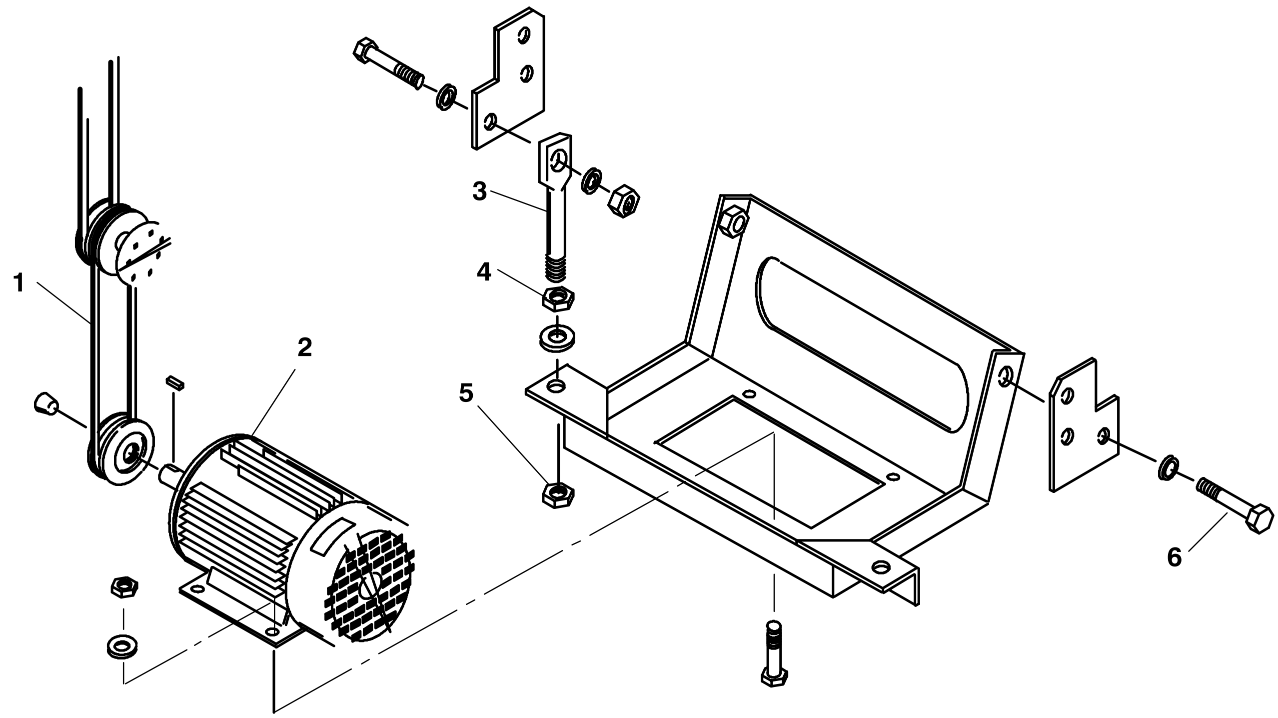
If the valve develops a refrigerant leak around the spring housing, it probably has been overheated during installation or the bellows has failed due to severe compressor pulsations. In either case the valve must be replaced.

6.10 REPLACING OR ADJUSTING GENERATOR BELT

a. Loosen generator support bracket rear pivot bolts (Item 6, Figure 6–4). Loosen jam nut on adjusting screw (Item 3) and take up on locknut enough to clear generator V–belt from the sheave.

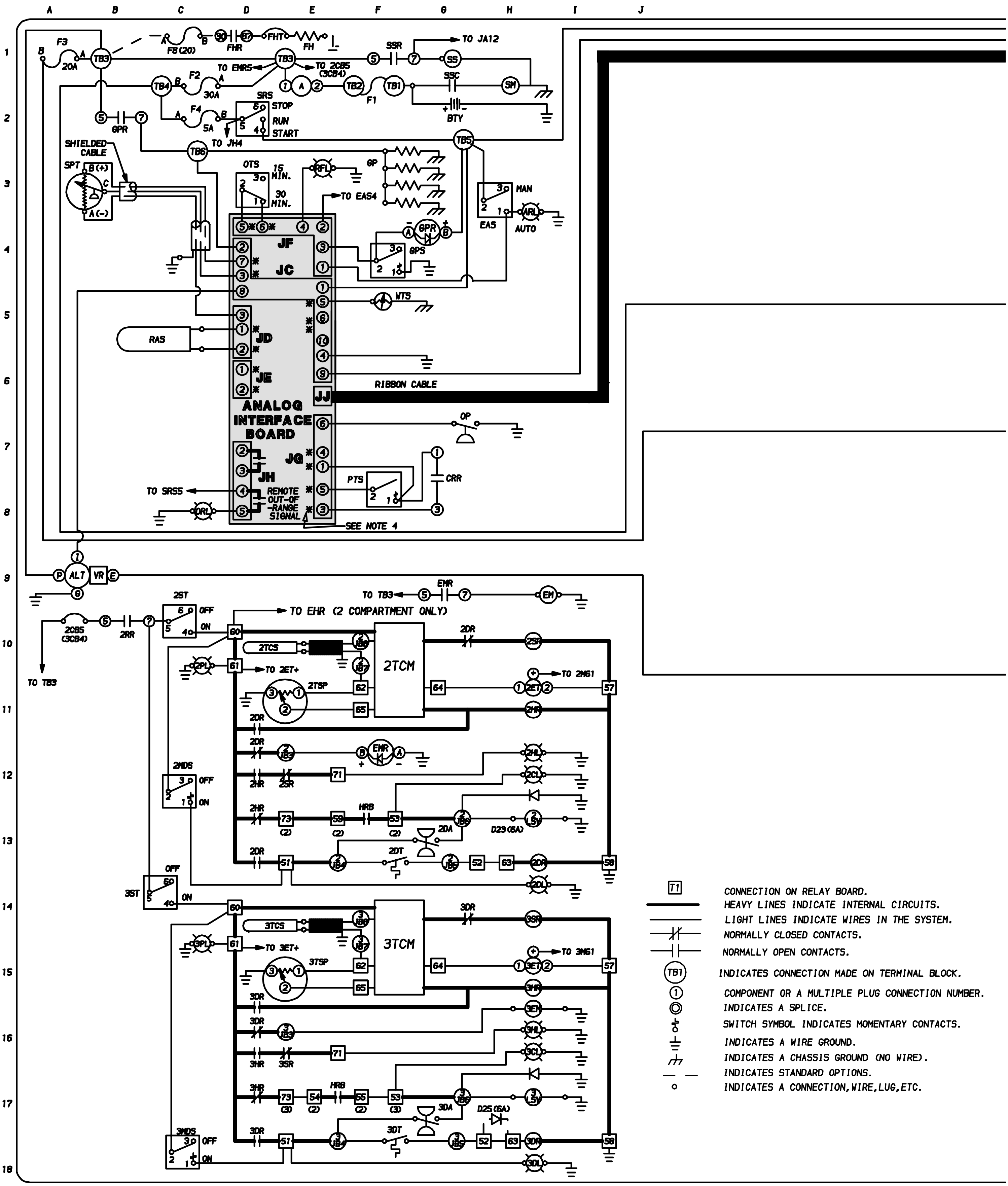
b. To remove generator V–belt from driveshaft, follow instructions in section 4.5. (See Figure 4–13)

c. After replacing belt, take up on jam nut and locknut on adjusting screw until belt does not slip.

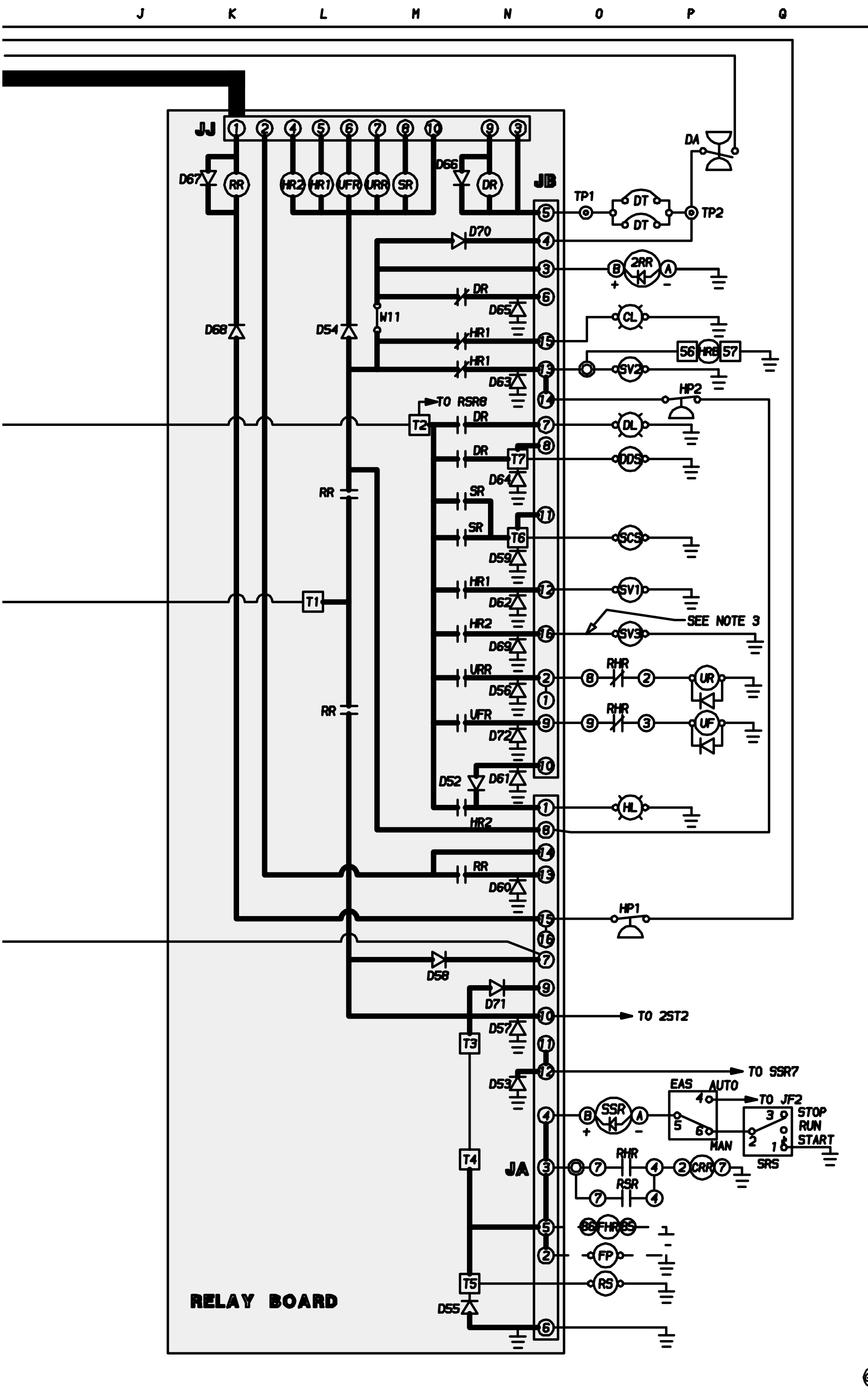


1. V–Belt
2. Generator 5kw
3. Adjusting Screw
4. Jam Nut
5. Locknut
6. Pivot Bolt

Figure 6–4. Generator

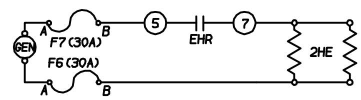


A B C D E F G H I J
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
F3
20A
TB3
F8 (20)
FHR
FHT
FH
SSR
TO JA12
SS
TO EMR5
TO 2CB5 (3CB4)
TB4
F2
30A
TB2
TB1
F1
SSC
SM
BTY
SRS
STOP
RUN
START
F4
5A
GPR
TO JH4
TB6
TB5
SHIELDED CABLE
SPT
OTS
15 MIN.
30 MIN.
RFL
GP
TO EAS4
MAN
EAS
AUTO
ARL
GPS
JF
JC
WTS
RAS
JD
JE
JJ
RIBBON CABLE
ANALOG INTERFACE BOARD
OP
JG
JH
PTS
CRR
TO SRS5
REMOTE OUT-OF -RANGE SIGNAL
ORL
SEE NOTE 4
ALT
VR
TO TB3
EMR
EM
2ST
OFF
ON
TO EHR (2 COMPARTMENT ONLY)
2CB5 (3CB4)
2RR
2DR
2SR
2TCS
2TCM
2PL
TO 2ET+
2TSP
TO 2M61
2ET
2HR
2HL
2CL
2MDS
HRB
2DA
D23 (6A)
LSV
2DT
2DL
3ST
3DR
3SR
3TCS
3TCM
3PL
TO 3ET+
3TSP
TO 3M61
3ET
3HR
3EH
3HL
3CL
3MDS
3DA
D25 (6A)
3DT
3DL
CONNECTION ON RELAY BOARD.
HEAVY LINES INDICATE INTERNAL CIRCUITS.
LIGHT LINES INDICATE WIRES IN THE SYSTEM.
NORMALLY CLOSED CONTACTS.
NORMALLY OPEN CONTACTS.
INDICATES CONNECTION MADE ON TERMINAL BLOCK.
COMPONENT OR A MULTIPLE PLUG CONNECTION NUMBER.
INDICATES A SPLICE.
SWITCH SYMBOL INDICATES MOMENTARY CONTACTS.
INDICATES A WIRE GROUND.
INDICATES A CHASSIS GROUND (NO WIRE).
INDICATES STANDARD OPTIONS.
INDICATES A CONNECTION, WIRE, LUG, ETC.

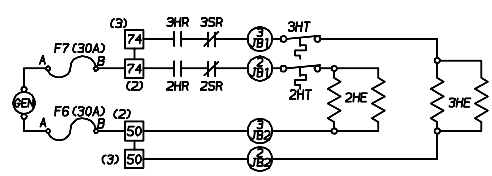


ZONE	SYMBOL	DESCRIPTION
E2	A	AMMETER
A11	ALT	ALTERNATOR
H4	ARL	AUTO RESTART LIGHT-REMOTE (RED/GREEN)
H6	ATS	AMBIENT TEMPERATURE SENSOR
G2	BTY	BATTERY
G2	CB4	CIRCUIT BREAKER (30) AMPERE
G2	CB5	CIRCUIT BREAKER (20) AMPERE
H6	CDT	COMPRESSOR DISCHARGE TEMPERATURE SENSOR
O4	CL	COOL LIGHT-REMOTE
G8,P13	CRR	CONTINUOUS RUN RELAY
L4	D54	DIODE NUMBER 54 (TYPICAL)
P2	DA	DEFROST AIR SWITCH
O6	DDS	DEFROST DAMPER SOLENOID
O6	DL	DEFROST LIGHT-REMOTE (AMBER)
N3,N4,N6	DR	DEFROST RELAY
O3	DT	DEFROST TERMINATION THERMOSTAT
H4,P13	EAS	ENGINE AUTO START SWITCH
D1,G9	EMR	EVAPORATOR MOTOR RELAY
F2	F1	FUSIBLE LINK (18 AWG)
C2	F2	FUSE (30 AMPERE) RELAY BOARD
A1	F3	FUSE (20 AMPERE) RELAY BOARD
C2	F4	FUSE (5 AMPERE) PROCESSOR
D1	F8	FUSE (20) AMPERE FUEL HEATER (OPTIONAL)
F1	FH	FUEL HEATER (OPTIONAL)
D1,C10	FHR	FUEL HEATER RELAY (OPTIONAL)
E1	FHT	FUEL HEATER THERMOSTAT (OPTIONAL)
O14	FP	FUEL PUMP (OPTIONAL)
G3	GP	GLOW PLUG
B2,G4	GPR	GLOW PLUG RELAY
F5	GPS	GLOW PLUG SWITCH
O9	HL	HEAT LIGHT-REMOTE (AMBER)
O11	HP1	HIGH PRESS CUT-OUT-SWITCH (N.C.)
P5	HP2	HIGH PRESS CUT-OUT-CONTROL (N.C.)
L3,N5,N7	HR1,HR2	HEAT RELAY
P11	HTT	HIGH TEMPERATURE THERMOSTAT
E7,L9	J	JUNCTION CONNECTOR, A (TYP)
E7,L9	MDS	MANUAL DEFROST SWITCH
F8	NHS	NORMAL-HIGH AIR FLOW SWITCH
G7	OP	OIL PRESSURE SAFETY SWITCH (N.O.)
C9	ORL	OUT-OF-RANGE LIGHT-REMOTE (RED)
D4	OTS	OFF TIME SWITCH
F9	PTS	PRE-TRIP SWITCH
O7,O8,O13	RHR	REAR HEAT RELAY
L15,O13	RSR	REAR SPEED RELAY
C6	RAS	RETURN AIR SENSOR
E3	RFL	RESTART FAILURE LIGHT-REMOTE (RED)
K3,L6,L8	RR	RUN RELAY
O14	RS	RUN SOLENOID
C6	SAS	SUPPLY AIR SENSOR (OPTIONAL)
O7	SCS	SPEED CONTROL SOLENOID
H2	SM	STARTER MOTOR
B3	SPT	SUCTION PRESSURE TRANSDUCER
M3,N6	SR	SPEED RELAY
D2,Q13	SRS	START-RUN-STOP SWITCH
G1	SS	STARTER SOLENOID
G2	SSC	STARTER SOLENOID CONTACTOR (N.O.)
F1,O13	SSR	STARTER SOLENOID RELAY
O7	SV1	COND. PRESS. CONTROL VALVE (N.O.)
O5	SV2	LIQUID SOLENOID VALVE (N.C.)
C8	SV3	HOT GAS SOLENOID VALVE (N.C.) (LARGE)
O8	TCM	TEMPERATURE CONTROL MODULE
O8	TCS	TEMPERATURE CONTROL SENSOR
O8	TSP	TEMP. SELECTOR POTENTIOMETER
O8	TB	TERMINAL BLOCK
	TP(1)	TEST POINT (DEFROST) (TYP.)
O3	UF	UNLOADER, FRONT
O8	UFR	UNLOADER FRONT RELAY
N9,L3	URR	UNLOADER REAR RELAY
N8,L3	UR	UNLOADER, REAR
P8	VR	VOLTAGE REGULATOR
B11	WTS	WATER TEMPERATURE SENSOR
F5		

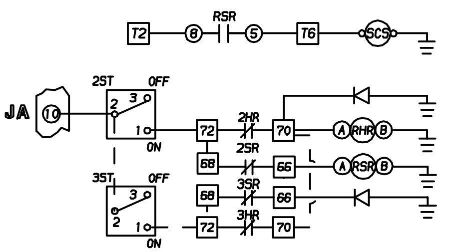
12 VDC HEATER CONTROL CIRCUIT



240 VAC 60 HZ HEATER CIRCUITS M2 MULTI-TEMP



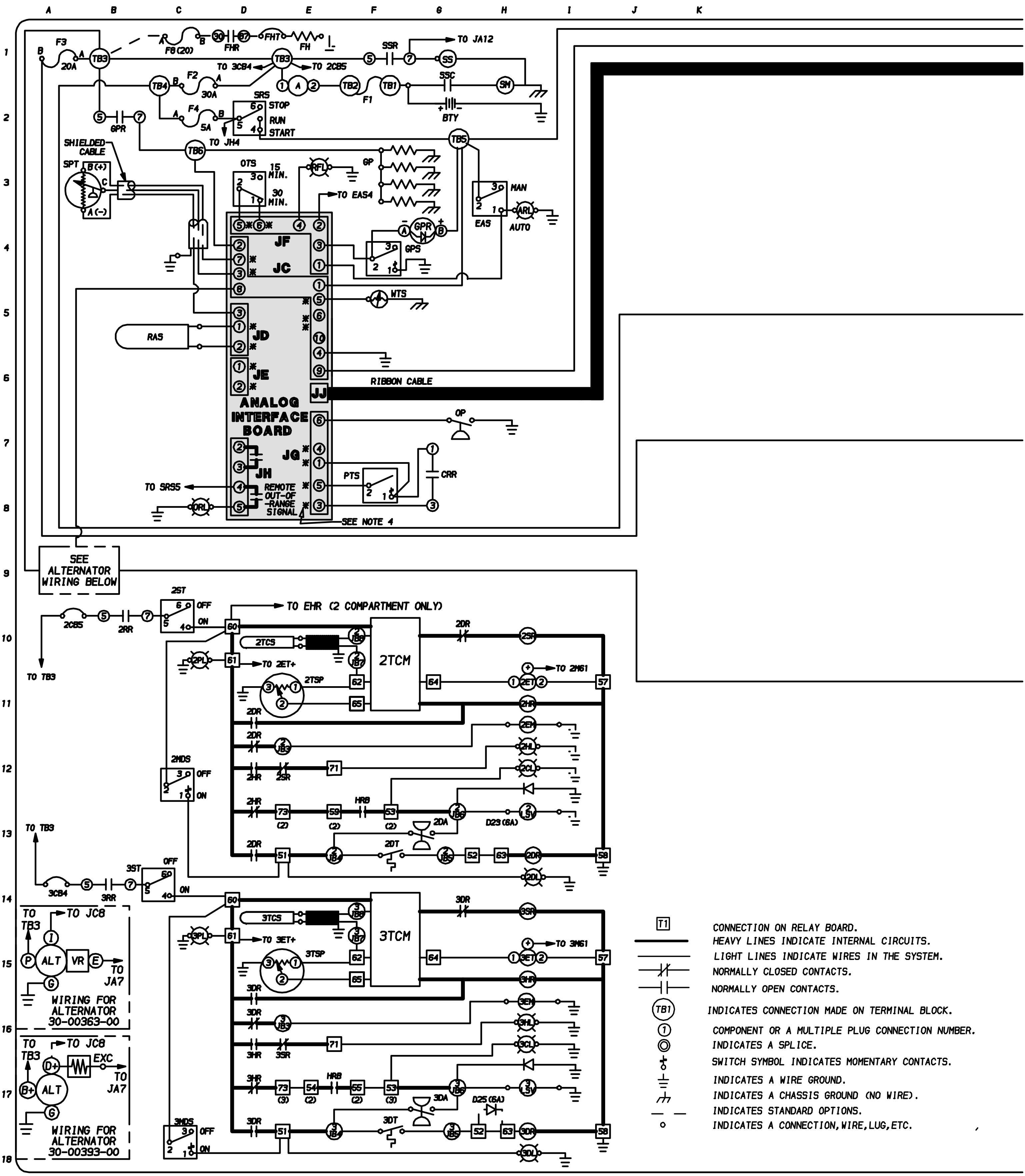
240 VAC 60 HZ HEATER CIRCUITS M3 MULTI-TEMP

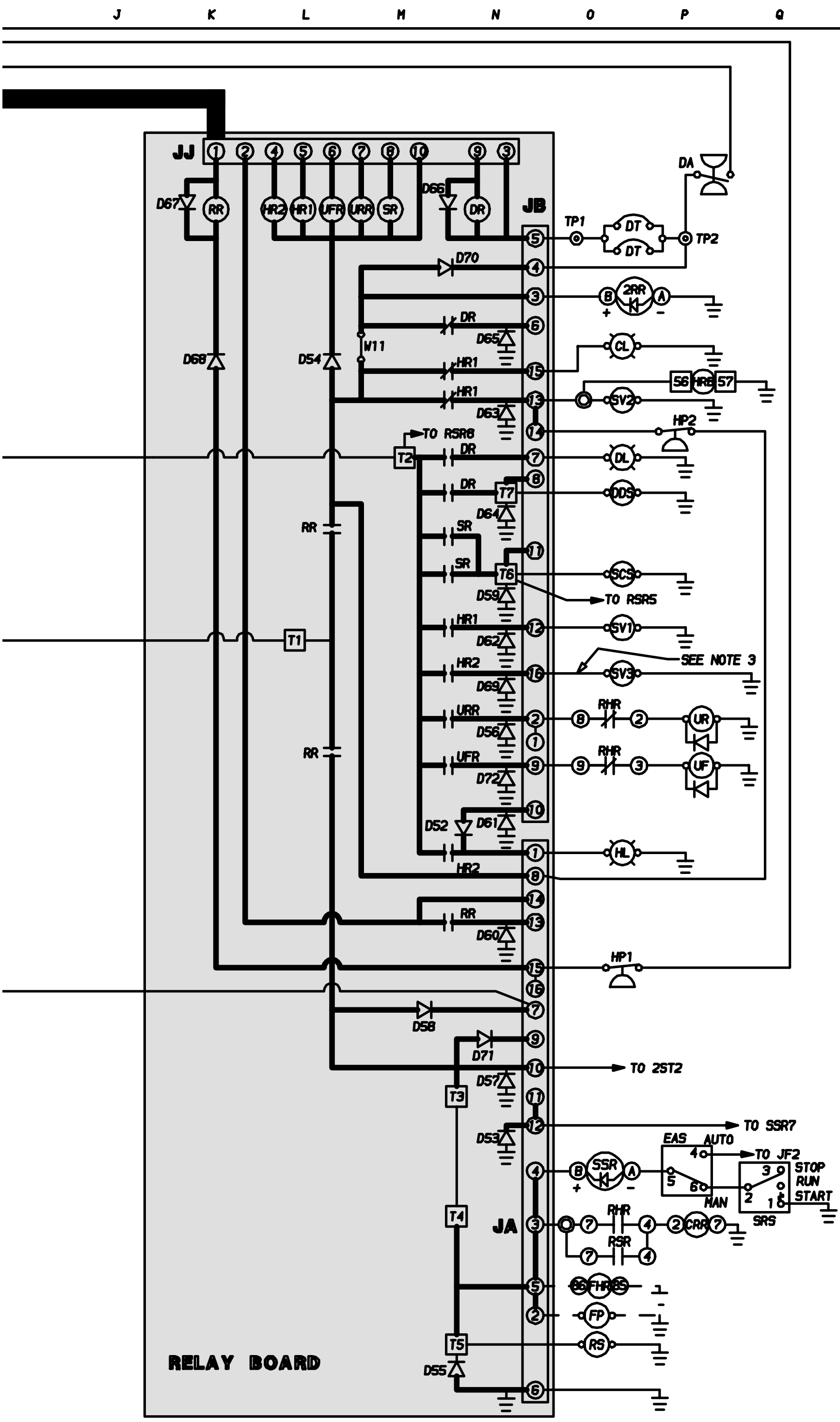


NOTES:

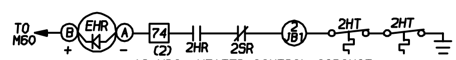
1. UNIT SHOWN IN "OFF" POSITION.
2. WIRE IDENTIFICATION SYSTEM:
   COLOR: WHITE - DC CONTROL CIRCUITS
   YELLOW - OPTIONAL CIRCUITS
   GREEN - GROUNDS
   RED - AC CIRCUITS
3. ADDRESS SYSTEM: EXAMPLE, JB16-SV3 INDICATES A WIRE BETWEEN PLUG JB, PIN #16 ON RELAY BOARD AND THE SV3 SOLENOID VALVE.
4. * VOLTAGE BELOW 12 VOLTS. REFER TO OWNERS MANUAL FOR TROUBLESHOOTING PROCEDURE.
5. DELETE THIS WIRE FOR (3) COMPARTMENT.

Figure 6–5. Electrical Schematic Wiring Diagram
Dwg. No. 62–03815 Rev B

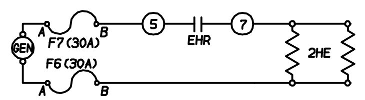

A B C D E F G H I J K
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
F3
20A
TB3
F8(20)
FHR
FHT
FH
TO JA12
SSR
SS
TO 3CB4
TO 2CB5
TB4
F2
30A
TB2
TB1
SSC
SM
F1
BTY
F4
5A
SRS
STOP
RUN
START
GPR
TO JH4
TB5
TB6
SHIELDED CABLE
SPT
B(+)
A(-)
OTS
15 MIN.
30 MIN.
RFL
GP
TO EAS4
MAN
EAS
AUTO
ARL
GPS
JF
JC
WTS
RAS
JD
JE
RIBBON CABLE
JJ
ANALOG INTERFACE BOARD
OP
JG
JH
CRR
PTS
TO SRS5
REMOTE OUT-OF -RANGE SIGNAL
ORL
SEE NOTE 4
SEE ALTERNATOR WIRING BELOW
2ST
OFF
ON
TO EHR (2 COMPARTMENT ONLY)
2CB5
2RR
TO TB3
2TCS
2TCM
2DR
2SR
2PL
TO 2ET+
2TSP
TO 2M61
2ET
2HR
2EH
2HL
2CL
2MDS
HRB
2LSV
D23 (6A)
2DA
2DT
2DR
2DL
TO TB3
3ST
3CB4
3RR
TO TB3
TO JC8
ALT
VR
TO JA7
WIRING FOR ALTERNATOR 30-00363-00
TO TB3
TO JC8
EXC
TO JA7
WIRING FOR ALTERNATOR 30-00393-00
3TCS
3TCM
3DR
3SR
3PL
TO 3ET+
3TSP
TO 3M61
3ET
3HR
3EH
3HL
3CL
3LSV
3DA
D25 (6A)
3DT
3MDS
3DL
CONNECTION ON RELAY BOARD.
HEAVY LINES INDICATE INTERNAL CIRCUITS.
LIGHT LINES INDICATE WIRES IN THE SYSTEM.
NORMALLY CLOSED CONTACTS.
NORMALLY OPEN CONTACTS.
INDICATES CONNECTION MADE ON TERMINAL BLOCK.
COMPONENT OR A MULTIPLE PLUG CONNECTION NUMBER.
INDICATES A SPLICE.
SWITCH SYMBOL INDICATES MOMENTARY CONTACTS.
INDICATES A WIRE GROUND.
INDICATES A CHASSIS GROUND (NO WIRE).
INDICATES STANDARD OPTIONS.
INDICATES A CONNECTION, WIRE, LUG, ETC.



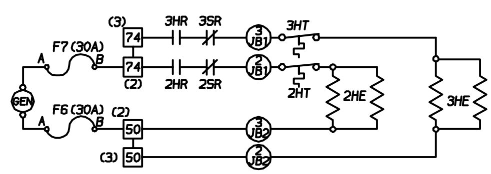
ZONE	SYMBOL	DESCRIPTION
E2	A	AMMETER
A11,A15,A17	ALT	ALTERNATOR
H4	ARL	AUTO RESTART LIGHT-REMOTE (RED/GREEN)
H6	ATS	AMBIENT TEMPERATURE SENSOR
G2	BTY	BATTERY
G2	CB4,5	CIRCUIT BREAKER (30) AMPERE
H6	CDT	COMPRESSOR DISCHARGE TEMPERATURE SENSOR
04	CL	COOL LIGHT-REMOTE
G8,P13	CRR	CONTINUOUS RUN RELAY
L4	D54	DIODE NUMBER 54 (TYPICAL)
P2	DA	DEFROST AIR SWITCH
06	DDS	DEFROST DAMPER SOLENOID
06	DL	DEFROST LIGHT-REMOTE (AMBER)
N3,N4,N6	DR	DEFROST RELAY
03	DT	DEFROST TERMINATION THERMOSTAT
H4,P13	EAS	ENGINE AUTO START SWITCH
T12	EHR	EVAP HEAT RELAY
R11	ESR	EVAP SPEED RELAY
F2	F1	FUSIBLE LINK (18 AWG)
C2	F2	FUSE (30 AMPERE) RELAY BOARD
A1	F3	FUSE (20 AMPERE) RELAY BOARD
C2	F4	FUSE (5 AMPERE) PROCESSOR
D1	F8	FUSE (20) AMPERE FUEL HEATER (OPTIONAL)
F1	FH	FUEL HEATER (OPTIONAL)
D1,C10	FHR	FUEL HEATER RELAY (OPTIONAL)
E1	FHT	FUEL HEATER THERMOSTAT (OPTIONAL)
014	FP	FUEL PUMP (OPTIONAL)
G3	GP	GLOW PLUG
B2,G4	GPR	GLOW PLUG RELAY
F5	GPS	GLOW PLUG SWITCH
09	HL	HEAT LIGHT-REMOTE (AMBER)
011	HP1	HIGH PRESS CUT-OUT-SWITCH (N.C.)
P5	HP2	HIGH PRESS CUT-OUT-CONTROL (N.C.)
L3,N5,N7,	HR1,HR2	HEAT RELAY
P4	HRB	HEAT RELAY "B"
E7,L9	J	JUNCTION CONNECTOR, A (TYP)
E7,L9	MDS	MANUAL DEFROST SWITCH
G7	OP	OIL PRESSURE SAFETY SWITCH (N.O.)
C9	ORL	OUT-OF-RANGE LIGHT-REMOTE (RED)
D4	OTS	OFF TIME SWITCH
F9	PTS	PRE-TRIP SWITCH
F5	RHR	REAR HEAT RELAY
L16	RSR	REAR SPEED RELAY
C6	RAS	RETURN AIR SENSOR
E3	RFL	RESTART FAILURE LIGHT-REMOTE (RED)
K3,L6,L8,	RR	RUN RELAY
014	RS	RUN SOLENOID
C6	SAS	SUPPLY AIR SENSOR (OPTIONAL)
07	SCS	SPEED CONTROL SOLENOID
H2	SM	STARTER MOTOR
B3	SPT	SUCTION PRESSURE TRANSDUCER
M3,N6	SR	SPEED RELAY
D2,Q13	SRS	START-RUN-STOP SWITCH
G1	SS	STARTER SOLENOID
G2	SSC	STARTER SOLENOID CONTACTOR (N.O.)
F1,013	SSR	STARTER SOLENOID RELAY
07	SV1	COND. PRESS. CONTROL VALVE (N.O.)
05	SV2	LIQUID SOLENOID VALVE (N.C.)
C8	SV3	HOT GAS SOLENOID VALVE (N.C.) (LARGE)
08	TCM	TEMPERATURE CONTROL MODULE
08	TCS	TEMPERATURE CONTROL SENSOR
08	TSP	TEMP. SELECTOR POTENTIOMETER
	TB	TERMINAL BLOCK
03	TP(1)	TEST POINT (DEFROST) (TYP.)
08	UF	UNLOADER, FRONT
N9,L3	UFR	UNLOADER FRONT RELAY
N8,L3	URR	UNLOADER REAR RELAY
P8	UR	UNLOADER, REAR
B11	VR	VOLTAGE REGULATOR
F5	WTS	WATER TEMPERATURE SENSOR



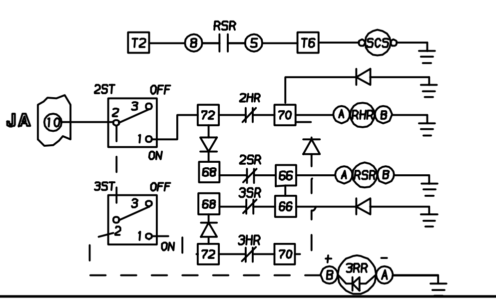
12 VDC HEATER CONTROL CIRCUIT



240 VAC 60 HZ HEATER CIRCUITS M2 MULTI-TEMP



240 VAC 60 HZ HEATER CIRCUITS M3 MULTI-TEMP



NOTES:

1. UNIT SHOWN IN "OFF" POSITION.
2. WIRE IDENTIFICATION SYSTEM:
   COLOR: WHITE - DC CONTROL CIRCUITS
   YELLOW - OPTIONAL CIRCUITS
   GREEN - GROUNDS
   RED - AC CIRCUITS
3. ADDRESS SYSTEM: EXAMPLE, JB16-SV3 INDICATES A WIRE BETWEEN PLUG JB, PIN #16 ON RELAY BOARD AND THE SV3 SOLENOID VALVE.
4. * VOLTAGE BELOW 12 VOLTS. REFER TO OWNERS MANUAL FOR TROUBLESHOOTING PROCEDURE.
5. DELETE THIS WIRE FOR (3) COMPARTMENT.

Figure 6-6. Electrical Schematic Wiring Diagram
Dwg. No. 62-03816 Rev D