SPECTRUM™ TS

TK 51448-1-MM (Rev. 0, 06/02)

The maintenance information in this manual covers unit models:	
SPECTRUM™ TS 30SR NAD (System No. 919120)	
SPECTRUM™ TS 50SR 230/3/60 NAD (System No. 919121)	
SPECTRUM™ TS 50SR 460/3/60 NAD (System No. 919122)	
For further information, refer to:	
SPECTRUM™ TS Microprocessor Controller Diagnostic Manual	**TK 51652**
SPECTRUM™ TS Operation Manual	**TK 51449**
SPECTRUM™ TS Parts Manual	**TK 51447**
Diagnosing Thermo King Refrigeration System	**TK 5984**
Tool Catalog	**TK 5955**
2.44, 2.49, 3.66, 3.74, 3.88, 3.95 Engine Overhaul Manual	**TK 8312**
Electrostatic Discharge Training Guide	**TK 40282**
The information in this manual is provided to assist owners, operators and service people in the proper upkeep and maintenance of Thermo King® units.	

This manual is published for informational purposes only and the information so provided should not be considered as all-inclusive or covering all contingencies. If further information is required, Thermo King Corporation should be consulted.

Sale of product shown in this manual is subject to Thermo King's terms and conditions including, but not limited to, the Thermo King Limited Express Warranty. Such terms and conditions are available upon request. Thermo King's warranty will not apply to any equipment which has been "so repaired or altered outside the manufacturer's plants as, in the manufacturer's judgment, to effect its stability."

No warranties, express or implied, including warranties of fitness for a particular purpose or merchantability, or warranties arising from course of dealing or usage of trade, are made regarding the information, recommendations, and descriptions contained herein. Manufacturer is not responsible and will not be held liable in contract or in tort (including negligence) for any special, indirect or consequential damages, including injury or damage caused to vehicles, contents or persons, by reason of the installation of any Thermo King product or its mechanical failure.

Recover Refrigerant

At Thermo King, we recognize the need to preserve the environment and limit the potential harm to the ozone layer that can result from allowing refrigerant to escape into the atmosphere.

We strictly adhere to a policy that promotes the recovery and limits the loss of refrigerant into the atmosphere.

In addition, service personnel must be aware of Federal regulations concerning the use of refrigerants and the certification of technicians. For additional information on regulations and technician certification programs, contact your local Thermo King dealer.

R-404A

WARNING: Use only Polyol Ester-based refrigeration compressor oil in R-404A. See Thermo King Parts Manual for part number.

Do not mix Polyol Ester and standard synthetic compressor oils. Keep Polyol Ester compressor oil in tightly sealed containers. If Polyol Ester oil becomes contaminated with moisture or standard oils, dispose of properly–DO NOT USE.

When servicing Thermo King R-404A unit, use only those service tools certified for and dedicated to R-404A refrigerant and Polyol Ester compressor oils. Residual non-HFC refrigerants or oils will contaminate R-404A systems.

Table of Contents

Unit Description (continued)

SPECTRUM™ TS Operation (continued)

List of Figures

Safety Precautions

General Practices

1. *Always wear goggles or safety glasses.* Refrigerant liquid, refrigeration oil, and battery acid can permanently damage the eyes.
2. Never close the compressor discharge service valve with the unit operating.
3. Never operate the unit with the compressor discharge valve closed.
4. Keep your hands, clothing and tools clear of the fans and belts when the unit is running. This should also be considered when opening and closing the compressor service valves.
5. Make sure gauge manifold hoses are in good condition. Never let them come in contact with a belt, fan motor pulley, or any hot surface.
6. Never apply heat to a sealed refrigeration system or container.
7. Fluorocarbon refrigerants in the presence of an open flame produce toxic gases that are severe respiratory irritants capable of causing death.
8. Make sure all mounting bolts are tight and are of correct length for their particular application.
9. Use extreme caution when drilling holes in the unit. The holes may weaken structural components, and holes drilled into electrical wiring can cause fire or explosion. Holes drilled into the refrigeration system will release refrigerant.
10. Use caution when working around exposed coil fins. The fins can cause painful lacerations.
11. Use caution when working with a refrigerant or refrigeration system in any closed or confined area with a limited air supply (for example, a truck body or garage). Refrigerant tends to displace air and can cause oxygen depletion resulting in suffocation and possible death.
12. When using ladder or scaffolding, use caution and follow manufacturer recommendations.

Auto Start/Stop

CAUTION: The unit may start automatically and at any time when the unit On/Off switch is in the On position. Units with the CYCLE-SENTRY™ start automatically in both CYCLE-SENTRY mode and Continuous mode. Be sure to turn the On/Off switch Off before opening doors or inspecting or working on any part of the unit.

Refrigerant

When removing refrigerant from a unit, a recovery process that prevents or minimizes refrigerant loss to the atmosphere is required by law.

When a refrigerant is exposed to the atmosphere in the liquid state, it evaporates rapidly, freezing anything it contacts. If refrigerant contacts the skin, severe frostbite can result.

First Aid

In the event of frostbite, the objectives of First Aid are to protect the frozen area from further injury, to warm the affected area rapidly and to maintain respiration.

- *Eyes*: For contact with liquid, immediately flush eyes with large amounts of water and get prompt medical attention.
- *Skin*: Flush area with large amounts of lukewarm water. Do not apply heat. Remove contaminated clothing and shoes. Wrap burns with dry, sterile, bulky dressing to protect from infection/injury. Get medical attention. Wash contaminated clothing before reuse.
- *Inhalation*: Move victim to fresh air and use cardiopulmonary resuscitation (CPR) or mouth-to-mouth ventilation if necessary. Stay with victim until arrival of emergency medical personnel.

Refrigeration Oil

Observe the following precautions when working with or around synthetic or polyol ester refrigerant oil:

- Do not allow refrigerant oil to contact your eyes.
- Do not allow prolonged or repeated contact with skin or clothing.
- To prevent irritation, you should wash thoroughly immediately after handling refrigerant oil. Rubber gloves are recommended when handling polyol ester oil.

First Aid

- *Eyes*: Immediately flush eyes with large amounts of water for at least 15 minutes while holding the eyelids open. Get prompt medical attention.
- *Skin*: Remove contaminated clothing. Wash thoroughly with soap and water. Get medical attention if irritation persists.
- *Inhalation*: Move victim to fresh air and restore breathing if necessary. Stay with victim until arrival of emergency personnel.
- *Ingestion*: Do not induce vomiting. Contact a local poison control center or physician immediately.

Electrical Hazards

Microprocessor Service

Precautions must be taken to prevent electrostatic discharge when servicing the microprocessor controller and related components. Potential differences considerably lower than those which produce a small spark from a finger to a door knob can severely damage or destroy solid-state integrated circuit components.

The following procedures must be rigidly adhered to when servicing units to avoid microprocessor damage or destruction.

1. Disconnect all power to the unit.
2. Avoid wearing clothing that generates static electricity (wool, nylon, polyester, etc.).
3. Do wear a static discharge wrist strap (see Tool Catalog) with the lead end connected to the microprocessor's ground terminal. These straps are available at most electronic equipment distributors. Do not wear these straps with power applied to the unit.

   See the SPECTRUM™ TS Microprocessor Controller Operations and Diagnosis Manual and the Electrostatic Discharge Training Guide for additional information.
4. Avoid contacting the electronic components on the circuit boards of the unit being serviced.
5. Leave the circuit boards in their static proof packing materials until ready for installation.
6. If a defective controller is to be returned for repair, it should be returned in the same static protective packing materials from which the replacement component was removed.
7. After servicing the controller or any other circuits, the wiring should be checked for possible errors before restoring power.
8. Never use testers consisting of a battery and a light bulb to test circuits on any microprocessor based equipment.
9. Before connecting or disconnecting the battery, the Microprocessor Power On/Off switch must be turned to the Off position. It is located on the roadside of the unit, lower left corner.

Welding of Units or Truck Bodies

When electric welding is to be performed on any portion of the temperature control unit, truck or truck chassis when the temperature control unit is attached, it is necessary to ensure that welding currents are *not* allowed to flow through the electronic circuits of the unit.

These procedures must be rigidly adhered to when servicing units to avoid damage or destruction of the controller.

1. Disconnect all power to the unit.
2. Disconnect all wire harnesses from the controller.
3. Switch all of the electrical circuit breakers in the control box to the Off position.
4. Weld unit or container per normal welding procedures. Keep ground return electrode as close to the area to be welded as practical. This will reduce the likelihood of stray welding currents passing through any electrical or electronic circuits.
5. When the welding operation is completed, the unit power cables, wiring and circuit breakers must be restored to their normal condition.

High Voltage

When servicing or repairing a temperature control unit, the possibility of serious or even fatal injury from electrical shock exists. Extreme care must be used when working with a refrigeration unit that is connected to a source of operating power, even if the unit is not operating. Lethal voltage potentials can exist at the unit power cord, inside the control box, at the motors and within the wiring harnesses.

Precautions

1. Be certain the Unit On/Off switch is turned Off before connecting or disconnecting the standby power plug. Never attempt to stop the unit by disconnecting the power plug.
2. Be certain the unit power plug is clean and dry before connecting it to a power source.
3. When working on high voltage circuits on the temperature control unit, do not make any rapid moves. If a tool drops, do not grab for it. People do not contact high voltage wires on purpose. It occurs from an unplanned movement.
4. Use tools with insulated handles that are in good condition. Never hold metal tools in your hand if exposed, energized conductors are within reach.
5. Treat all wires and connections as high voltage until a meter and wiring diagram show otherwise.
6. Never work alone on high voltage circuits on the temperature control unit. Another person should always be present to shut off the temperature control unit and to provide aid in the event of an accident.
7. Have electrically insulated gloves, cable cutters and safety glasses available in the immediate vicinity in the event of an accident.

First Aid

Immediate action must be initiated after a person has received an electrical shock. Obtain immediate medical assistance if available.

The source of shock must be immediately removed by either shutting down the power or removing the victim from the source. If it is not possible to shut off the power, the wire should be cut with either an insulated instrument (e.g., a wooden handled axe or cable cutters with heavy insulated handles) or by a rescuer wearing electrically insulated gloves and safety glasses. Whichever method is used do not look at the wire while it is being cut. The ensuing flash can cause burns and blindness.

If the victim must be removed from a live circuit, pull the victim off with a non-conductive material. Use the victim's coat, a rope, wood, or loop your belt around the victim's leg or arm and pull the victim off. *Do not touch* the victim. You can receive a shock from current flowing through the victim's body. After separating the victim from the power source, check immediately for the presence of a pulse and respiration. If a pulse is not present, start CPR (Cardiopulmonary Resuscitation) and call for emergency medical assistance. If a pulse is present, respiration may be restored by using mouth-to-mouth resuscitation, but call for emergency medical assistance.

Low Voltage

Control circuits used in the temperature control unit are low voltage (24 Vac and 12 Vdc). This voltage potential is not considered dangerous, but the large amount of current available (over 30 amps) can cause severe burns if shorted or ground.

Do not wear jewelry, watch or rings when working on the unit. If these items contact an electrical circuit, severe burns may result.

Specifications

Engine

Engine	TK 3.95
Fuel Type	No. 2 Diesel fuel under normal conditions No. 1 Diesel fuel is acceptable cold weather fuel
Oil Capacity: Crankcase & Oil Filter	12 quarts (11.2 liters)
w/Bypass Oil Filter	13 quarts (12.3 liters) Fill to full mark on dipstick
Oil Type	API Type CF-4 or CG-4 or better multigrade oil API Synthetic Type CF-4, CG-4 or better after first 500 hours (optional)
Oil Viscosity	**Multigrade Oil Ambient Temperature** SAE 5W 30 -22 to +86 F (-30 to +30 C) SAE 10W 30 -4 to +86 F (-20 to + 30 C) SAE 10W 40 -4 to +104 F (-20 to + 40 C) SAE 15W 40 +5 to +104 F (-15 to + 40 C)
Engine RPM: Low Speed Operation	1800 ± 25 RPM
High Speed Operation	2425 ± 25 RPM
Engine Oil Pressure	35 to 60 psig (241 to 414 kPa)
Intake Valve Clearance	0.006 to 0.010 in. (0.152 to 0.254 mm)
Exhaust Valve Clearance	0.006 to 0.010 in. (0.152 to 0.254 mm)
Valve Setting Temperature	Room temperature
Timing Injection Pump	14 degrees BTDC
Injection Nozzle Pressure	1700 psig (11722 kPa)
Low Oil Pressure Switch	10 ± 2 psig (69 ± 14 kPa)—shutdown
High Coolant Temperature Sensor	220 ± 5 F (104 ± 3 C)—shutdown
Engine Thermostat	180 F (82 C)
ELC (Extended Life Coolant)	ELC is red. Units equipped with ELC have an ELC nameplate on the expansion tank. Use a 50/50 concentration of any of the following equivalents: Texaco ELC (16445, 16447) Havoline Dex-Cool® (7994, 7995, 7997, 7998) Havoline XLC for Europe (30379, 33013) Shell Dexcool® (94040) Shell Rotella (94041) Saturn/General Motors Dex-Cool® Caterpillar ELC Detroit Diesel POWERCOOL® Plus ***CAUTION: Do not mix conventional coolant and ELC.***
Coolant System Capacity	4.8 qts (4.5L) with overflow tank
Radiator Cap Pressure	10 psig (69 kPa)

SPECTRUM™ TS Component Operating Speeds

	Engine	Motor	Alternator	Compressor	Engine Idler	Comp Idler
High Speed Diesel	2425	2393	4000	4000	2564	3489
Low Speed Diesel	1800	1776	2969	2969	1903	2590
Electric Standby 60Hz	1788	1765	2959	2959	1891	2583
Electric Standby 50Hz	1501	1481	2483	2483	1586	2167
Pulley Diameters (at the top) All Diameters in inches	7.4	7.5/8.05	4.79	4.79	7	5.5

Belt Tension

	Tension on TK Gauge (See Tool Catalog)	
	New Belt	Field Reset
Engine/Electric Motor Reading on bottom span between engine and electric motor	55 to 65	55 to 60
Electric Motor Compressor Reading between electric motor and alternator (or 1/4 in. deflection with 10 lb pressure)	55 to 60	55 to 60
Water Pump	40	40

NOTE: Use belt tension gauge (See Tool Catalog) whenever possible to check belt tension. New belts should be tensioned cold and tensioned cold again after 10 hours of unit operation.

Refrigeration System

Compressor Model		TKO Scroll
Refrigerant Charge		Approximately 13.44 lbs. (6kg)
*Compressor Oil Charge		1.6 qt (1.5 liters)
Compressor Oil Type: R-404A (EAL 22)		Ester base required for Scroll compressor (See Tool Catalog) Tk. No 203-516
Throttling Valve Setting		27 ± 1 psig (186 ± 7 kPa)
High Pressure Cutout Switch:	Open	470 ± 7 psig (3241 ± 48 kPa)
	Close	375 ± 38 psig (2586 ± 262 kPa)
Liquid Injection Valve:	Closed	Below 250 F (121 C)
	Open	285 F (141 C)
Compressor High Temperature:		
	Shutdown	300°F for 3 seconds
	Restart	≤250°F plus a 15 min timer
Discharge Pressure Regulator Valve Setting:		350 psig with one zone in defrost regardless of ambient temperature

When the compressor is removed from the unit, oil level should be noted or the oil removed from the compressor should be measured so that the same amount of oil can be added before placing the replacement compressor in the unit.

Engine Clutch - Hilliard

Model	p/n 107-291
Engagement	600 ± 100 RPM
Dynamic Torque	66 ft-lb (89.5 N•m) minimum @ 1600 RPM

Electrical Control System

Control System Voltage	12.5 Vdc
Battery Fuse F1 (2 Circuit)	60 amps
Fan Motor Fuses	30 amps ea.
Starter Fuse F2 (2Circuit)	40 amps
Battery Charging System	12 volts 90 amp alternator
Voltage Regulator Setting	14.1 ± 0.1 Volts @ 77°F
Alternator/Regulator Capacitor	4.7 µfd 50 Vdc
Alternator/Output Capacitor	0.5 µfd 100 Vdc
Interface Board Fuses	See Description Section
NOTE: Disconnect components from unit circuit to check resistance.	

Defrost Timer

SPECTRUM™ TS with HMI Controller	2, 4, 6, 8 or 12 hours (adjustable through SPECTRUM™ TS Microprocessor controller) (default setting =6)

Thermostat

Type	SPECTRUM™ TS Microprocessor Controller

Electrical Components

		Current Draw (Amps) at 12.5 Vdc	**Resistance— (Ohms)**
Glow Plug		7 to 8.3	1.5 ± 0.15
Fuel Solenoid:	Pull In	18 to 36	0.3 to 0.7
	Hold In	0.49 to 0.6	22 to 26
Starter Motor		90 to 105 (cranking)	
High Speed Solenoid		2.9	4.3
Condenser Inlet Solenoid 22 Watt		1.76	7.1
Purge Valve 15 Watt		1.20	10.4
Liquid Injection Solenoid 13 Watt		1.04	12.0
Hot Gas Bypass Solenoid 10 Watt		0.80	15.6
Hot Gas Solenoids 18 Watt		1.4	8.7
Liquid Line Solenoids 15 Watt		1.20	10.4
Suction Line Solenoids 18 Watt		1.4	8.7

Electrical Components

NOTE: Disconnect components from unit circuit to check resistance.

Standby Power Requirements

Supply Circuit Breaker	50 amp/230 volts 20 amp/460 volts
Extension Cord Size	Up to 50 ft—10 gauge 75 ft—8 gauge

Electric Standby (Model 50 Unit Only)

Voltage/Phase/Frequency	Configuration	Horsepower	Kilowatts	RPM	Full Load (Amps)	Locked Rotor Amps
208/3/60	WYE	12	8.9	1735	31.4	32
220/3/50	DELTA	10	7.5	1445	25.1	28
230/3/60	WYE	12	8.9	1750	28.8	32
380/3/50	WYE	10	7.5	1445	14.5	16
460/3/60	WYE	12	8.9	1750	14.4	16

Maintenance Inspection Schedule

Pretrip	1,200 Hours	2,000 Hours	Annual/ 3,000 Hours	Inspect/Service These Items
				Microprocessor
•				Run pretrip test (see “Pretrip Test” in the Operating Manual).
				Engine
•				Check fuel supply.
•	•			Check engine oil level.
•	•			Check engine coolant (check gauges screen on HMI)
				CAUTION: Do not remove radiator cap while coolant is hot (should display “ok”).
•	•			Inspect belts for condition and proper tension.
•	•			Check engine oil pressure hot, on high speed (should display “OK”).
•	•	•	•	Listen for unusual noises, vibrations, etc.
		•		Dry air cleaner. Replace air cleaner element at 2,000 hours or 1 year (whichever occurs first)
	•			Check air cleaner hose for damage.
		•		Change EMI 2000 (black) fuel filter.
	•			Inspect and clean electric fuel pump filter.
			•	Drain water from fuel tank and check vent.
			•	Check and adjust engine speeds (high and low speed).
			•	Check condition of engine mounts.
			•	Maintain year round antifreeze protection at –30 F (–34 C).
			—	Change green engine coolant every 2 years.
			—	Change ELC (red) engine coolant every 5 years or 12,000 hours. Units equipped with ELC have an ELC nameplate on the expansion tank.
				Engine Oil Change Intervals (see below)
				NOTE: Change engine oil and filter (hot).
				NOTE: The 1,200 hour maintenance interval may be extended to 2,000 hours or 1 year (whichever occurs first) when equipped with EMI fuel filter and EMI bypass oil filter.
	•			Oil change interval with API classification CG-4 (or better) mineral oil or synthetic oil.
		•		Oil change interval with API classification CG-4 (or better) mineral oil or synthetic oil, and EMI 2000 bypass oil filter (see Tool Catalog).

Pretrip	1,200 Hours	2,000 Hours	Annual/ 3,000 Hours	Inspect/Service These Items
				Electrical
•				Check controller for alarms.
•				Run pre-trip test
•				Check battery voltage screen.
	•			Inspect battery terminals and electrolyte level.
	•			Inspect electrical contacts for pitting or corrosion.
	•			Inspect wire harness for damaged wires or connections.
			•	Check calibration of return and discharge air sensors in 32 F (0 C) ice water.
			•	Inspect alternator bearings and brushes*.
			•	Inspect electric motor bearings* (Model 50).
*With Belt removed, spin bearings by hand. Listen for noise (bearings roll freely).				
				Refrigeration
•	•			Check refrigerant level.
	•			Check compressor oil level.
			•	Check suction pressure regulator or throttling valve setting on Defrost or Heat.
			•	Check discharge and suction pressures.
			•	Check compressor efficiency.
			—	Replace dehydrator and compressor oil filter every two (2) years.
				Structural
•	•			Visually inspect unit for fluid leaks.
•	•			Visually inspect unit for damaged, loose or broken parts (includes air ducts and bulkheads).
	•		•	Inspect clutch for shoe and anchor bushing wear with a mirror. Check bearings.*
			•	Inspect idlers for leakage and bearing wear.*
			•	Clean entire unit including condenser coils, evaporator coils, and defrost drains.
	•	•	•	Check all unit, fuel tank, engine, and electric motor mounting bolts, brackets, lines, hoses, etc.
*With belt removed, spin bearings by hand. Listen for noise (bearings roll freely). Up to 1/8” axial play (wobble) in either direction is normal for composite idlers.				

Unit Description

AJA1350

Figure 1: SPECTRUM™ TS Front View

Unit Overview

The SPECTRUM™ TS is a diesel-powered, multi-temperature cooling/heating system designed to control temperature in up to two separate truck cargo compartments. Each compartment contains a SPECTRUM™ remote evaporator. The condensing unit is mounted on the outside front of the truck box, contains the diesel engine, compressor and condenser and is connected to the remote evaporator(s) located inside the truck box.

The SPECTRUM™ TS operates under the control of a SPECTRUM™ TS Microprocessor Controller. The SPECTRUM™ TS Microprocessor Controller has an in-cab HMI (Human Machine Interface) control panel that provides safe, convenient operation and monitoring of cargo compartment temperatures. The temperature of each of the compartments can be controlled separately.

There are two SPECTRUM™ TS models:

- SPECTRUM™ TS 30: Cooling and heating on diesel engine operation.
- SPECTRUM™ TS 50: Cooling and heating on diesel engine operation or electric standby operation.

Design Features

- Air Cleaner, Dry Type
- Alarm Code Display
- Alternator, 90 amp
- Automatic Phase Correction (Model 50)
- Battery Voltage Display
- Bypass Oil Filter
- Condenser Top Screen
- Continuous System Monitoring
- Coolant Expansion Tank
- Coolant Temperature Display
- Corrosion Resistant Protection
- CYCLE-SENTRY Start/Stop Controls
- Diesel/Electric Autoswitching
- Total Run Hourmeter
- Electric Hourmeter
- Engine Hourmeter
- Fahrenheit and Celsius Scales
- Fuel Filter, Spin On
- SPECTRUM™ TS HMI Control Panel
- SPECTRUM™ TS Microprocessor Controller
- Oil Filter, Full Flow
- Oil Pressure Display
- R-404A
- Scroll Compressor
- Smart Defrost
- Stainless Steel Condenser Hardware
- Stainless Steel Evaporator Hardware
- TK 3.95 Engine
- Silicone Hoses

Unit Options

- DAS (Data Acquisition System)
- Door Switch
- Electric Standby
- Engine Block Heater
- Remote Status Light
- Synthetic Engine Oil
- Hose Management Kit

Engine

Engine power for the SPECTRUM™ TS is provided by the TK 3.95, a three cylinder, special clean and silent diesel engine rated at 17.0 continuous horsepower (12.7 kW) at 2400 rpm. A belt drive system transfers energy to the compressor, unit fans and alternator.

Clutch

The centrifugal clutch engages fully at 600 ± 100 rpm on engine operation, constantly turning the compressor and alternator at both high and low speed. The clutch isolates the engine from the belt drive system during electric standby operation on Model 50 units.

ELC (Extended Life Coolant)

ELC (Extended Life Coolant) is standard in these units. The maintenance interval for ELC is five years or 12,000 hours. A nameplate on the coolant expansion tank identifies units with ELC (see "Safety Decals and Locations"). The new engine coolant, Texaco Extended Life Coolant, is RED instead of the previous GREEN or BLUE-GREEN conventional coolants.

ELC cannot be used in older units. The water pump seal bellows and O-rings used in older units are not compatible with ELC.

CAUTION: Do not add "RED" Extended Life Coolants to cooling systems using "GREEN" or "BLUE-GREEN" coolants. Do not add "GREEN" or BLUE-GREEN" coolants to cooling systems using "RED" Extended Life Coolants.

NOTE: The use of 50/50% pre-mixed ELC is recommended to ensure that deionized water is being used. If 100% full strength concentrate is used, deionized or distilled water is recommended instead of tap water to ensure the integrity of the cooling system is maintained.

NOTE: Units equipped with ELC are not necessarily equipped with EMI 2000, but units equipped with EMI 2000 are equipped with ELC.

EMI 2000

EMI 2000 is an extended maintenance interval package. It is standard equipment on this unit. The EMI 2000 package consists of the following key components:

- New EMI 2000-Hour Cyclonic Air Cleaner Assembly and Air Cleaner Element (standard equipment on all TS Units)
- New EMI 2000-Hour Fuel Filter (black with gold lettering)
- New EMI 2000-Hour By-Pass Oil Filter (black with gold lettering)
- API Rating CG-4 Mineral Oil
- Five Year or 12,000 Hour ELC (Extended Life Coolant)

The EMI package allows standard maintenance intervals to be extended to 2,000 hours, or 1 year, whichever occurs first.

NOTE: Units equipped with the EMI 2000 package do require regular inspection in accordance with Thermo King's maintenance recommendations.

SPECTRUM™ Remote Evaporator

Figure 2: SPECTRUM™ Remote Evaporator

A SPECTRUM™ Remote Evaporator is located in each compartment and can provide separate temperature controlled areas.

Compressor

The unit features a high performance 6 hp TKO Scroll compressor.

SPECTRUM™ TS HMI Control Panel

The HMI (Human Machine Interface) Control Panel consists of a display and eight touch sensitive keys. The four keys on each side of the display screen are used to turn the unit on and off, initiate a manual defrost cycle, and select the high speed lockout mode operation. The function of the four keys located under the display screen (referred to as “softkeys”) change as required by the current menu shown on the display screen.

The display screen is used by the microprocessor to provide visual prompt and display information to the operator, such as operating mode, setpoints, hourmeter readings and operating conditions of the diesel engine. All information is shown in English, with the ability to display in several other languages.

Figure 3: HMI Control Panel

Microprocessor Power Switch

The Microprocessor Power switch applies 12 Vdc control power to the microprocessor and must be On to operate the unit. It is located on the roadside of unit, lower left corner.

NOTE: When the Microprocessor Power Switch is turned to the Off position, power is still applied to the Interface Board and control circuits. To completely remove power from the control system, disconnect the unit battery.

Figure 4: Microprocessor Power Switch

CYCLE-SENTRY Start/Stop System

A CYCLE-SENTRY Start-Stop fuel saving system provides optimum operating economy.

WARNING: Turn the unit off by pressing the OFF key before opening doors or inspecting any part of the unit. The unit can start at any time without warning if it has been turned on by pressing the ON key.

The CYCLE-SENTRY system automatically starts the unit on microprocessor demand and shuts down the unit when all demands are satisfied.

The system monitors and maintains the compartment temperature, the engine block temperature, and battery charge levels at a point where quick, easy starts are possible.

Defrost

Frost will gradually build up on the remote evaporator coils as a result of normal operation. Periodically this frost must be melted to prevent a loss of cooling and airflow.

Defrost is accomplished by passing hot refrigerant gas through the affected evaporator coil, thus melting the frost (or ice). Melted frost drains out of the unit onto the ground through the drain tubes.

Defrost can be initiated at any time the evaporator coil temperature is below 45 F (7 C).

Only one zone can be in defrost at a time.

There are three methods of defrost initiation:

SPECTRUM™ TS Microprocessor Controller: The Microprocessor Controller is programmed to

8. Initiate timed defrost cycles.
9. Initiate forced defrost cycles. The SPECTRUM™ TS uses temperature sensors to determine if forced defrost is required.
10. Manual Defrost allows the operator to initiate a defrost cycle by pressing the **DEFROST** key. See "Initiating a Manual Defrost Cycle."

DAS - Data Acquisition System (Optional)

The DAS (Data Acquisition System) works with the SPECTRUM™ TS Microprocessor to monitor and record the temperatures of (up to) six additional sensors. The sensors are independent from the microprocessor and are normally located in the truck box to monitor load temperatures. Data from the DAS sensors and the SPECTRUM™ TS Microprocessor can be downloaded through a serial port to an IBM® PC compatible computer. WinTrac™ 4.2 (or higher) software is used to view and analyze the data. Brief reports can be printed on a microprinter connected to the serial port.

Electric Standby (Model 50 Units Only)

The Electric Standby option allows the unit to be operated on either the diesel engine or external electric power. The units are supplied to operate on three phase power.

CAUTION: High voltage AC power is present whenever the unit is operating in Electric mode and whenever the unit is connected to external standby power. Voltages of this magnitude can be lethal. Exercise extreme caution when working on the unit.

Standard Model 50 Features

The following features are standard equipment on units equipped with Electric Standby.

- **Automatic Diesel/Electric Selection –** The unit will automatically switch to electric operation when a power cord is connected and the standby power is switched "on". The unit can also be programmed to automatically switch back to diesel power if the standby power is switched off or fails.
- **Automatic Overload Reset -** The overload relay resets automatically after the motor cools.
- **Hot Gas Heat -** Hot gas heat is utilized on standard model 50 units.
- **Automatic Phase Correction -** The control system features two motor contactors. This allows correct motor rotation regardless of phase rotation on the incoming power.

High Voltage Tray

The high voltage tray contains the contactors, overload relay and phase select module used to operate the drive motor on units equipped with Electric Standby. The contactors are controlled by +12 volt dc control signals from the Interface Board. The high voltage tray is located inside the control box just to the right of the Microprocessor/Interface Board Assembly.

Phase Detect Module for Truck Unit Model 50 Applications

The new phase detect module is designed to monitor both single and 3 phase voltages from 160 volts AC thru 510 volts AC.

The Phase Detection Module will detect missing phases, phase rotation and low voltage on three phase power.

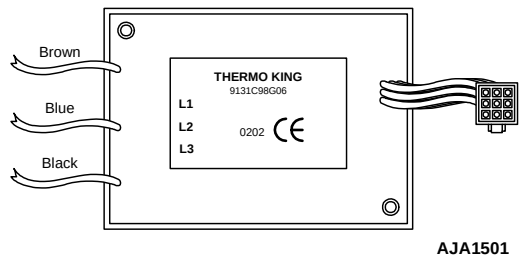


Figure 5: Phase Detect Module

Unit Instruments

- **Coolant Expansion Tank-**The coolant level and temperature are monitored by the SPECTRUM™ TS Microprocessor controller. If the coolant temperature becomes too high or the level becomes too low, an alarm will occur and the engine will shut down.

The engine must have antifreeze protection to –30 F (–34 C). Check and add coolant in the expansion tank as needed.

CAUTION: Do not add "RED" Extended Life Coolants to cooling systems using "GREEN" or "BLUE-GREEN" coolants. DO not add "GREEN" or "BLUE-GREEN" coolants to cooling systems using "RED" Extended Life Coolants.

CAUTION: Do not remove expansion tank cap while the coolant is hot.

- **Compressor Oil Sight Glass-**The compressor oil sight glass is used to check the relative level of compressor oil in the compressor sump.
- **Engine Oil Dipstick-**Use the engine oil dipstick to check the engine oil level.
- **Receiver Tank Sight Glass-**The receiver tank sight glass is used to check the amount of refrigerant in the system, and the moisture content of the refrigerant.

Unit Sensors

The sensors monitor temperatures and pressures at various points in the system as well as oil pressure, oil and coolant levels and engine speed.

Graded and Ungraded Sensors

The Return Air and Discharge Air sensors are graded sensors. This feature allows accuracy without the need for ice water calibration. The sensor grade (from 1L thru 9H) is stamped on the sensor and must be entered into the microprocessor when a sensor is changed in order to properly calibrate temperature readings. An ungraded sensor is used to measure the evaporator coil temperature and ambient temperature since these temperatures are not as critical as Return and Discharge air temperatures.

- **Return Air Sensor** - monitors the temperature of the air returning to the remote evaporator coil. The sensor is located in the return air flow and is connected directly to the SPECTRUM™ TS Microprocessor. The unit controls on this sensor under normal conditions. This is a graded sensor and must be replaced with a graded sensor. The SPECTRUM™ TS Microprocessor must be calibrated to the sensor grade of the sensor installed in the return air position in order to operate properly. It is connected to the microprocessor via the RTP and RTN wires.
- **Discharge Air Sensor -** monitors the temperature of the air leaving the evaporator coil. The sensor is located in the remote evaporator discharge air path and is connected directly to the SPECTRUM™ TS Microprocessor. The unit will control on this sensor if the return air sensor fails or if discharge air sensor control is selected. This is a graded sensor and must be replaced with a graded sensor. The microprocessor must be calibrated to the sensor grade of the sensor installed in the discharge air position in order to operate properly. It is connected to the microprocessor via the DTP and DTN wires.
- **Coil Temperature Sensor -** monitors the temperature of the evaporator coil. The sensor is located on the remote evaporator coil header plate and is connected directly to the micro-processor. This is not a graded sensor. It is connected to the microprocessor via the CTP and CTN wires.
- **Ambient Temperature Sensor -** monitors the ambient air temperature. The sensor is located in the main unit and is connected directly to the microprocessor. This is not a graded sensor. It is connected to the microprocessor via the ATP and ATN wires.

Refrigeration System Components

The refrigeration system controls are used to control the operation of the refrigeration system as required by the microprocessor. The microprocessor determines these requirements by considering the setpoint, the software, the setting of programmable features and the information supplied by the sensors. Refer to the TK51652 SPECTRUM™ TS Microprocessor Diagnostic Manual for additional information.

These three valves are located in the condenser section of the unit. They are common to all zones.

- **Condenser Inlet Solenoid -** This valve controls the flow of refrigerant to the condenser. This solenoid is energized (closed) when any compartment is operating in heat or defrost mode. This is a normally open valve.
- **Receiver Tank Pressure Check Valve-** This check valve is used to equalize pressure in the receiver tank in the off cycle.
- **Purge Valve -** The purge valve operates in the heat or defrost mode to make sure adequate refrigeration is available.

The following components are located in the condensing section of the unit and serve the scroll compressor. They are controlled by compressor temperature, suction pressure and discharge pressure.

- **Liquid Injection Valve (LIV) -** This valve helps control the temperature of the scroll compressor. It is energized or pulsed (open) when the scroll compressor temperature exceeds a set value to inject liquid refrigerant directly into the compressor. The liquid refrigerant flashes to a gas to effectively cool the compressor. This valve is normally closed. This component is located between the liquid line and the compressor in the condenser section of the unit.
- **Hot Gas Bypass Valve (HGB) -** This valve helps control suction pressure. If the suction pressure falls below a set limit this valve is energized (open) to allow hot refrigerant gas to flow to the suction line until the suction pressure rises to an acceptable level. This valve is normally closed. This component is located in the hot gas bypass line next to the compressor. This valve uses a similar technique for controlling compression ratios.
- **Discharge Pressure Regulator (DPR)** (This component is a mechanical control device) - This valve is used to increase the discharge pressure during heat and defrost. The valve controls discharge pressure mechanically based on temperature and the actual system pressure.
- This valve is normally closed and opens when the set pressure is reached. This component is located in the hot gas line in the condenser section of the unit

The following components are also located in the main unit.

- **High Pressure Cutout -** The high pressure cutout is located on the discharge line of scroll compressors. This switch monitors the discharge pressure at the compressor. The switch is closed with normal pressures and open with excessive pressures. The switch will open and close at pressures determined by the refrigerant used in the unit. It opens on high discharge pressure to shut the unit down to prevent damage.
- **Discharge Pressure Transducer** - This transducer supplies the discharge pressure at the compressor to the microprocessor. This information is used by the microprocessor and software to determine the unit operating conditions.
- **Suction Pressure Transducer -** This transducer supplies the suction pressure at the compressor to the microprocessor. This information is used by the microprocessor and software to determine the unit operating conditions. It should be noted that the suction pressure transducer is located downstream of the throttle valve. As a result, the suction pressure displayed is compressor suction pressure.
- **Compressor Temperature Sensor** - This transducer supplies the compressor temperature to the microprocessor. This

information is used by the microprocessor and software to determine the unit operating conditions.

The following valves are required for each zone. They are located in the remote evaporator(s) for each zone.

- **Liquid Line Solenoid -** This valve is energized (open) any time cooling, heating or defrosting is required in its zone. The valve is de-energized when the zone is in null to stop refrigerant flow in that zone. This is a normally closed valve.
- **Hot Gas Solenoid -** This valve is energized (open) any time heating or defrosting is required in the zone. This is a normally closed valve.
- **Suction Line Solenoid -** If a zone is capable of reverse cycle operation it is said to be invertible. Reverse cycle means that the evaporator coil in that zone is used as the condenser coil during heat operation as long as at least one other zone is operating in cool mode.

  The suction line solenoid is energized (closed) when its compartment is operating in heat mode as long as at least one other zone is operating in cool mode. This is a normally open valve.

Engine Controls

The engine controls are used to control the operation of the diesel engine (or electric motor) as required by the microprocessor. The microprocessor determines these requirements by considering the setpoint, the software, the setting of programmable features and the information supplied by the sensors.

- **Coolant Temperature Sensor -** This sensor monitors the temperature of the coolant in the diesel engine. It is located on the diesel engine thermostat housing and is connected to the microprocessor via the WTP and WTN wires.
- **Coolant Level Sensor -** This sensor monitors the level of coolant in the radiator used by the diesel engine. It is located on the radiator expansion tank. If the coolant level falls below the sensor for a specified period of time a low coolant condition is assumed to exist. It is connected to the microprocessor via the CLS wire.
- **Oil Pressure Switch -** The oil pressure switch monitors the oil pressure of the diesel engine. It is located on the engine side of the unit frame. It is connected to the microprocessor via the 20B and CHO- wires.
- **Oil Level Sensor -** The oil level sensor monitors the oil level in the diesel engine. It is located above the oil pan on the door side of the engine. It supplies information on the oil level to the microprocessor via the OLS wire. The switch is closed with low oil level.
- **Flywheel Sensor -** This sensor monitors the RPM of the diesel engine. The flywheel sensor is located just under the door side engine mount. It supplies engine speed information to the microprocessor via the RPMP and RPMN wires.
- **Glow Plugs -** The glow plugs are energized by the microprocessor via the H wire to preheat the engine.
- **Starter -** The starter is located on the compressor side of the engine. It is energized by the microprocessor via the 8S wire to crank the engine.
- **Fuel Solenoid** -The fuel solenoid is located at the rear of the injector pump and is used to start and stop the flow of fuel to the diesel engine. It is energized to start fuel flow by the microprocessor via the 8D wire. The fuel solenoid features two coils, a pull-in coil and a hold coil. The pull-in coil draws approximately 40 amperes and the hold coil draws approximately 1 ampere. The pull-in coil is momentarily energized by the fuel solenoid timer for a few seconds to shift the fuel linkage.
- **Throttle Solenoid -** The high speed (throttle) solenoid is located just below the fuel injection pump. It is energized by the microprocessor via the 7D wire to initiate high speed operation.

Refrigeration Cycles

All Zones Cooling

When all zones are cooling the unit condenser is used to eliminate the heat from all zones. This is a Conventional Cooling cycle.

One Zone Cooling-One Zone Heating

When at least one zone is cooling and another zone is heating, the evaporator in the heating zone is used as a condenser to remove the heat from the zone that is cooling. The unit condenser is not used. This is Reverse Cycle.

- **Invertible System -** If a zone is capable of reverse cycle operation it is said to be invertable. Reverse cycle means that the evaporator coil in that zone is used as the condenser coil during heat operation as long as at least one other zone is operating in cool mode. All invertable systems are capable maintaining any temperature in any zone and can also heat or cool in any zone at any time

All Zones Heating

When all zones are heating the unit condenser is not used. This is Hot Gas Heat operation.

Any Zone Defrosting

When any zone enters defrost, zones that are cooling or heating are placed in Delayed Cool/Heat mode. The unit condenser is not used. Defrost is accomplished by means of Hot Gas Heat.

Technician Features

The Thermo King SPECTRUM™ TS control system features many special technician functions. These functions are available from the Maintenance Menus. A brief explanation of each menu is included here. For additional details refer to the SPECTRUM™ TS Microprocessor Diagnostics Manual.

Hours Display Menu: The Hours Menu allows the operator to check the readings of all unit hour-meters that have been enabled. In addition, a reset button is provided for each user programmable hour-meter.

Gauges Display Menu: The Gauges Display allows the operator to display the unit operating gauges such as coolant level and temperature, engine RPM and suction and discharge pressure.

Sensors Display Menu: The Sensors Display allows the operator to display the temperature of all unit temperature sensors and the temperature differential for each zone.

Service Test Mode Menu: Since it is impossible to predict exact operating conditions, a trouble-shooting feature called Service Test Mode has been incorporated. This feature allows the unit to be “forced” to a known set of operating conditions in Diesel mode, regardless of setpoint or temperature sensor inputs. Service personnel can now troubleshoot the system under defined conditions. Service Test Mode can be used with the unit running or shut down.

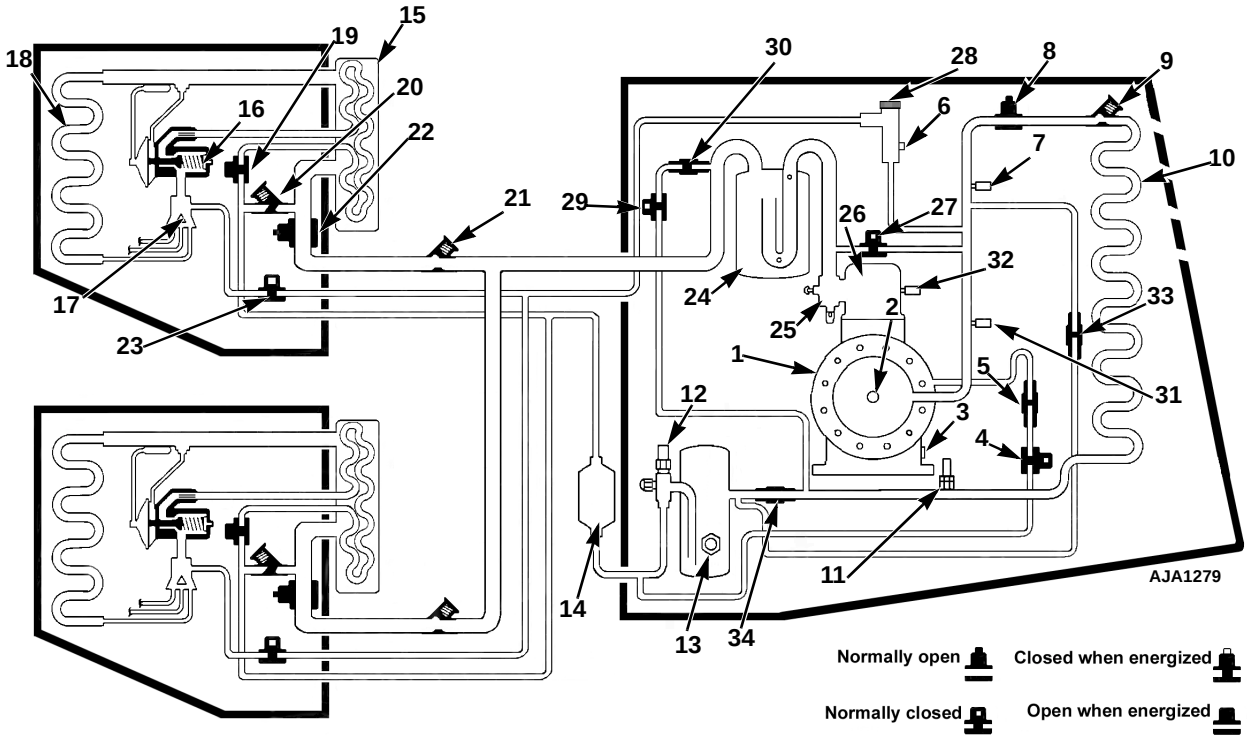
When a Service Test Mode function is selected, the unit will operate in that mode for 15 minutes. If no other Service Test Mode function is selected during this time the unit will shut down and generate Alarm Code 54. All protection circuits operate normally in Service Test Mode. The Service Test Mode display also shows return air temperature, discharge air temperature, evaporator coil temperature and the calculated value for temperature differential. The Gauge Menu is also available.

Interface Board Test Mode Menu: Interface Board Test Mode allows individual relays or outputs to be energized. This permits service personnel to troubleshoot the system under defined conditions. Interface Board Test mode is use with the unit shut down.

Relays and outputs can all be energized momentarily. In addition, all functions except the Preheat relay and starter can be locked on. If a function is locked on that function will remain energized for 15 minutes if no other Interface Board Test Mode function is selected.

At the end of 15 minutes, if no other function is selected the unit will shut down and record Alarm Code 54. All protection circuits operate normally in Service Test Mode.

The Interface Board Test Mode display also shows suction pressure, discharge pressure, amps and battery volts.



1.	Scroll Compressor	18.	Evaporator Coil
2.	Thermister	19.	Liquid Line Solenoid
3.	Compressor Oil Sight Glass	20.	Liquid Return Check Valve
4.	Liquid Injection Solenoid	21.	Suction Line Check Valve
5.	Liquid Injection Check Valve	22.	Suction Line Solenoid
6.	Discharge Service Port	23.	Hot Gas Solenoid
7.	High Pressure Cutout Switch	24.	Accumulator Tank
8.	Condenser Inlet Solenoid	25.	Suction Service Valve
9.	Condenser Inlet Check Valve	26.	Throttling Valve
10.	Condenser Coil	27.	Hot Gas Bypass Solenoid
11.	High Pressure Relief Valve	28.	Discharge Pressure Regulator Valve
12.	Receiver Outlet Valve	29.	Purge Valve
13.	Receiver Sight Glass	30.	Purge Check Valve
14.	Dehydrator	31.	Discharge Pressure Transducer
15.	Heat Exchanger	32.	Suction Pressure Transducer
16.	Expansion Valve	33.	Receiver Tank Pressure Check Valve
17.	Distributor	34.	Condenser Check Valve

Figure 6: Cool Cycle Diagram

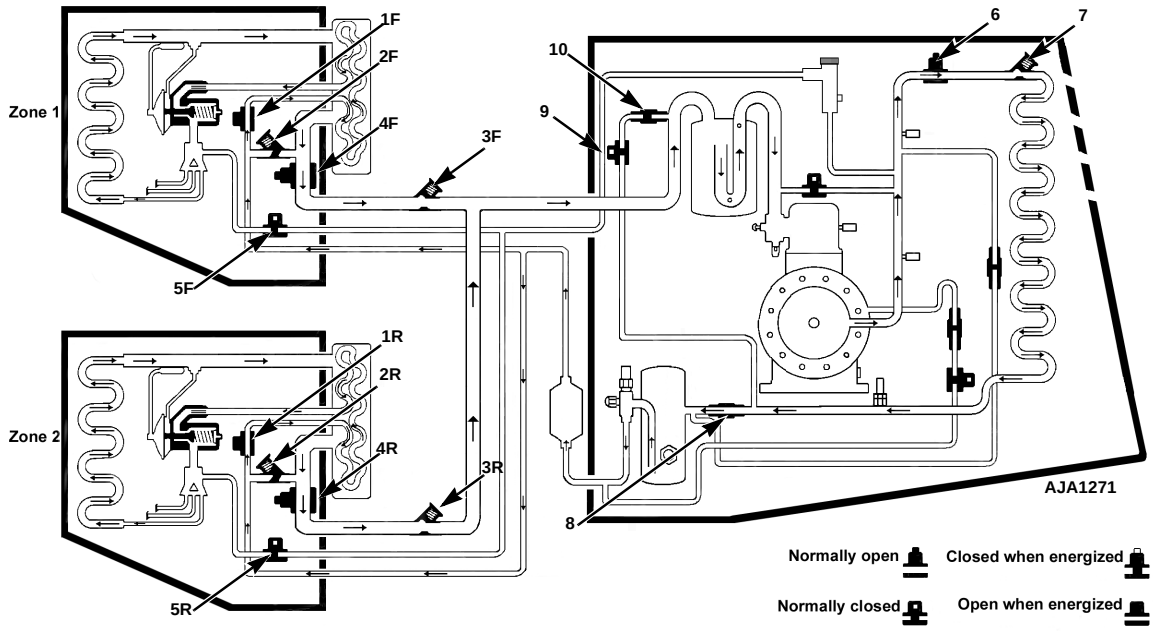


Figure 7: Zone 1 and Zone 2 Cool

Zone 1 Cool and Zone 2 Cool

High pressure refrigerant vapor leaves the compressor and flows through the open CIS to the condenser where the refrigerant condenses into high pressure liquid. The liquid refrigerant flows through the receiver tank into the liquid lines.

The LLS1 is open so some of the refrigerant flows through the Zone 1 expansion valve into the Zone 1 evaporator. There, liquid refrigerant cools the Zone 1 evaporator as it evaporates into low pressure vapor. The refrigerant returns to the compressor through the SLS1, the suction line, SLCV1 and the accumulator.

The LLS2 is also open so some of the refrigerant flows through the Zone 2 expansion valve into the Zone 2 evaporator. There, liquid refrigerant cools the Zone 2 evaporator as it evaporates into low pressure vapor. The refrigerant returns to the compressor through the SLS2, the second suction line, the SLCV2 and the accumulator.

Zone 1 Evaporator

1F. Zone 1 Liquid Line Solenoid (LLS1)-Open

2F. Zone 1 Liquid Return Check Valve (LRCV1)-Closed

3F. Zone 1 Suction Line Check Valve (SLCV1)-Open

4F. Zone 1 Suction Line Solenoid (SLS1)-Open

5F. Zone 1 Hot Gas Solenoid (HGS1)-Closed

Zone 2 Evaporator

1R. Zone 2 Liquid Line Solenoid (LLS2)-Open

2R. Zone 2 Liquid Return Check Valve (LRCV2)-Closed

3R. Zone 2 Suction Line Check Valve (SLCV2)-Open

4R. Zone 2 Suction Line Solenoid (SLS2)-Open

5R. Zone 2 Hot Gas Solenoid (HGS2)-Closed

Condensing Unit

6. Condenser Inlet Solenoid (CIS)-Open

7. Condenser Inlet Check Valve (CICV)-Open

8. Condenser Check Valve (CCV)-Open

9. Purge Valve (PV)-Closed

10. Purge Check Valve (PCV)-Closed

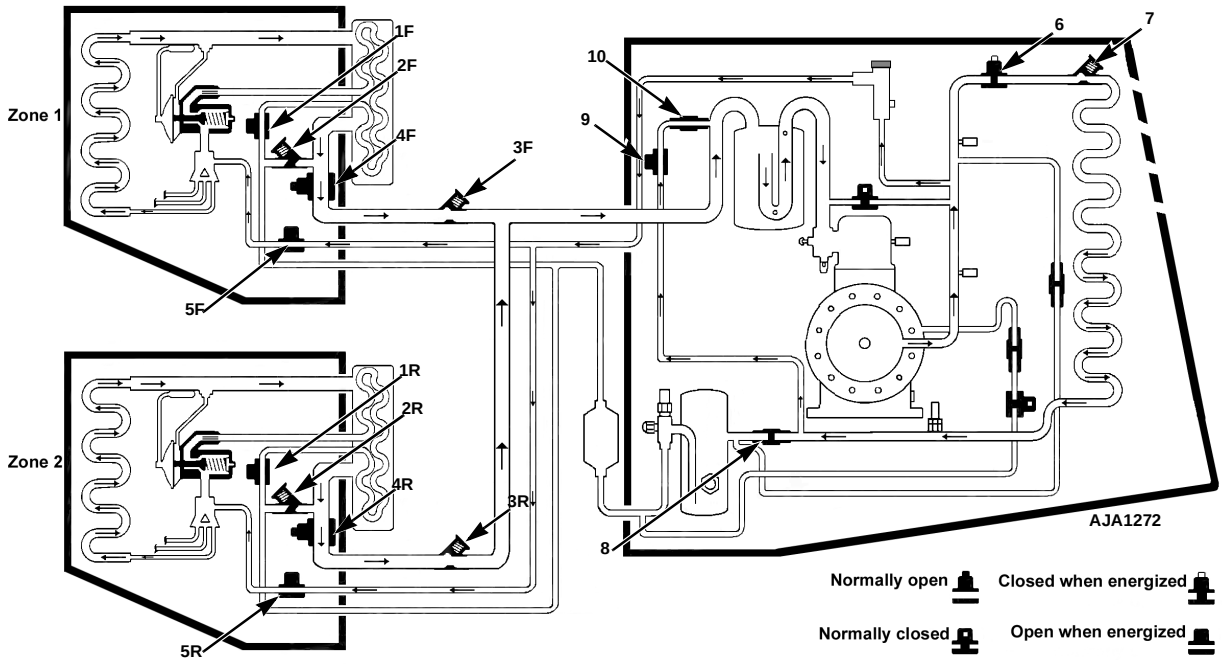


Figure 8: Zone 1 and Zone 2 Heat

Zone 1 Heat and Zone 2 Heat

The CIS is closed so high pressure refrigerant vapor leaves the compressor and flows through the DPR to Zone 1 and Zone 2 hot gas lines and through HGS1 and HGS2 into both evaporators. There, the refrigerant heats both evaporators and condenses into high pressure liquid. The refrigerant flows through the open suction line solenoids and back to accumulator.

In the condensing unit, the CIS valve closes and opens to regulate head pressure. The purge valve is opened continuously during heat to drain the condenser coil.

Zone 1 Evaporator

1F. Zone 1 Liquid Line Solenoid (LLS1)-Open

2F. Zone 1 Liquid Return Check Valve (LRCV1)-Closed

3F. Zone 1 Suction Line Check Valve (SLCV1)-Open

4F. Zone 1 Suction Line Solenoid (SLS1)-Open

5F. Zone 1 Hot Gas Solenoid (HGS1)-Open

Zone 2 Evaporator

1R. Zone 2 Liquid Line Solenoid (LLS2)-Open

2R. Zone 2 Liquid Return Check Valve (LRCV2)-Closed

3R. Zone 2 Suction Line Check Valve (SLCV2)-Open

4R. Zone 2 Suction Line Solenoid (SLS2)-Open

5R. Zone 2 Hot Gas Solenoid (HGS2)-Open

Condensing Unit

6. Condenser Inlet Solenoid (CIS)-Closed/Open (Pressure Dependent)

7. Condenser Inlet Check Valve (CICV)-Closed/Open

8. Condenser Check Valve (CCV)-Closed

9. Purge Valve (PV)-Open

10. Purge Check Valve (PCV)-Open

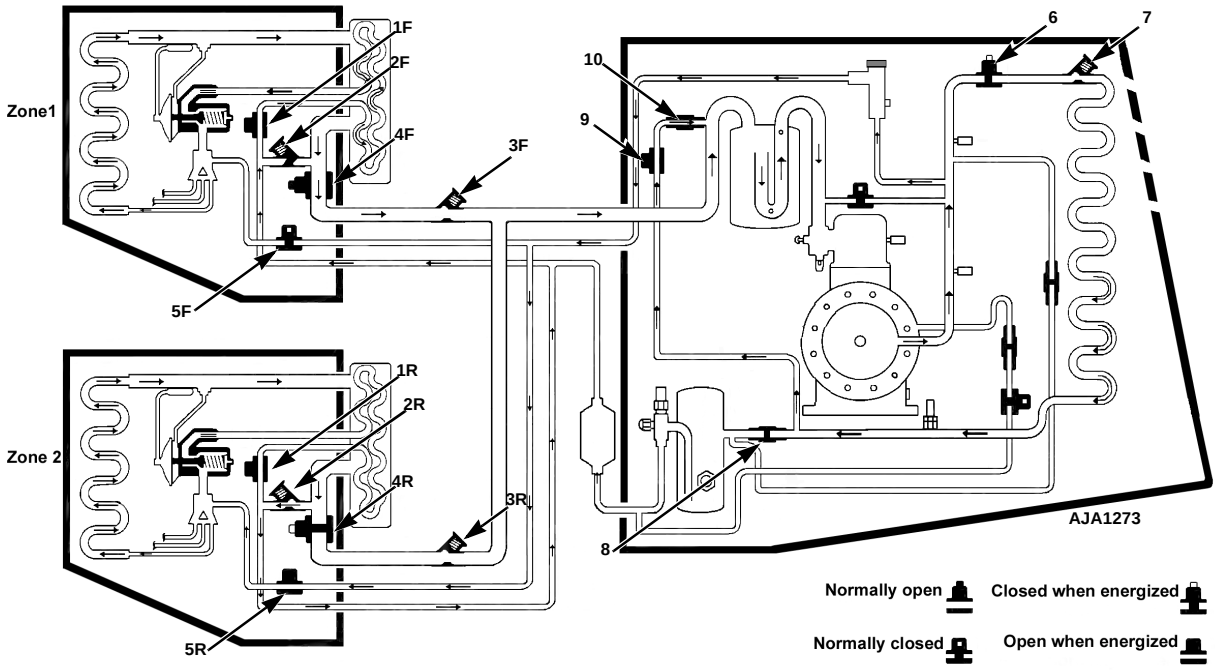


Figure 9: Zone 1 Cool and Zone 2 Heat

Zone 1 Cool and Zone 2 Heat

The CIS is closed so high pressure refrigerant vapor leaves the compressor and flows through the DPR to the Zone 2 hot gas line and the open HGS2 into the Zone 2 evaporator. There, the refrigerant heats the Zone 2 evaporator and condenses into high pressure liquid. Because the SLS2 is closed, the liquid refrigerant flows through the LRCV2 and the liquid line to the LLS1.

The LLS1 is open so the refrigerant flows through the Zone 1 expansion valve into the Zone 1 evaporator. There, the liquid refrigerant cools the Zone 1 evaporator as it evaporates into low pressure vapor. The refrigerant returns to the compressor through the SLS1, Suction Line, SLCV1 and the accumulator.

In the condensing unit, the CIS valve closes and opens to regulate head pressure. The purge valve is opened continuously during heat to drain the condenser coil.

Zone 1 Evaporator

1F. Zone 1 Liquid Line Solenoid (LLS1)-Open

2F. Zone 1 Liquid Return Check Valve (LRCV1)-Closed

3F. Zone 1 Suction Line Check Valve (SLCV1)-Open

4F. Zone 1 Suction Line Solenoid (SLS1)-Open

5F. Zone 1 Hot Gas Solenoid (HGS1)-Closed

Zone 2 Evaporator

1R. Zone 2 Liquid Line Solenoid (LLS2)-Open

2R. Zone 2 Liquid Return Check Valve (LRCV2)-Open

3R. Zone 2 Suction Line Check Valve (SLCV2)-Closed

4R. Zone 2 Suction Line Solenoid (SLS2)-Closed

5R. Zone 2 Hot Gas Solenoid (HGS2)-Open

Condensing Unit

6. Condenser Inlet Solenoid (CIS)-Closed/Open (Pressure Dependent)

7. Condenser Inlet Check Valve (CICV)-Closed/Open

8. Condenser Check Valve (CCV)-Closed

9. Purge Valve (PV)-Open

10. Purge Check Valve (PCV)-Open

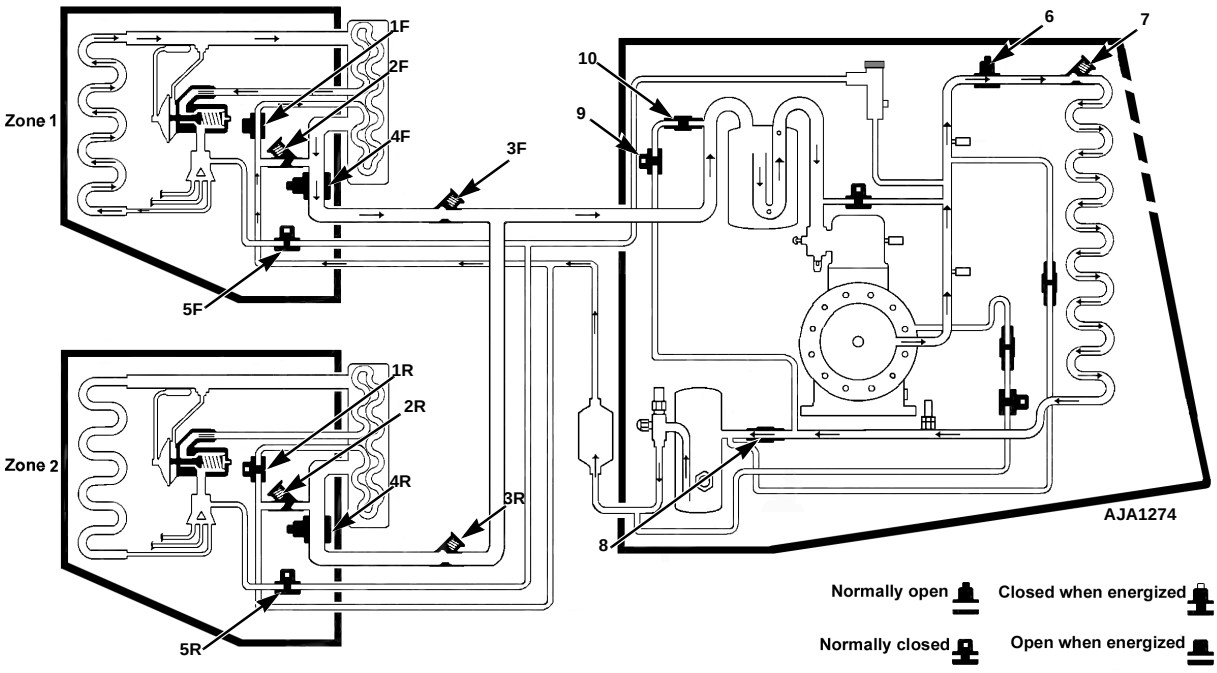


Figure 10: Zone 1 Cool and Zone 2 Null

Zone 1 Cool and Zone 2 Null

High pressure refrigerant vapor leaves the compressor and flows through the open CIS to the condenser, where refrigerant condenses into high pressure liquid. The liquid refrigerant flows through the receiver tank into the Zone 1 liquid line.

The LLS1 is open so the refrigerant flows through the Zone 1 expansion valve into the Zone 1 evaporator. There, the liquid refrigerant cools the Zone 1 evaporator as it evaporates into low pressure vapor. The refrigerant returns to the compressor through the SLS1, suction line, SLCV1 and the accumulator.

The LLS2 is closed, which prevents refrigerant from reaching the Zone 2 evaporator.

Zone 1 Evaporator

1F. Zone 1 Liquid Line Solenoid (LLS1)-Open

2F. Zone 1 Liquid Return Check Valve (LRCV1)-Closed

3F. Zone 1 Suction Line Check Valve (SLCV1)-Open

4F. Zone 1 Suction Line Solenoid (SLS1)-Open

5F. Zone 1 Hot Gas Solenoid (HGS1)-Closed

Zone 2 Evaporator

1R. Zone 2 Liquid Line Solenoid (LLS2)-Closed

2R. Zone 2 Liquid Return Check Valve (LRCV2)-Closed

3R. Zone 2 Suction Line Check Valve (SLCV2)-Open

4R. Zone 2 Suction Line Solenoid (SLS2)-Open

5R. Zone 2 Hot Gas Solenoid (HGS2)-Closed

Condensing Unit

6. Condenser Inlet Solenoid (CIS)-Open

7. Condenser Inlet Check Valve (CICV)-Open

8. Condenser Check Valve (CCV)-Open

9. Purge Valve (PV)-Closed

10. Purge Check Valve (PCV)-Closed

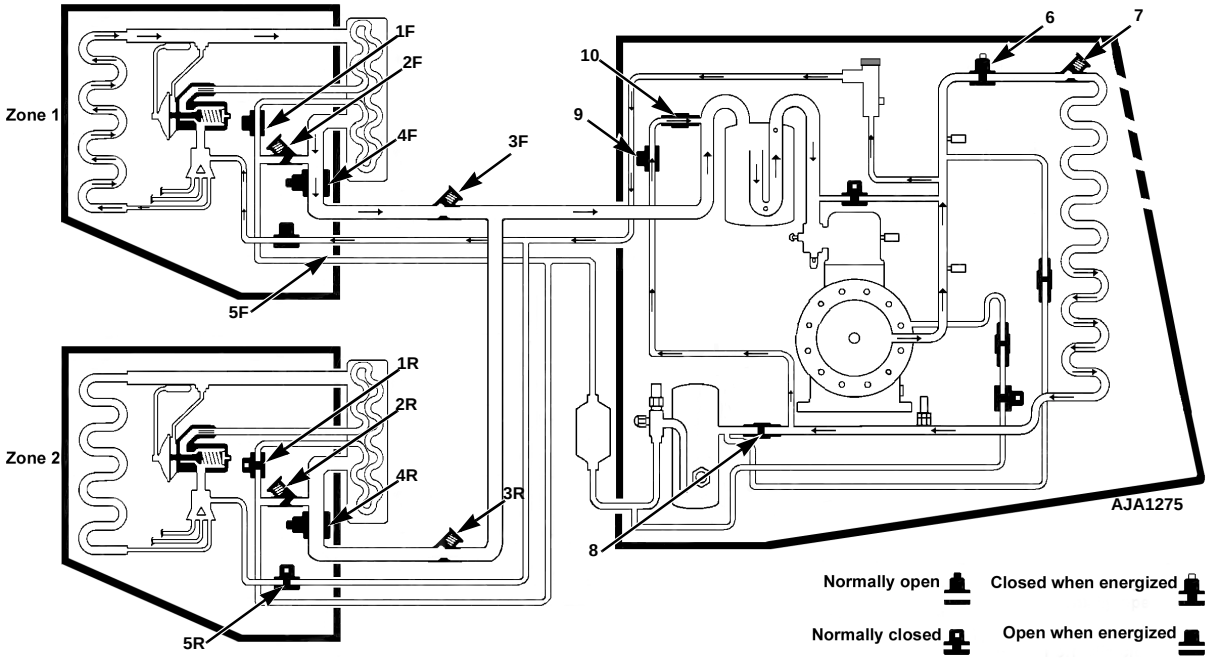


Figure 11: Zone 1 Heat and Zone 2 Null

Zone 1 Heat and Zone 2 Null

The CIS is closed so high pressure refrigerant vapor leaves the compressor and flows through the DPR to the Zone 1 hot gas line and though HGS1 into the Zone 1 evaporator. There, the refrigerant heats the evaporator and condenses into high pressure liquid. The refrigerant returns to the compressor through the SLS1, Suction Line, SLCI, and the accumulator.

In the condensing unit, the CIS valve closes and opens to regulate head pressure. The purge valve is opened continuously during heat to drain the condenser coil.

Zone 1 Evaporator

1F. Zone 1 Liquid Line Solenoid (LLS1)-Open

2F. Zone 1 Liquid Return Check Valve (LRCV1)-Closed

3F. Zone 1 Suction Line Check Valve (SLCV1)-Open

4F. Zone 1 Suction Line Solenoid (SLS1)-Open

5F. Zone 1 Hot Gas Solenoid (HGS1)-Open

Zone 2 Evaporator

1R. Zone 2 Liquid Line Solenoid (LLS2)-Closed

2R. Zone 2 Liquid Return Check Valve (LRCV2)-Closed

3R. Zone 2 Suction Line Check Valve (SLCV2)-Open

4R. Zone 2 Suction Line Solenoid (SLS2)-Open

5R. Zone 2 Hot Gas Solenoid (HGS2)-Closed

Condensing Unit

6. Condenser Inlet Solenoid (CIS)-Closed/Open (Pressure Dependent)

7. Condenser Inlet Check Valve (CICV)-Closed/Open

8. Condenser Check Valve (CCV)-Closed

9. Purge Valve (PV)-Open

10. Purge Check Valve (PCV)-Open

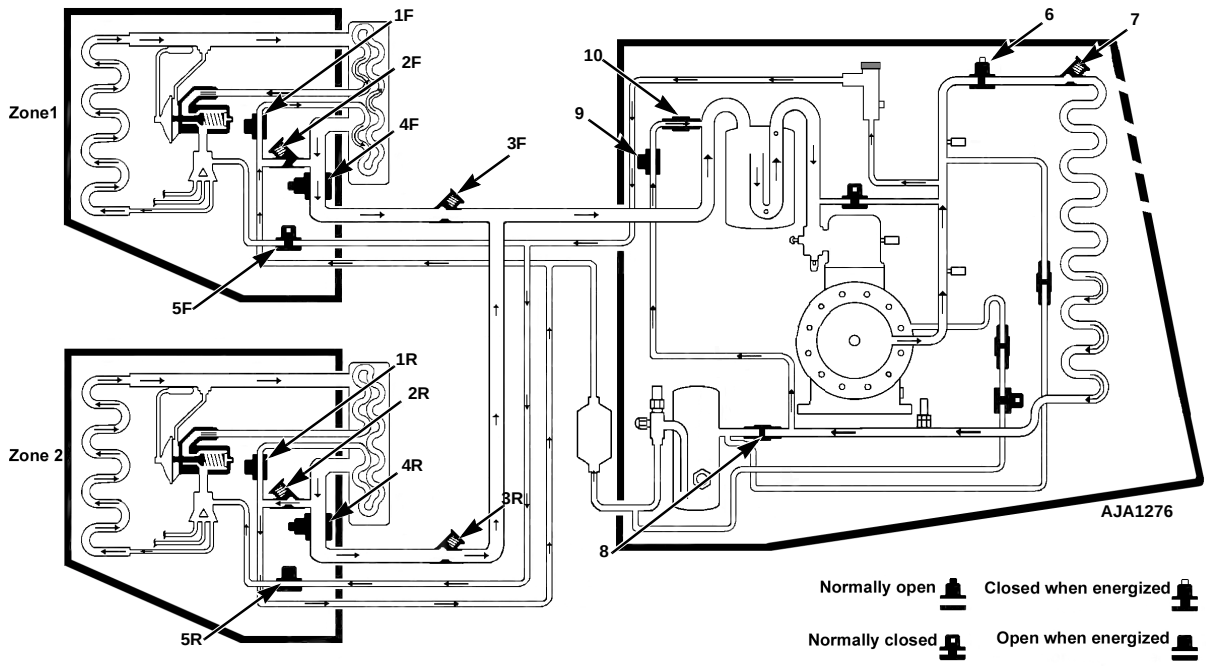


Figure 12: Zone 1 Cool and Zone 2 Defrost

Zone 1 Cool and Zone 2 Defrost

The CIS is closed so high pressure refrigerant vapor leaves the compressor and flows through the DPR to the Zone 2 hot gas line and the open HGS2 into the Zone 2 evaporator. There, the refrigerant heats the Zone 2 evaporator and condenses into high pressure liquid. Because the SLS2 is open, the liquid refrigerant returns to the compressor through the SLS2, the second suction line, SLCV2 and the accumulator. The fans stay off in the Zone 2 evaporator, allowing the coil to defrost without warming the load.

Due to the low pressure in the second suction line, little or no refrigerant goes through the Zone 1 evaporator.

In the condensing unit, the CIS valve closes and opens to regulate head pressure. The purge valve is opened continuously during defrost to drain the condenser coil.

Zone 1 Evaporator

1F. Zone 1 Liquid Line Solenoid (LLS1)-Open

2F. Zone 1 Liquid Return Check Valve (LRCV1)-Closed

3F. Zone 1 Suction Line Check Valve (SLCV1)-Open

4F. Zone 1 Suction Line Solenoid (SLS1)-Open

5F. Zone 1 Hot Gas Solenoid (HGS1)-Closed

Zone 2 Evaporator

1R. Zone 2 Liquid Line Solenoid (LLS2)-Open

2R. Zone 2 Liquid Return Check Valve (LRCV2)-Open

3R. Zone 2 Suction Line Check Valve (SLCV2)-Open

4R. Zone 2 Suction Line Solenoid (SLS2)-Open

5R. Zone 2 Hot Gas Solenoid (HGS2)-Open

Condensing Unit

6. Condenser Inlet Solenoid (CIS)-Closed/Open (Pressure Dependent)

7. Condenser Inlet Check Valve (CICV)-Closed/Open

8.Condenser Check Valve (CCV)-Closed

9. Purge Valve (PV)-Open

10. Purge Check Valve (PCV)-Open

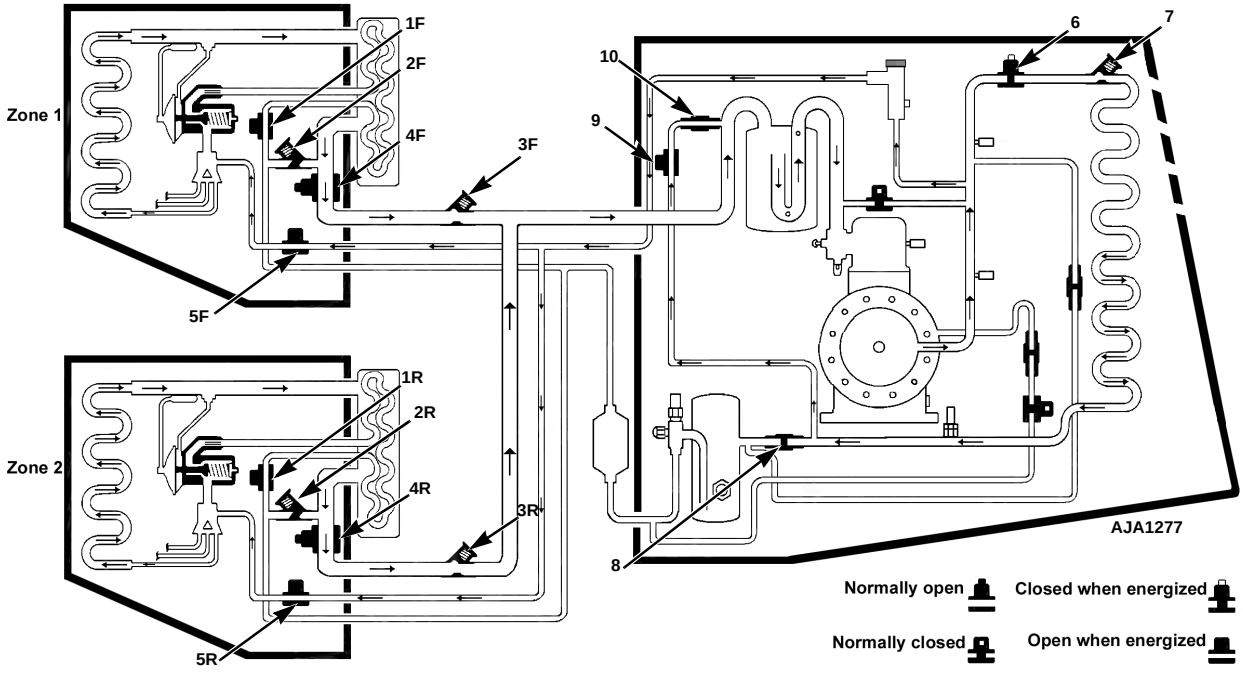


Figure 13: Zone 1 Heat and Zone 2 Defrost

Zone 1 Heat and Zone 2 Defrost

The CIS is closed so high pressure refrigerant vapor leaves the compressor and flows through the DPR to Zone 1 and Zone 2 hot gas lines and through HGS1 and HGS2 into both evaporators. There, the refrigerant heats both evaporators and condenses into high pressure liquid. The refrigerant flows through the open suction line solenoids and back to accumulator. The fans stay off in the Zone 2 evaporator, allowing the coil to defrost without warming the load.

In the condensing unit, the CIS valve closes and opens to regulate head pressure. The purge valve is opened continuously during defrost to drain the condenser

Zone 1 Evaporator

1F. Zone 1 Liquid line Solenoid (LLS1)-Open

2F. Zone 1 Liquid Return Check Valve (LRCV1)-Closed

3F. Zone 1 Suction Line Check Valve (SLVC1)-Open

4F. Zone 1 Suction Line Solenoid (SLS1)-Open

5F. Zone 1 Hot Gas Solenoid (HGS1)-Open

Zone 2 Evaporator

1R. Zone 2 Liquid Line Solenoid (LLS2)-Open

2R. Zone 2 Liquid Return Check Valve (LRCV2)-Closed

3R. Zone 2 Suction Line Check Valve (SLCV2)Open

4R. ZOne 2 Suction Line Solenoid (SLS2)-Open

5R. Zone 2 Hot Gas Solenoid (HGS2)-Open

Condensing Unit

6. Condenser Inlet Solenoid 9CIS)-Closed/Open (Pressure Dependent)

7. Condenser Inlet Check Valve (CICV)-Closed/Open

8. Condenser Check Valve (CCV)-Closed

9. Purge Valve (PV)-Open

10. Purge Check Valve (PCV)-Open

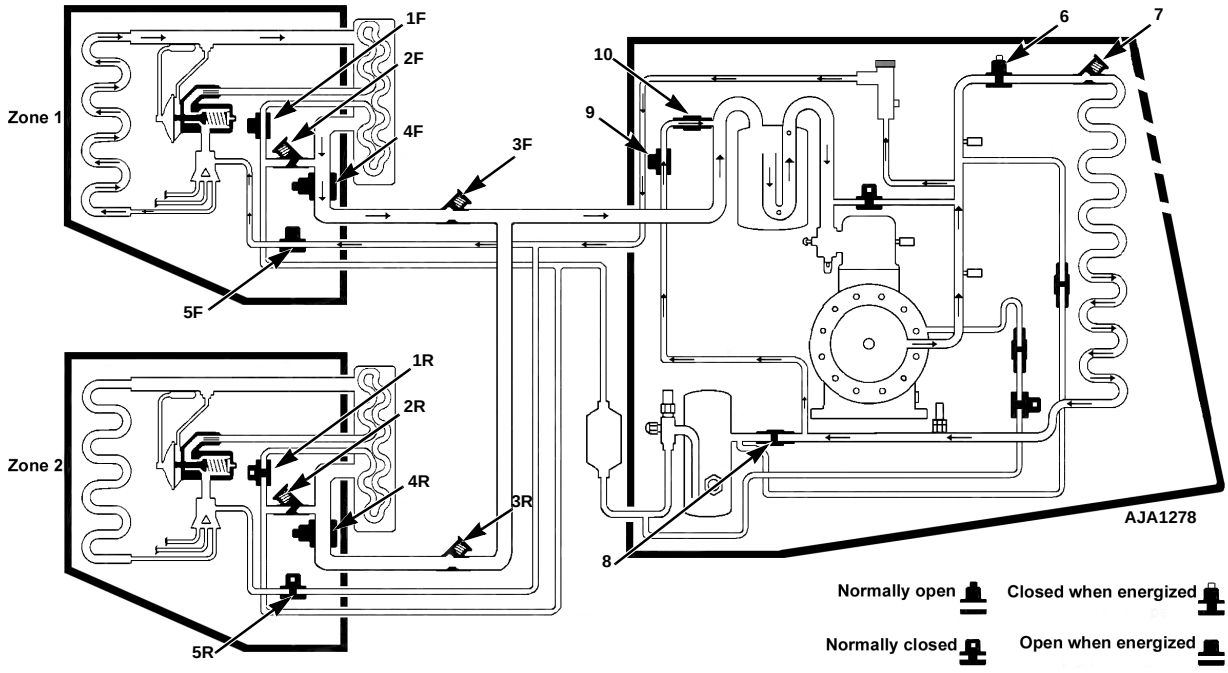


Figure 14: Zone 1 Defrost and Zone 2 Null

Zone 1 Defrost and Zone 2 Null

The CIS is closed so high pressure refrigerant vapor leaves the compressor and flows through the DPR to the Zone 1 hot gas line and through HGS1 into the Zone 1 evaporator. There, the refrigerant heats the evaporator and condenses into high pressure liquid. The refrigerant flows through the open suction line solenoid and back to accumulator. The fans stay off in the Zone 1 evaporator, allowing the coil to defrost without warming the load.

In the condensing unit, the CIS valve closes and opens to regulate head pressure. The purge valve is opened continuously during defrost to drain the condenser

Zone 1 Evaporator

1F. Zone 1 Liquid Line Solenoid (LLS)-Open

2F. Zone 1 Liquid Return Check Valve (LRCV)-Closed

3F. Zone 1 Suction Line Check Valve (SLCV)-Open

4F. Zone 1 Suction Line SOlenoid (SLS)-Open

5F. Zone 1 Hot Gas Solenoid (HGS)-Open

Zone 2 Evaporator

1R. Zone 2 Liquid Line Solenoid (LLS2)-Closed

2R. Zone 2 Liquid Return Check Valve (LRCV2)-Closed

3R. Zone 2 Suction Line Check Valve (SLCV2)-Open

4R. Zone 2 Suction Line Solenoid (SLS2)-Open

5R. Zone 2 Hot Gas Solenoid (HGS2)-Closed

Condensing Unit

6. Condenser Inlet Solenoid (CIS)-Closed/Open (Pressure Dependent)

7. Condenser Inlet Check Valve (CICV)-Closed/Open

8. Condenser Check Valve (CCV)-Closed

9. Purge Valve (PV)-Open

10. Purge Check Valve (PCV)-Open

Inverted Heat Mode

When the unit switches from cooling in both zones to reverse heat, there is a one-minute period where the purge valve is energized, while both zones remain in cool. This is followed by a two-minute period where the hot gas solenoid in the zone calling for heat is energized along with the condenser inlet solenoid. Finally, the suction line solenoid in the zone calling for heat is energized. This process pre-conditions the evaporator in the zone calling for heat.

The heating system increases the capacity of the Heat mode by making more refrigerant available for use in the Heat mode. This is accomplished by the Purge Valve, which opens during the beginning of the Heat mode to move liquid refrigerant from the condenser to the accumulator where it can be used in the Heat mode. The Purge Valve controls the flow of refrigerant through the Purge Valve line. The Purge Valve line runs from the liquid line upstream of the Condenser Check Valve to the accumulator inlet. The Condenser Check Valve is located in the liquid line after the condenser outlet.

Defrost Mode

The delayed switching of the Hot Gas Solenoid, Condenser Inlet Solenoid, and Suction Line Solenoid does not occur before the Defrost mode. The Purge Valve, Hot Gas Solenoid and Condenser Inlet Solenoid are all energized at he same time. The Purge Valve remains open while the unit is in the Defrost Mode.

Start Up and Sweeping Unit Evaporator Coils

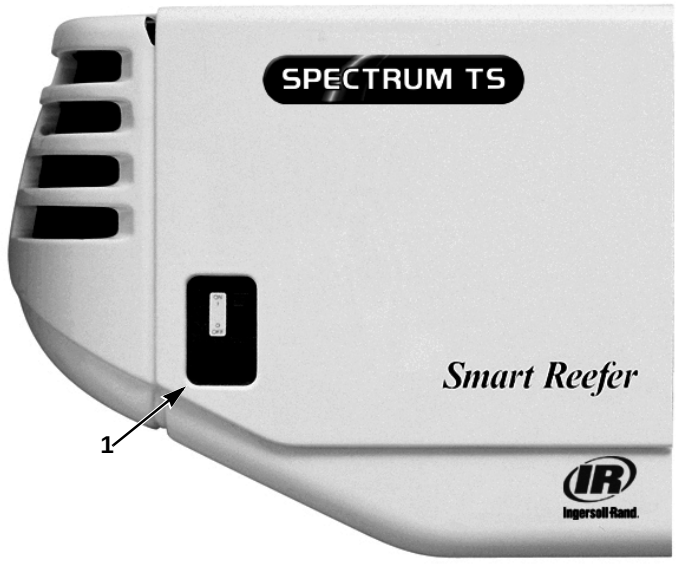
For the first 30 seconds following unit start up, the Hot Gas Solenoids in both zones are energized as well as the Liquid Line Solenoid in Zone 1. This sweeps refrigerant from the coils and returns it to the compressor along with oil trapped in the evaporators. High speed diesel operation is delayed for 2 minutes after startup and the alternator excitation output is delayed for 30 seconds after startup to reduce the load on the engine.

AJA1350

Figure 15: Front View

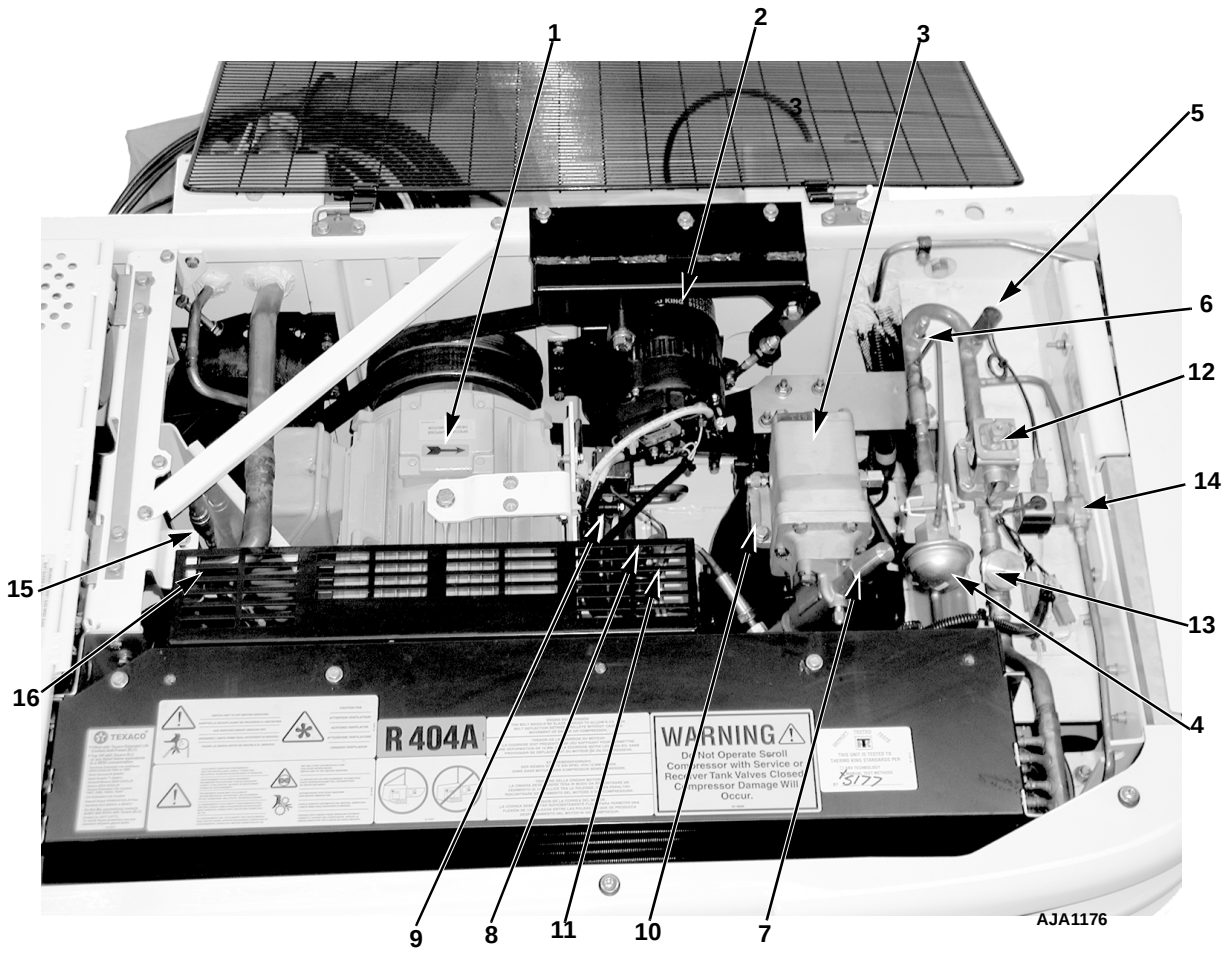
AJA1500

Figure 16: Back View



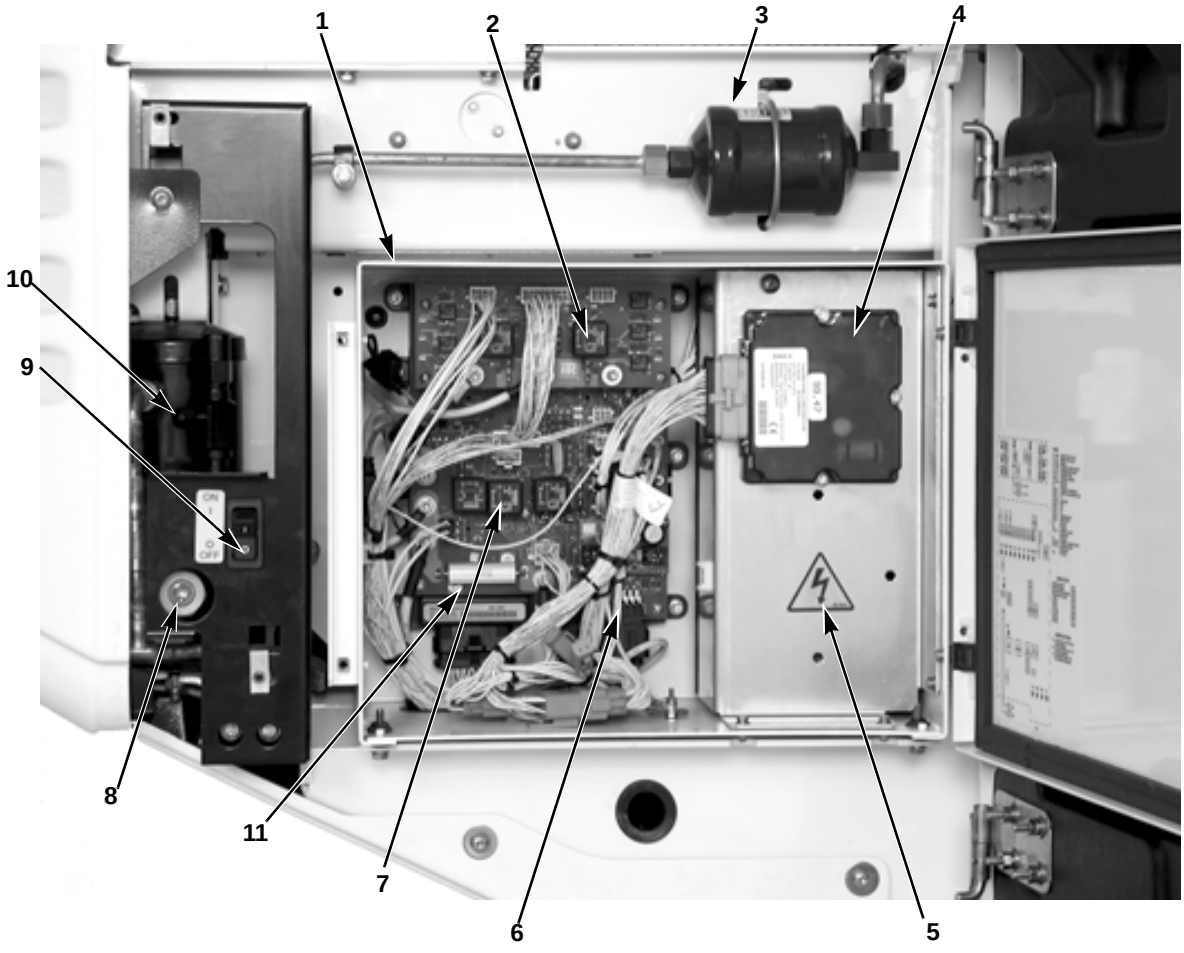
1.	On/Off Switch

Figure 17: Side View



1.	Electric Motor	9.	Hot Gas Bypass
2.	Alternator	10.	Suction Pressure Transducer
3.	Throttle Valve	11.	Discharge Pressure Transducer
4.	Discharge Pressure Regulator	12.	Condenser Inlet Solenoid
5.	High Pressure Cutout Switch Location	13.	Condenser Inlet Check Valve
6.	Discharge Service Port	14.	Receiver Tank Pressure Check Valve
7.	Suction Service Valve	15.	Purge Check Valve
8.	Liquid Injection Valve	16.	Purge Valve

Figure 18: Condenser Compartment Components

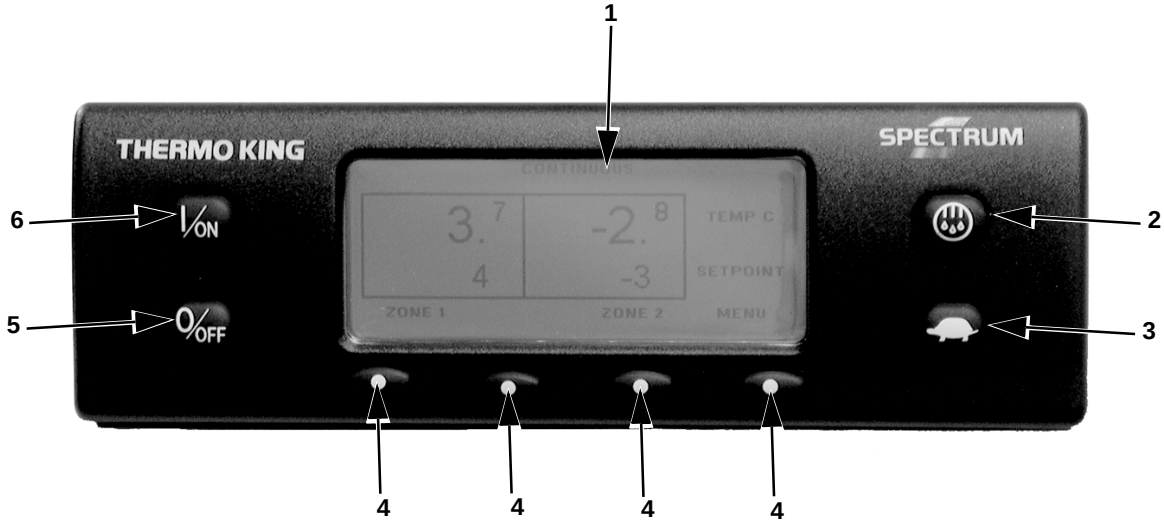


1.	Control Box	7.	Interface Board
2.	Multi-Temp Option Board	8.	Receiver Tank Sight Glass
3.	Filter Drier	9.	Main On/Off Switch
4.	DAS Module	10.	Receiver Tank
5.	High Voltage Shield	11.	SPECTRUM™ TS Microprocessor
6.	Power Supply Board		

Figure 19: Control Box and Miscellaneous Components

AJA455

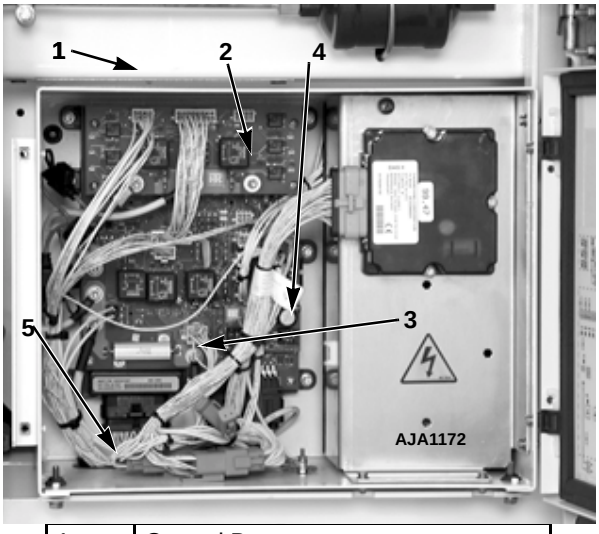
Figure 20: Power Receptacle Box—Model 50



1.	Display Screen
2.	Defrost Key
3.	High Speed Lockout Key
4.	Soft Keys
5.	Off Key
6.	On Key

Figure 21: HMI Control Panel

Control Box, Fuses and Relays



1.	Control Box
2.	Multi-Temp Option Board
3.	Interface Board
4.	Power Supply Board
5.	SPECTRUM™ TS Microprocessor

Figure 22: Control Box Components

The control box is located on the compressor side of the unit. It contains the SPECTRUM™ TS Microprocessor (not shown) SPECTRUM™ TS Interface board, SPECTRUM™ TS Multi-Temp Option board, SPECTRUM™ TS power supply, the high voltage tray, and miscellaneous fuses and relays located on these boards.

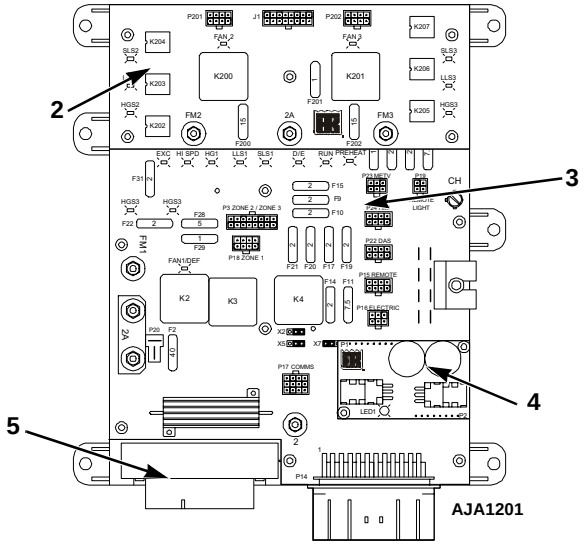
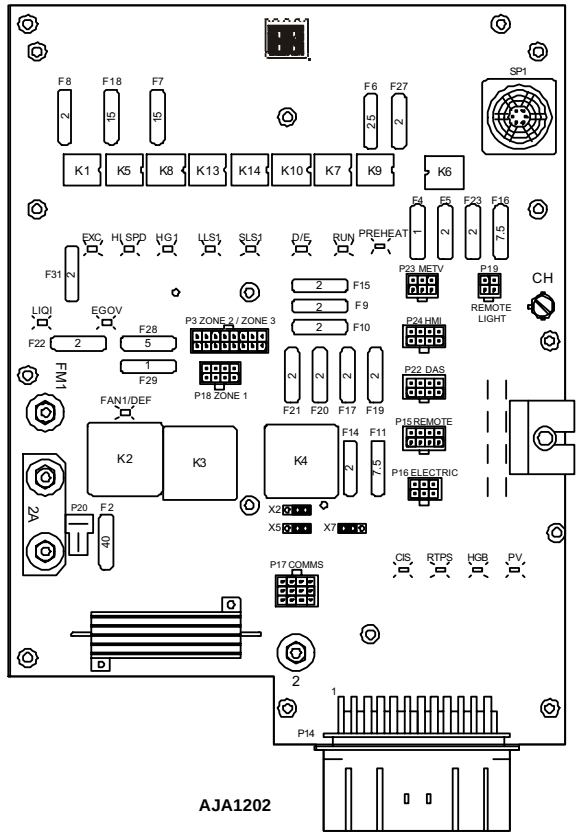


Figure 23: Complete SPECTRUM™ TS Control System with Multi-Temp Option Board



Fuse	Size	Function
F2	40A	Starter, Fuel Pull-In
F4	1A	Remote Status Light (Option)
F6	40A	Preheat
F7	15A	2A Power Zone 1
F8	2A	Alternator Excitation
F9	2A	DAS 2A Power (Option)
F11	7.5A	Run Relay
F15	2A	HMI 2A Power
F16	2A	8 Power to HMI, DAS
F17	2A	Purge Valve
F18	15A	High Speed Solenoid
F19	2A	Receiver Tank Pressure Sol
F20	2A	Hot Gas Bypass
F21	2A	Condenser Inlet Solenoid
F22	2A	Liquid Injection Valve
F23	2A	Power Supply
F29	1A	Zone 1 Door Switch 2A Power

Figure 24: Interface Board Fuse Size and Function

Relay	Function
K1	Alternator Excitation Relay
K2	Zone 1 Fan Relay
K3	Starter Relay
K4	Fuel Solenoid Pull In Relay
K5	Throttle Solenoid Relay
K6	On/Off Relay
K7	Run Relay
K8	Zone 1 Hot Gas Solenoid Relay
K9	Preheat Relay
K10	Diesel/Electric Relay
K13	Zone 1 Liquid Line Solenoid Relay
K14	Zone 1 Suction Line Solenoid Relay

Figure 25: SPECTRUM™ TS Interface Board Relay Functions

SPECTRUM™ TS Power Supply Board

The power supply board provides regulated DC power to the microprocessor and interface board. It is separate from the other boards due to manufacturing considerations and to allow the capability to be increased as required for future applications.

If the LED on the power supply board is illuminated the power supply board is functioning normally.

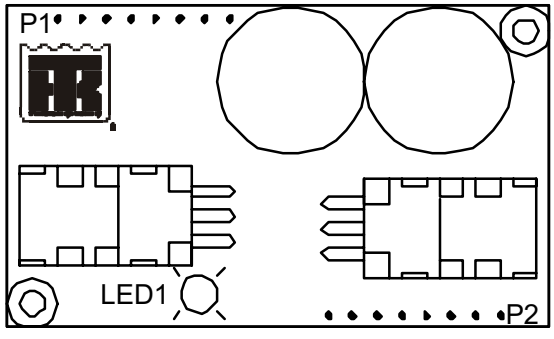


Figure 26: SPECTRUM™ TS Power Supply Board

SPECTRUM™ TS Multi-Temp Option Board

The Multi-temp Option Board adds the control functions for Zone 2 and Zone 3 (future expandability). The micro-processor controls the operation of the additional zones through the control relays on the multi-temp option board. An LED is illuminated when a relay is energized by the microprocessor and has transferred its contacts to the energized state.

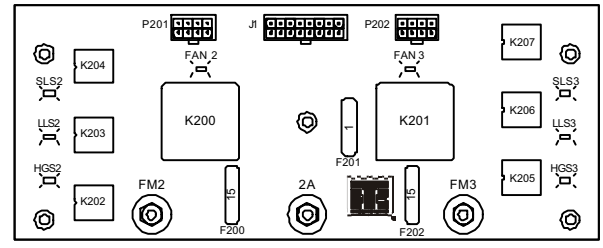
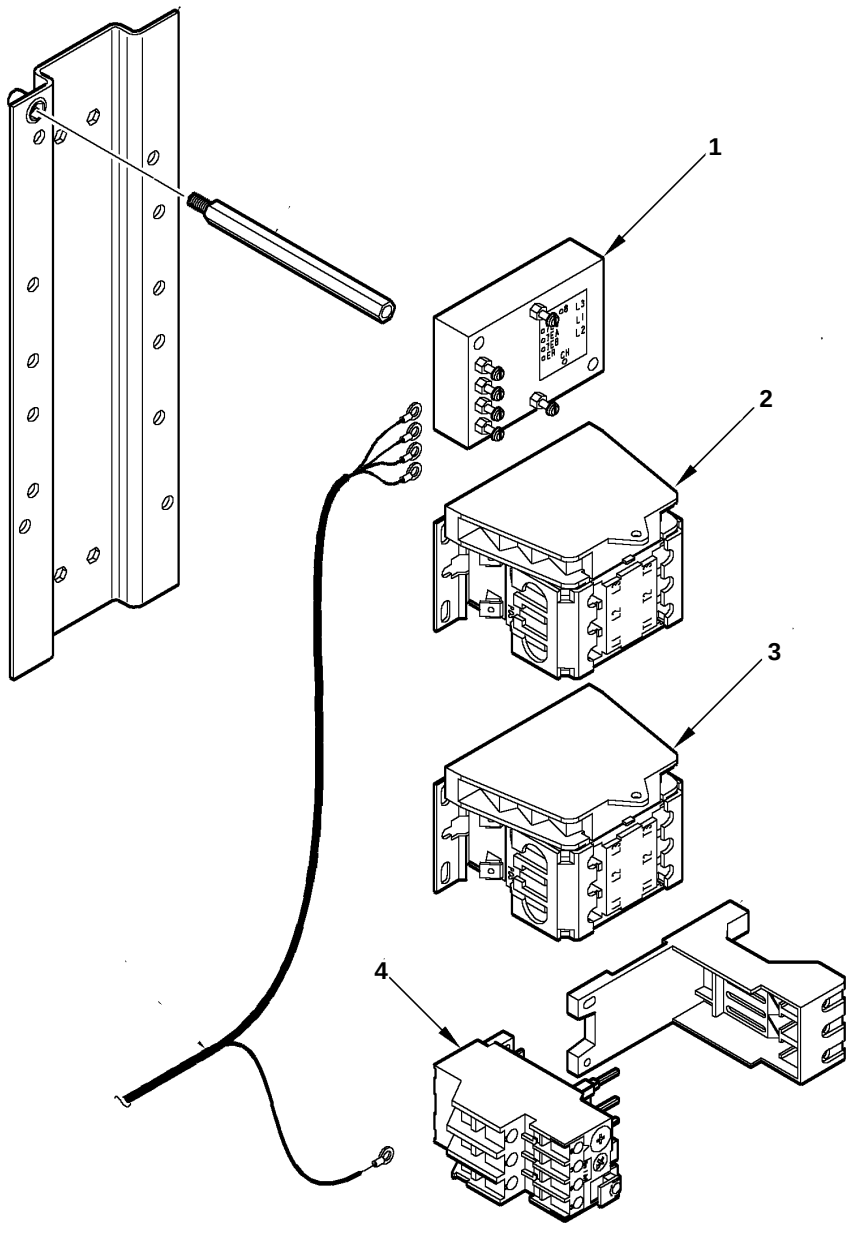


Figure 27: SPECTRUM™ TS Multi-Temp Option Board

The only user serviceable components on the “multi-temp option board” are the fuses and jumpers.

Fuse	Size	Function
F200	15A	2A Power Zone 2
F201	1A	Zone 2,3 Door Switch 2A Power
F202	15A	2A Power Zone 3

Figure 28: Multi-Temp Option Board Fuse Size and Function



1.	Phase Detect Module
2.	Motor Contactor
3.	Motor Contactor
4.	Overload Relay

Figure 29: High Voltage Contactors with Shield Removed

Serial Number Locations

Write the unit model and unit serial number in the spaces provided in the following chapter, “Emergency Cold Line.” This information is needed to service the unit.

Figure 30: Engine Serial Number Location

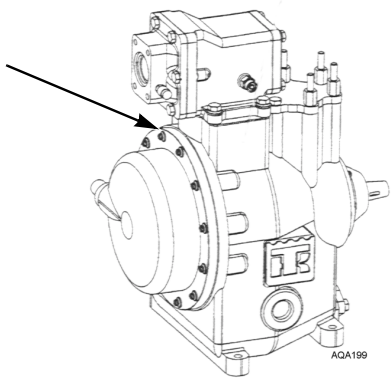
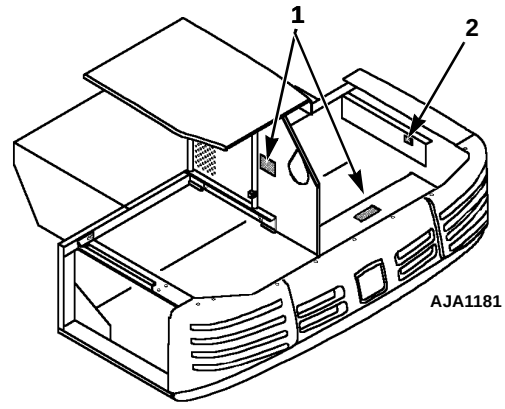


Figure 31: Compressor Serial Number Location

Serial Number and Refrigerant Label Locations



1.	Refrigerant Type
2.	Unit Serial Plate

Figure 32: Label Locations

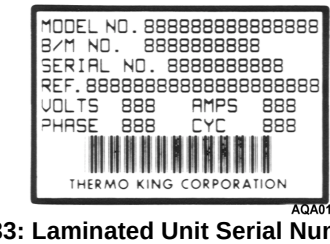


Figure 33: Laminated Unit Serial Number Plate

- Nameplate on inside of top right side of unit frame. See Figure 32 on page 53.

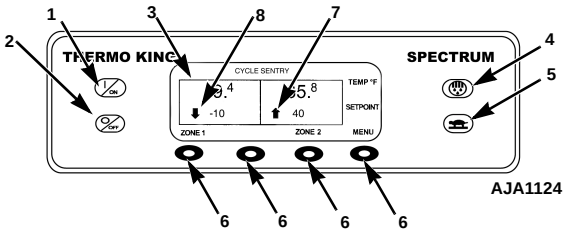
Figure 34: Refrigerant Type Label

This label identifies the type of refrigerant in the unit. See Figure 32 on page 53.

HMI Controller Overview

The HMI (Human Machine Interface) Control Panel is connected to the microprocessor and is used to operate the unit. It is located in the truck cab mounted in or under the dashboard.

The HMI control panel consists of a display and 8 touch sensitive keys. The display is capable of showing both text and graphics. The four keys on the left and right sides of the display are dedicated keys and the functions are described in detail later in this chapter. The four keys under the display are “soft” keys. The function of “soft” keys change depending on the operation being performed. If a soft key is active, the current key function will be shown in the display directly above the key.



1.	On Key (Dedicated Key)
2.	Off Key (Dedicated Key)
3.	Display
4.	Defrost Key (Dedicated Key)
5.	High Speed Lockout Key (Dedicated Key)
6.	Soft Keys
7.	Arrow Up- Zone is Heating
8.	Arrow Down - Zone is Cooling
9.	No Arrows - Zone is in Null

Figure 35: Dedicated and soft keys

Display

The display is used to supply unit information to the operator. This information includes setpoint and temperature for all installed zones, zone operating information, unit gauge readings, system temperatures and other information as selected by the operator.

The Standard Display of box temperature and setpoint for 2 zones is shown here. In the display shown here, Zone 1 has a setpoint of -10 F and a box temperature of -9.4 F. Zone 2 has a setpoint of 35 F and a box temperature of 35.8 F

Microprocessor Power Switch

The Microprocessor Power switch applies 12 Vdc power to the microprocessor. The switch must be in the “On” position to operate the microprocessor. It is located on the unit frame on the road side of the unit.

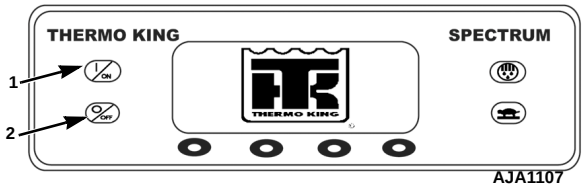
NOTE: When the Microprocessor Power Switch is turned to the Off position, power is still applied to the Interface Board and the HMI. To completely remove power from the control system, disconnect the unit battery.

Figure 36: Microprocessor Power Switch

Turning the Unit On and Off

The unit is turned on by pressing the **ON** key and off by pressing the **OFF** key. When the On key is pressed the display will briefly show THERMO KING as the display initializes.

Then the startup screen shown below appears while communications are established and the unit prepares for operation. See Figure 38 on page 56



1.	On Key
2.	Off Key

Figure 37: On/Off Key

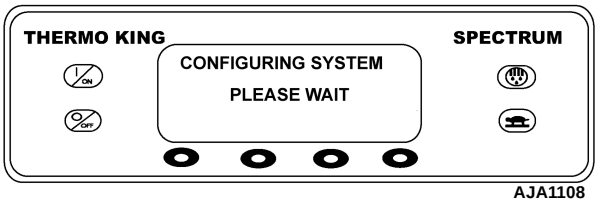


Figure 38: Startup Screen

When the unit is ready to run the Standard Display will appear. See Figure 39 on page 56.

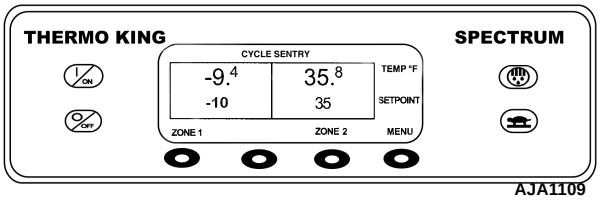


Figure 39: Standard Display

Pressing the OFF key stops unit operation. The unit will shutdown and the display will briefly show OFF and then the display will go blank.

The Standard Display

The Standard Display is the default display that appears if no other display function is selected. The Standard Display shows the box temperature and setpoint or OFF for all installed zones. The box temperature is that measured by the controlling sensor, usually the return air sensor. A two zone application is shown here. The temperature in Zone 1 is –9.4°F with a –10°F setpoint. The temperature in Zone 2 is 35.8°F with a 35°F setpoint. The top of the display shows that the unit is operating in CYCLE SENTRY mode. The two arrows indicate that both zones are cooling.

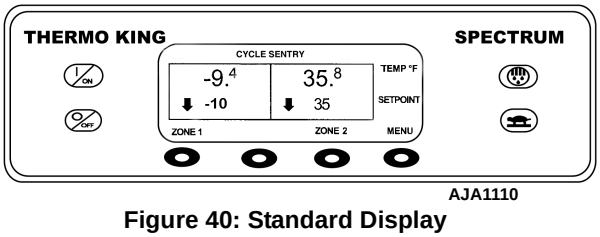
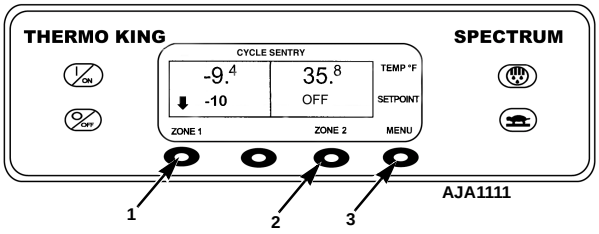


Figure 40: Standard Display

If OFF appears below the box temperature as shown below for Zone 2, then the zone has been turned off. If the setpoint appears the zone is turned on, as shown below for Zone 1.



1.	Zone 1 Soft Keys
2.	Zone 2 Soft Key
3.	Menu Soft Key

Figure 41: One Zone Off

The soft key labeled Zone 1 is used to select the Zone 1 Display, the Zone 2 soft key selects Zone 2 Display and the Menu soft key selects the Main Menu Display. The unlabeled soft key is not used from the Standard Display.

Selecting a Zone Display

To select a zone from the Standard Display, press the soft key for the desired zone. Zone 1 will be selected here.

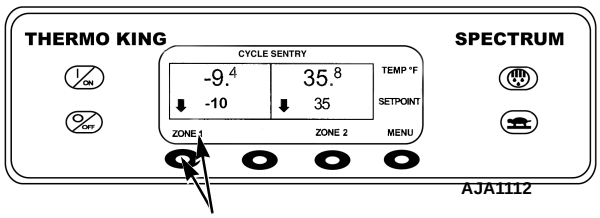
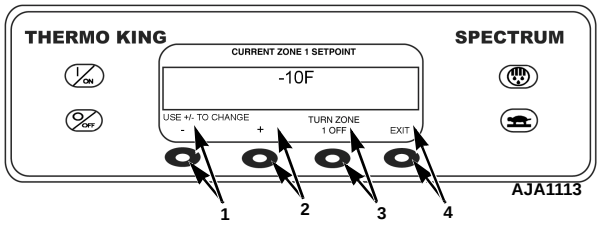


Figure 42: Standard Display

When a Zone soft key is pressed the Zone Display shown will appear. The zone display allows the operator to change the zone setpoint and turn the zone on and off. To return to the Standard Display press the soft key labeled EXIT. If no key is pressed the display will return to the Standard Display after 30 seconds.

The soft keys labeled "–" and "+" are used to change the setpoint. The Zone On/Off soft key identifies the zone being displayed and indicates if the zone is on or off. If the zone being shown by the Zone Display is currently turned on the third soft key will be labeled "TURN ZONE X OFF". If the zone is currently turned off the third soft key will be labeled "TURN ZONE X ON". Zone 1 is turned on in the illustration shown on the next page. Pressing the EXIT soft key returns the display to the Standard Display.



1.	"-" Soft Key
2.	"+" Soft Key
3.	Zone "X" Soft Key
4.	EXIT Soft Key

Figure 43: Selecting A Zone

Turning a Zone On and Off

At the Standard Display, press the soft key to show the Zone Display for the desired zone.

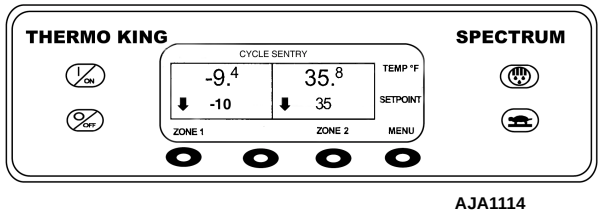


Figure 44: Standard Display

If the zone shown by the Zone Display is currently turned on the third soft key will be labeled "TURN ZONE X OFF", where X is the zone number. If the zone is currently turned off the third soft key will be labeled "TURN ZONE X ON". Zone 1 is shown on the display below, with the zone turned on.

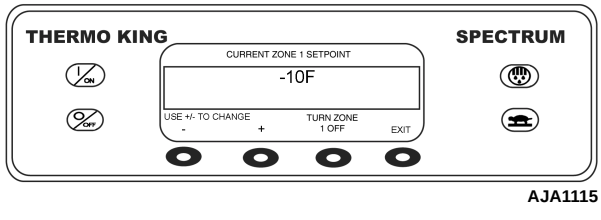


Figure 45: Zone 1 On

Pressing the "TURN ZONE 1 OFF" key will turn Zone 1 Off, and the soft key label will then read ZONE 1 ON as shown below. Pressing the key again will turn the zone back on.

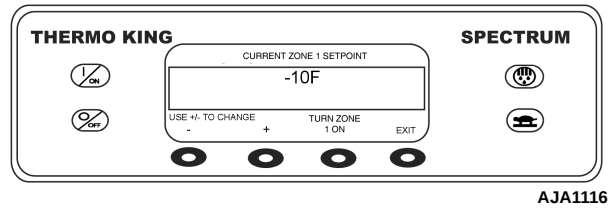


Figure 46: Zone 1 Off

When the zone is turned on or off, the display will briefly indicate that the change is being made as shown below.

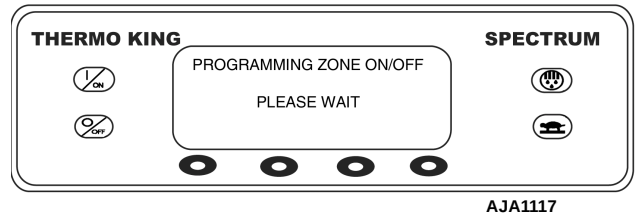


Figure 47: Programming Screen

The display will show the new setting for several seconds as shown below.

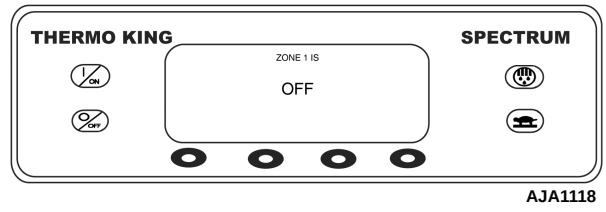


Figure 48: Displays New Setting

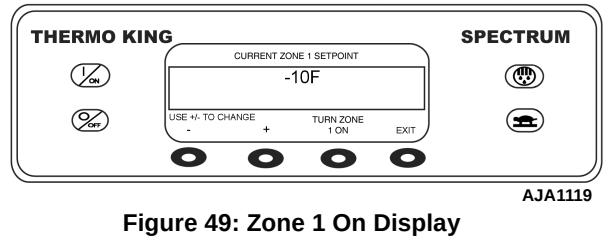


Figure 49: Zone 1 On Display

The display then returns to the Zone Display. Pressing the ZONE 1 ON key will turn the zone back on.

If no keys are pressed the display will return to the Standard Display after 30 seconds.

Changing the Setpoint

At the Standard Display, press the soft key to show the Zone Display for the desired zone. The display below shows the Zone 2 display with a setpoint of 35 F. The Zone is turned on as shown previously.

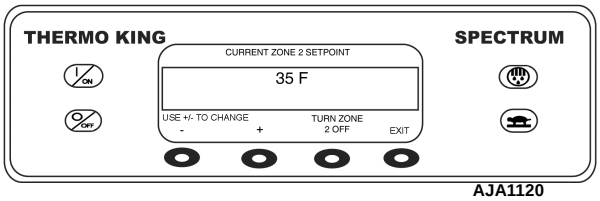
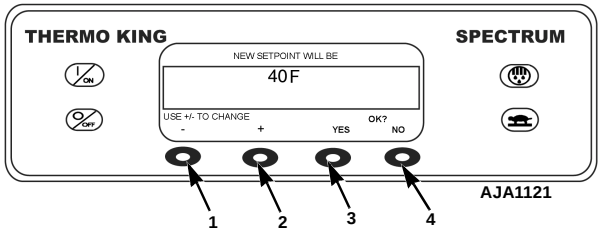


Figure 50: Zone 2 Display

Pressing the "-" and/or "+" soft keys changes the display to the Setpoint Display for the selected zone. The display title changes and the YES and NO soft keys appear as shown below. The "+" and "-" soft keys are used to increase or decrease the setpoint. Here the setpoint has been changed to 40 F using the "+" key.



1.	"-" Soft Key
2.	"+" Soft Key
3.	Yes Soft Key
4.	No Soft Key

Figure 51: New Setpoint Display

The YES and NO soft keys confirm the setpoint change. When the desired setpoint has been selected using the "+" and/or "-" keys, press the YES soft key to confirm and load the new setpoint. If the setpoint is changed using the "+" or "-" keys, the change must confirmed or rejected by pressing the YES or NO soft key within 10 seconds of changing the setpoint.

Failure to confirm the new setpoint by pressing Yes or No within 10 seconds of changing the setpoint will result in Alarm Code 127 (Setpoint not entered)

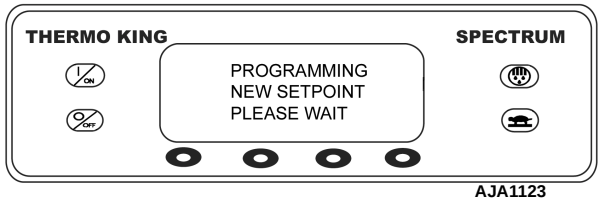


Figure 52: Programming New Setpoint Display

After the YES soft key has been pressed the display will briefly show PROGRAMMING NEW SETPOINT as shown above.

The display then confirms the new setpoint for several seconds as shown below.

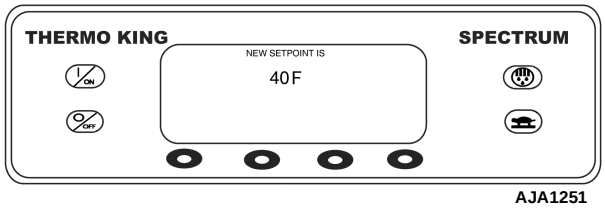


Figure 53: New Setpoint

The display then returns to the Standard Display showing the new setpoint.Notice that the Zone 2 arrow now points up to indicate the zone is heating.

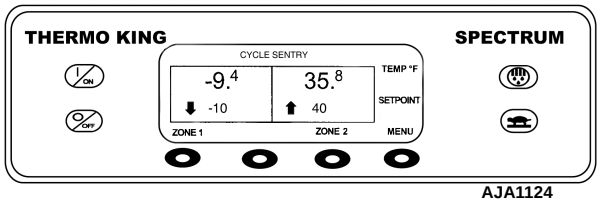
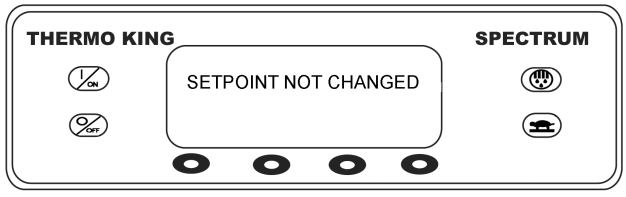


Figure 54: Standard Display With New Setpoint Displayed

IMPORTANT: If the setpoint is changed using the "+" or "-" keys, the change must be confirmed or rejected by pressing the YES or NO soft key within 10 seconds of changing the setpoint.

- If the YES key is pressed, the setpoint change made with the "+" or "-"keys will be accepted, the setpoint will be changed and the display will return to the Standard Display.
- If the NO key is pressed the setpoint change made with the "+" or "-" keys will not be accepted, the setpoint will not be changed and the display will return to the Setpoint Display.

- If the YES or NO key is not pressed within 10 seconds of making a change with the “+” or “-” keys, the setpoint will not be changed and the display will return to the Setpoint Display. The display will briefly show [SETPOINT NOT CHANGED] and **Alarm Code 127 Setpoint Not Entered** will be set to indicate that the setpoint change was started but not completed.



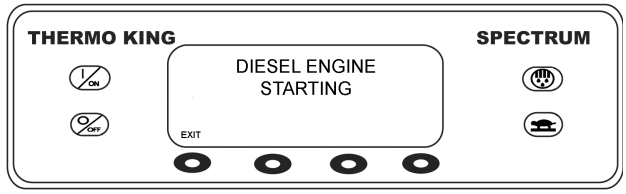
AJA1125

Figure 55: Setpoint Not Changed Display

Starting the Diesel Engine

Diesel engine preheats and starts are automatic in both Continuous Mode and Cycle Sentry Mode. The engine will preheat and start if necessary when the unit is turned on. The engine preheat and start will be delayed in Cycle Sentry mode if there is no current need for the engine to run. If any keys are being pressed on the HMI, the engine will preheat and start 10 seconds after the last key is pressed.

When the engine is preparing to start the HMI will display the engine start screen as shown below.



AJA1126

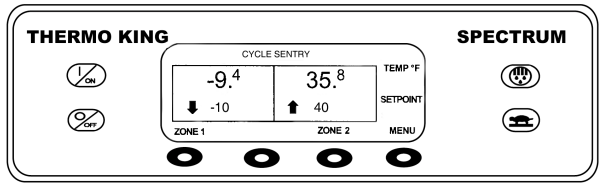
Figure 56: Diesel Engine Start Display

CAUTION: The engine may start automatically any time the unit is turned on.

WARNING: Never use starting fluid.

Initiating a Manual Defrost Cycle

Defrost cycles are usually initiated automatically based on time or demand. Manual defrost is also available. Manual defrost is available if the unit is running, the zone is turned on and the zone coil temperature is less than 45 F (7 C). Only one zone can be in defrost at a time. Other features such as economy mode or door switch settings may not allow manual defrost in some instances.

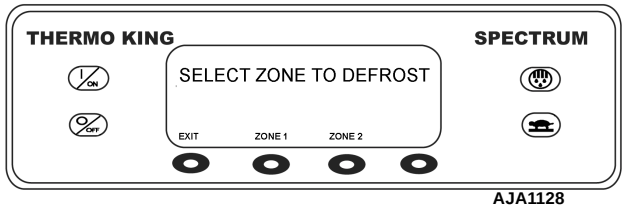


AJA1127

Figure 57: Standard Display

To initiate a manual defrost cycle, press the Defrost Key from the standard display. The display will prompt for the desired zone.

Press the soft key to select the zone to defrost as shown below. Pressing the indicated soft key will initiate a defrost cycle in Zone 1.

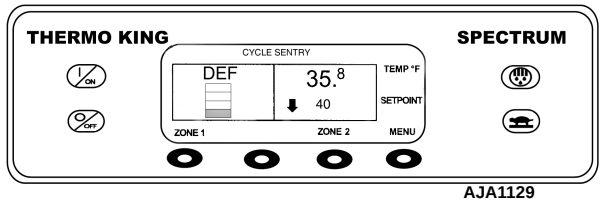


AJA1128

Figure 58: Select Zone To Defrost Display

The display will briefly show [PROGRAMMING DEFROST] and then briefly show [ZONE “X” DEFROST STARTED], where “X” is the number of the selected zone.

The display will then return to the Standard Display as shown below. The zone in defrost will show “DEF” instead of setpoint and a status bar to indicate time to complete defrost as shown below.



AJA1129

Figure 59: Zone 1 in Defrost

Terminating a Defrost Cycle

The defrost cycle will terminate automatically when the coil temperature is greater than 52 F (11 C) or the defrost timer expires. Defrost can also be terminated by turning the unit off and back on.

Selecting High Speed Lockout (if enabled)

If enabled, high speed operation can be locked out if required in noise sensitive areas.

NOTE: High Speed Lockout Enable must be programmed [YES] or this feature will not be available.

The High Speed Lockout key is a toggle. If high speed is enabled, then pressing the key will disable high speed operation. Pressing the key again will enable high speed operation.

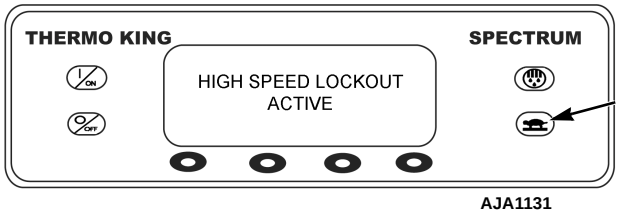


Figure 60: Programming Display

The display will then return to the Standard Display.

If High Speed Lockout is turned on, the message HIGH SPEED LOCKOUT ACTIVE will replace the CYCLE SENTRY/CONTINUOUS indication at the top of the display. Pressing the High Speed Lockout key again will turn this feature off.

The display will briefly show [PROGRAMMING HIGH SPEED LOCKOUT] and then [HIGH SPEED LOCKOUT ACTIVE] or [HIGH SPEED LOCKOUT INACTIVE] as shown below.

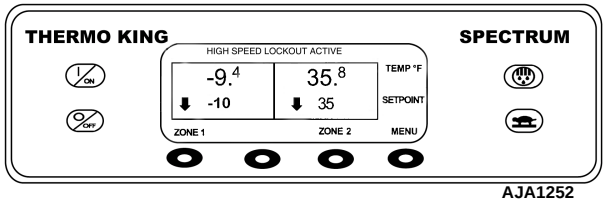


Figure 61: Standard Display with High Speed Lockout Active

Using the Operators Menu

The Operators Menu contains several additional menus that allow the operator to view information and modify unit operation. To access the Operators Menu press the MENU key.

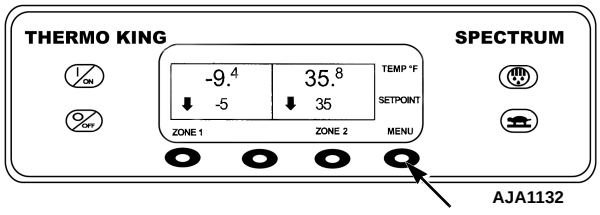
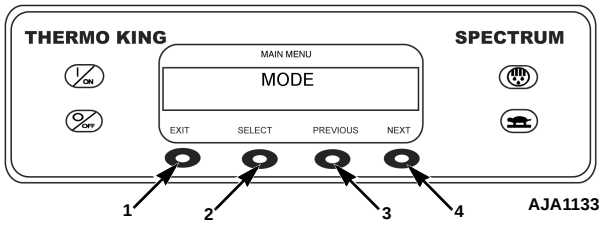


Figure 62: Menu Key

The first menu choice will appear. Press the NEXT and PREVIOUS keys to scroll thru the menu choices. When the desired choice is shown on the display, press the SELECT key to access it. The MODE Menu is shown here.



1.	Exit Key
2.	Select Key
3.	Previous Key
4.	Next Key

Figure 63: Mode Display

The Operators Menu choices are shown on the next page. For detailed information see the individual explanations of each menu item later in this section of the manual. To return to the Standard Display press the EXIT key.

Operators Menu Choices

Language Menu: If enabled, allows the operator to select a language from a list of 5 languages. All other subsequent displays are shown in the selected language. English is the default language. *See "Selecting a Language" on page 61.*

Alarm Menu: Shows any active alarms, and allows alarms to be cleared. *See "Displaying and Clearing Alarm Codes" on page 71.*

Mode Menu: Allows the operator to change the unit operating modes.

Cycle Sentry Mode: Allows the operator to change the unit to cycle sentry mode. See “Selecting Cycle Sentry or Continuous Mode” on page 62.

Continuous Mode: Allows the operator to change the unit to continuous mode. See “Selecting Cycle Sentry or Continuous Mode” on page 62.

Economy Mode: Allows the operator to change the unit to economy mode. See “Selecting Economy Mode” on page 63.

Sleep Mode: Allows the operator to change the unit to the sleep mode. See “Selecting Sleep Mode” on page 64.

Pretrip Menu: Allows the operator to select a Full Pretrip Test or Running Pretrip Test. *See “Performing a Pretrip Test” on page 66.*

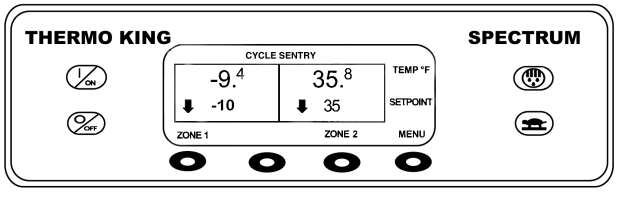
Display Intensity: Allows the operator to adjust the display intensity as required by conditions.

Selecting a Language

If the Language feature is enabled an alternate language can be selected from the Operators Menu. After a new language is chosen all displays will appear in that language. If the language feature is not enabled this menu does not appear.

Languages currently supported are English, German, Spanish, French and Italian. The default language is English. Only languages that have been enabled will appear on this menu.

To select an alternate language, press the MENU key.

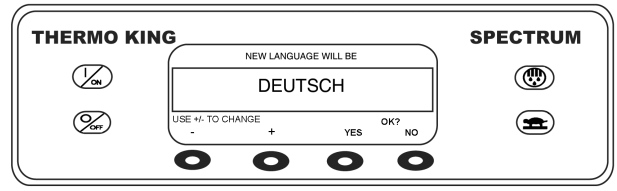


AJA1257

Figure 64: Standard Display

The Language Menu is the first menu item to appear as shown below. Press the SELECT key to choose the Language menu.

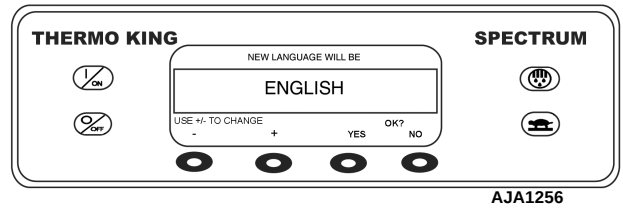
The Language menu will appear as shown below. Press the + or - keys to select the desired language.



AJA1255

Figure 65: New Language

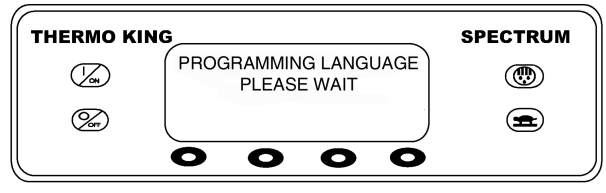
When the desired language is shown press the YES key to confirm the choice.



AJA1256

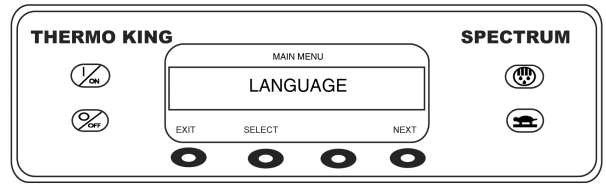
Figure 66: New Language

The display will briefly show PROGRAMMING LANGUAGE-PLEASE WAIT



AJA1258

Figure 67: Programming Please Wait



AJA1257

Figure 68: Language Menu

The display will then return to the language menu.

To select a different Main Menu item press the NEXT key. To return to the Standard Display press the EXIT key.

Selecting Cycle Sentry or Continuous Mode

When Cycle Sentry mode is selected the unit will start and stop automatically to maintain setpoint in all compartments, keep the engine warm and the battery charged. When Continuous Mode is selected, the unit will start automatically and run continuously to maintain setpoint and provide constant airflow.

Cycle Sentry and Continuous Mode are selected using the Mode Menu. From the Standard Display, press the MENU key.

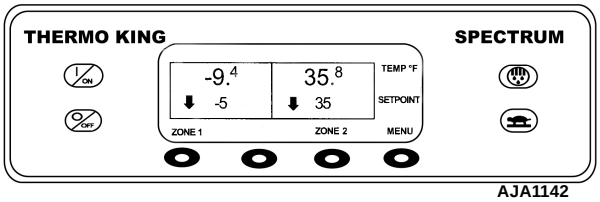


Figure 69: Standard Display

The Language Menu or Alarm Menu will appear. Press the NEXT key as required to show the Mode Menu. When the Mode Menu is shown press the SELECT key.

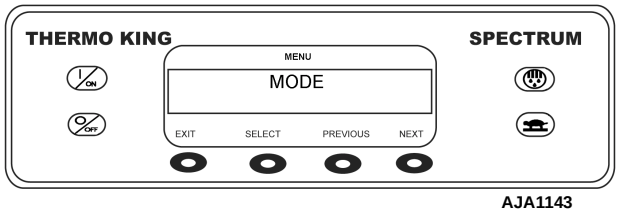


Figure 70: Mode Display

The current mode, either Cycle Sentry or Continuous, will be indicated by the display. In the display shown below, the unit is operating in Cycle Sentry mode and the option exists to switch to Continuous mode. In this example, pressing the Select key will switch the mode from Cycle Sentry to Continuous.

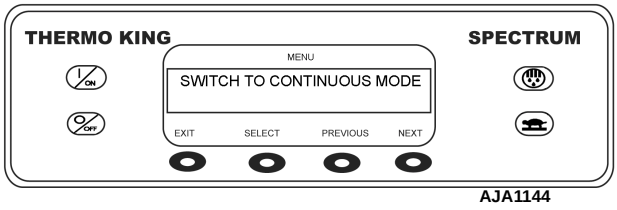


Figure 71: Switching Modes Display

Pressing the Select key will change the mode from Cycle Sentry to Continuous. The display will confirm the change as shown below.

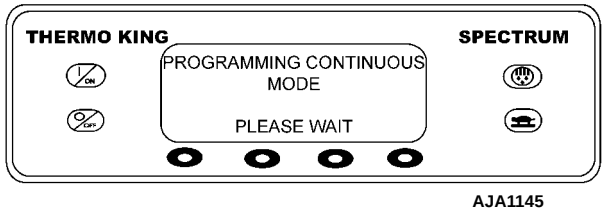


Figure 72: Programming Modes Display

The new mode is then confirmed for 10 seconds.

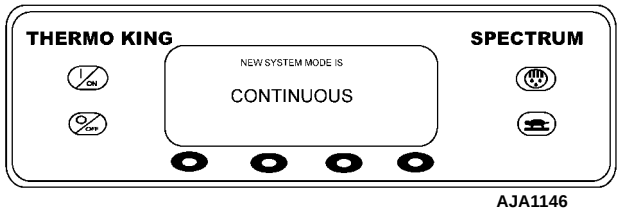


Figure 73: Continuous Mode Display

The display then returns to the Mode Menu. In the example here the unit is running in Continuous mode. Pressing the Select key again allows the operator to change back to Cycle Sentry mode operation.

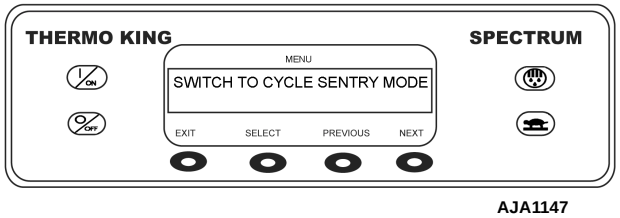


Figure 74: Cycle Sentry Mode Display

CAUTION: If the unit is in Cycle Sentry null and the mode is switched to Continuous Mode, the unit will start automatically

Selecting Economy Mode

Economy Mode is used on selected loads that do not require critical temperature control. The temperature control points are relaxed and other features are optimized for maximum fuel economy. This mode should be used as directed by individual company policy. Economy Mode can be turned on or off as required.

Economy Mode is turned On and Off using the Mode Menu. From the Standard Display, press the MENU key.

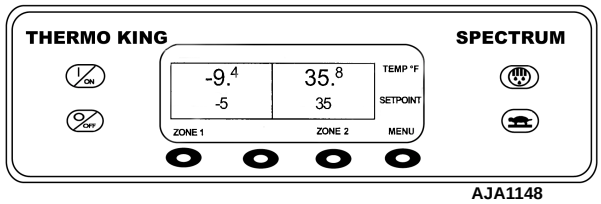


Figure 75: Standard Display

The Language Menu, then Alarm Menu appears. Press the NEXT key as required to show the Mode Menu. When the Mode Menu is shown press the SELECT key.

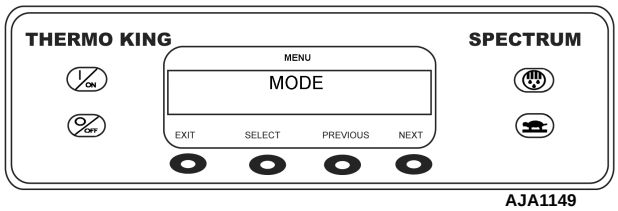
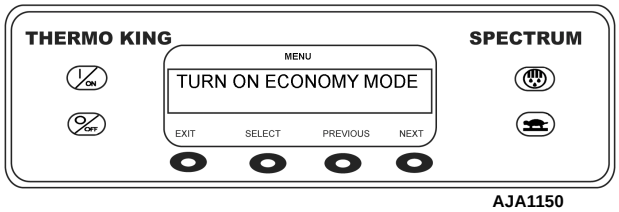


Figure 76: Mode Display

Press the Next key as required to display Economy Mode. The current state of Economy mode, either On or Off, will be indicated by the display. In the display shown below, Economy Mode is turned off and the option exists to turn Economy mode on. In this example, pressing the Select key will turn Economy Mode on.



Pressing the Select key will turn Economy Mode on. The display will confirm the change as shown below.

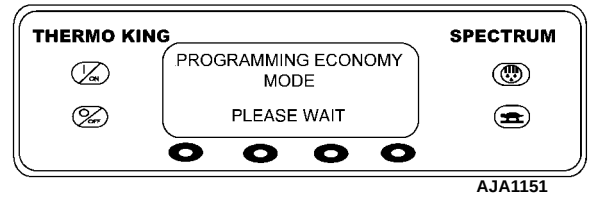


Figure 77: Programming Economy Mode Display

The new mode is then confirmed for 10 seconds.

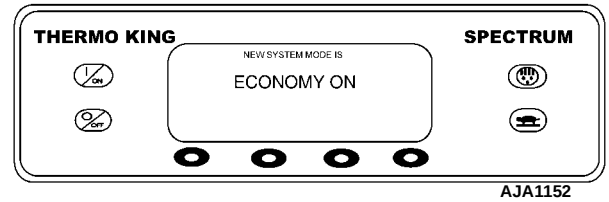


Figure 78: Programming Economy Mode Display

The display then returns to the Mode Menu. In the example here Economy Mode is turned on. Pressing the Select key again allows the operator to turn Economy Mode off.

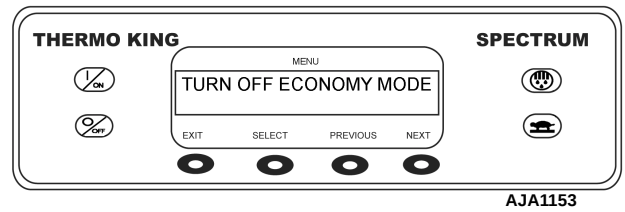


Figure 79: Economy Mode Display

Selecting Sleep Mode

CAUTION: The engine may start automatically any time the unit is turned on.

Normal Cycle Sentry mode starts and stops the unit as required to maintain the desired temperature in all zones, maintain the unit battery in a charged condition and keep the unit engine warm in cold ambient conditions. Sleep mode does not maintain zone temperatures – it only keeps the engine warm and the unit battery charged. This is useful in extremely cold weather or when the unit is to be out of service for an extended time.

Sleep mode operates in both Diesel mode and Electric mode. In Diesel mode the unit will start and stop as required to maintain engine temperature and battery charge. In Electric mode the unit starts and stops as necessary to maintain battery charge only.

When Sleep mode is entered, the operator can program an automatic Wake-up Time up to a week away. Using this feature, the unit will automatically restart and run normally at the determined time. If a Wake-up Time is programmed the operator can also program an automatic Pretrip Test when the unit restarts.

Sleep Mode is turned On and Off using the Mode Menu. From the Standard Display, press the MENU key.

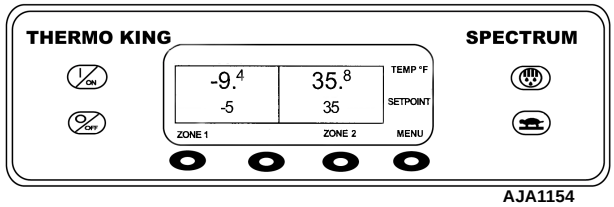


Figure 80: Standard Display

The Language Menu or Alarm Menu will appear. Press the NEXT key as required to show the Mode Menu. When the Mode Menu is shown press the SELECT key.

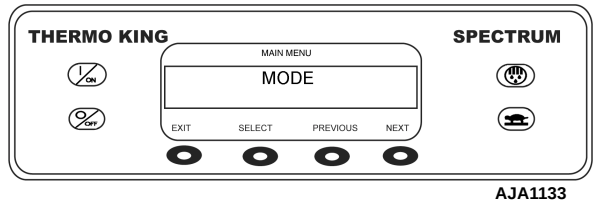


Figure 81: Mode Display

Press the Next key as required to display the Sleep Mode prompt.

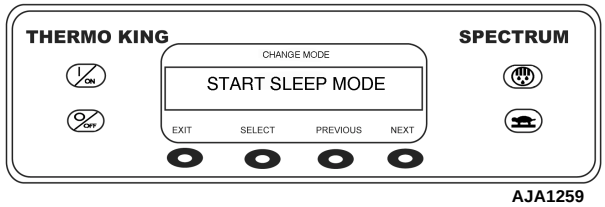


Figure 82: Start Sleep Mode

Press the Select key to choose the Sleep Mode menu.

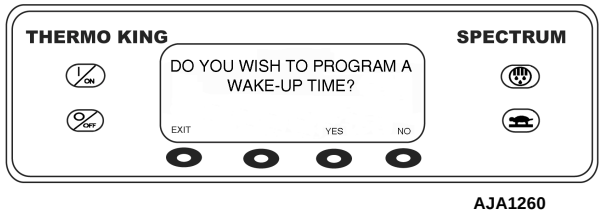


Figure 83: Program Wake-Up Time

The operator can now choose a Sleep Mode Wake-up Time or simply enter Sleep Mode immediately. If NO is pressed the unit will immediately enter Sleep Mode

The display will show SLEEP and the unit will start and stop as required to keep engine warm and/or the battery charged. Sleep mode does not maintain zone temperatures. To exit Sleep Mode press the EXIT key or turn the unit off and back on. The unit will resume normal operation and control to setpoint.

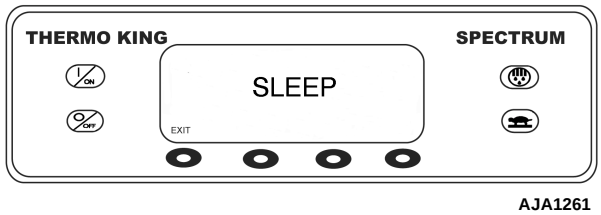


Figure 84: Sleep

To enter a Wake-up Time verify that the unit clock is set properly. Then press the YES key at the Sleep Mode menu.

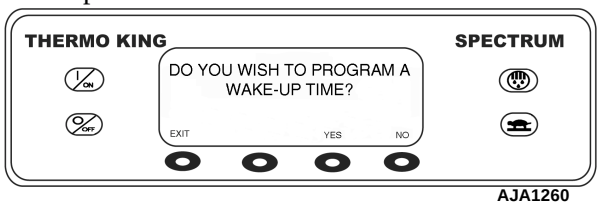


Figure 85: Program Wake-Up Time

The display will prompt the operator for the DAY the unit is to restart in normal operation. In this example Monday has been chosen. Press the YES key to confirm the DAY.

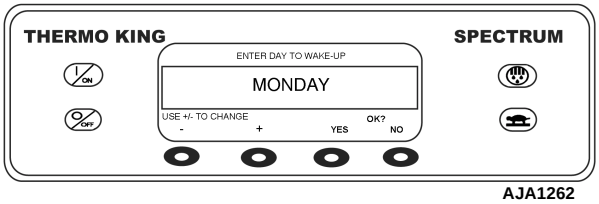
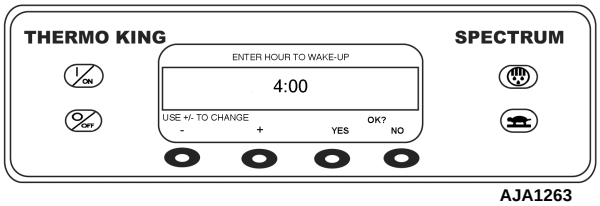


Figure 86: Select Day Screen

The display will now prompt the operator for the Hour the unit is to restart in normal operation. In this example 4:00 am has been chosen. Press the YES key to confirm the HOUR. Not that 24 hour “military time” is used.



The display will now prompt the operator for the MINUTE the unit is to restart in normal operation. In this example 4:30 am has been chosen. Press the YES key to confirm the MINUTE.

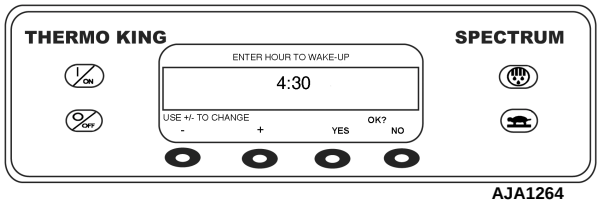


Figure 87: Select Time Screen

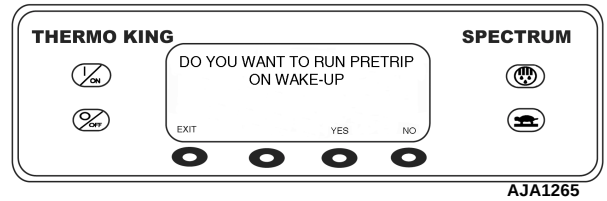


Figure 88: Run Pretrip On Wake-Up

The display will show SLEEP and the unit will start and stop as required to keep the engine warm and/or the battery charged. Sleep mode does not maintain zone temperatures.

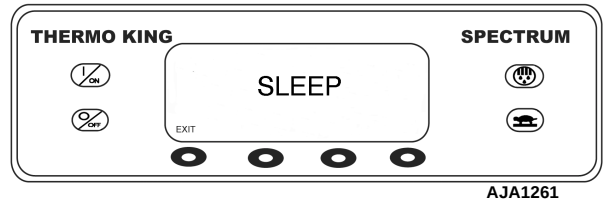


Figure 89: Sleep

The unit will restart at the programmed time (in this example 4:30 am) and perform a Pretrip Test (if selected). After the Pretrip Test is complete the test results will be displayed and the unit will resume normal operation and control to setpoint.

To exit Sleep Mode before the selected Wake-up time press the EXIT key or turn the unit off and back on. The unit will resume normal operation and control to setpoint.

Pretrip Tests

CAUTION: The engine may start automatically any time the unit is turned on.

A Pretrip Test verifies unit operation. This display allows a Pretrip Test to be selected and initiated by the operator. If the Pretrip Test is entered with the unit shut down a Full Pretrip Test with device amp checks will be performed. If the Pretrip Test is entered with the unit running in either diesel or electric mode a Partial Pretrip Test is performed. Test results are reported as PASS, CHECK or FAIL when the Pretrip Test is completed.

Pretrip Test Conditions:

- All zones are forced on.
- Pretrip Test can be run in either Diesel or Electric Mode.

- The unit will autoswitch from Diesel Mode to Electric Mode or from Electric Mode to Diesel Mode during a Pretrip Test if these features are enabled.

Pretrip Tests are not allowed if:

- Any alarms are present.
- The unit is in Sleep Mode.
- Unit is in Service Test Mode, Interface Board Test Mode or Evacuation Mode.

Pretrip Test Sequence:

Pretrip tests proceed in the order shown below. A Full Pretrip Test includes all tests. A Partial Pretrip Test is started with the engine or motor running and does not include the Amp Checks or Engine Start Check.

- Amp Checks – Each electrical control component is energized and the current drawn is confirmed as within specification.
- Engine Start – The Engine will start automatically.
- Zone 1 Defrost – If the Zone 1 coil temperature is below 45°F (7°C), a defrost is cycle is initiated.
- Zone 1 Cool Check – The ability of the unit to cool in low speed is checked.
- RPM Check – The engine RPM in high and low speed is checked during the Zone 1 Cool Check.
- Zone 1 Heat Check - The ability of the unit to heat in low speed is checked.
- Zone 2 Cool Check – The ability of the unit to cool in low speed is checked.
- Zone 2 Heat Check – The ability of the unit to heat in low speed is checked.
- Report Test Results – The test results are reported as PASS, CHECK or FAIL when the Pretrip Test is completed. If test results are CHECK or FAIL alarm codes will exist to direct the technician to the source of the problem.

Performing a Pretrip Test

CAUTION: The engine may start automatically any time the unit is turned on.

If a Pretrip Test is initiated with the engine shut down a Full Pretrip Test will be performed. If a Pretrip Test is initiated with the engine or motor running a Partial Pretrip Test is performed.

Before initiating a Pretrip Test, clear all alarm codes.

Pretrip Tests are initiated using the Pretrip Menu. From the Standard Display, press the MENU key.

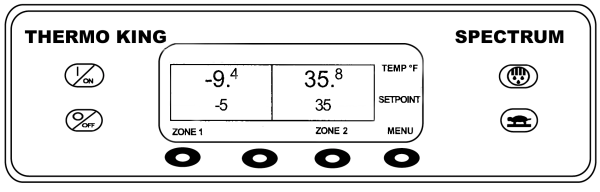


Figure 90: Standard Display

The Language Menu or Alarm Menu will appear. Press the NEXT key as required to show the Pretrip Menu. When the Pretrip Menu is shown press the SELECT key to start a Pretrip Test.

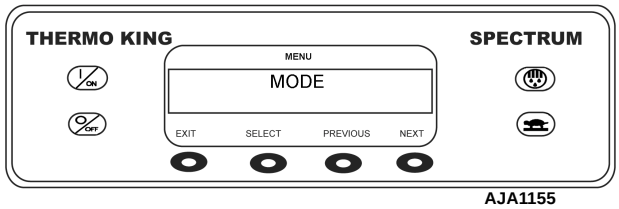


Figure 91: Mode

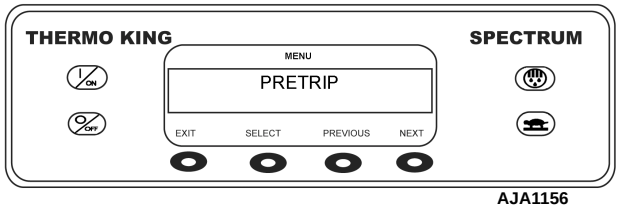


Figure 92: Pretrip Display

If the unit is not running a Full Pretrip Test will be initiated. If the unit is running in either diesel or electric mode a Running Pretrip will be performed.

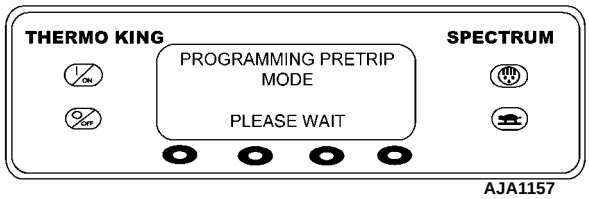


Figure 93: Programming Test Pretrip Display

The Pretrip Test display appears. The top line of the display indicates the unit is performing the non-running Pretrip Test. Test progress is measured by the number of tests completed out of a total of 26. In the example below the unit is performing Test 1 of 26, Sensor Check. The soft keys may be used during the Pretrip Test to select the Hourmeter, Gauge or Sensor menus.

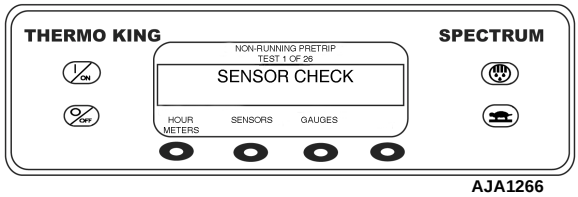


Figure 94: Selecting Menus

When all tests are complete, the results are reported as PASS, CHECK or FAIL. If the results are CHECK or FAIL, the accompanying alarm codes will direct the technician to the cause of the problem.

When the non-running test are complete the unit will start automatically and continue with the Running Pretrip Test. In the example shown below the unit is in the Running Pretrip and is performing Test 21 of 26, Zone 1 Cool test.

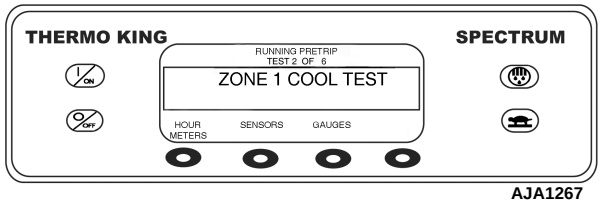


Figure 95: Zone 1 Cool Test

If the Pretrip Test results are CHECK or FAIL the problem should be diagnosed and corrected before the unit is released for service.

To stop a Pretrip Test at any time turn the unit off. This will generate Alarm Code 28 Pretrip Abort. Other alarm codes may also be generated. This is normal when the Pretrip test is halted before completion.

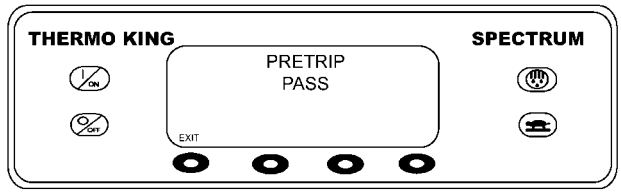


Figure 96: Pretrip Pass Display

Selecting Diesel or Electric Operation

The Diesel or Electric Display allows the operator to manually select diesel mode operation. The unit can also be programmed to automatically select electric mode operation when standby power is available and diesel mode operation if standby power fails or is removed. If the unit is programmed to switch automatically from diesel to electric and electric to diesel these screens do not appear.

Factory units are programmed to automatically switch to electric mode when standby power becomes available. The unit must be switched to diesel power manually as programmed from factory.

If the unit has standby power available and is turned on, the electric standby run screen will appear after the standard screen. The new mode is then confirmed for 10 seconds.

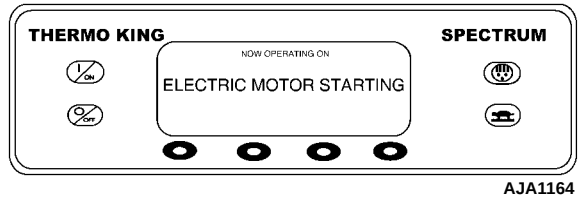


Figure 97: Electric Standby Display

IMPORTANT: If the unit was switched on or to electric and electric standby power is not available. the operator will receive a prompt to return to Diesel Mode operation. The prompt will appear as show below.

To switch back to Diesel mode press the YES key. Pressing the NO key will allow the unit to remain in Electric Standby mode even though standby power is not available.

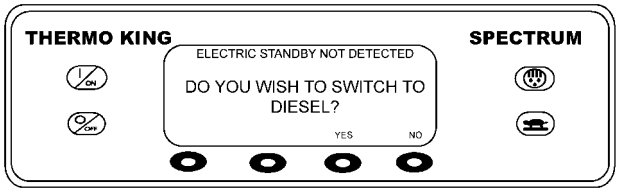


Figure 98: Switch To Diesel Display

Single Temperature Operation

If a single temperature is desired in both zones, turn both zones on and set the same setpoint in both zones. The compartment bulkheads may be installed or removed.

NOTE: It is recommended to leave bulkheads up to ensure proper system operation.

In the example shown below, a single temperature of 35°F (2°C) has been set for both zones.

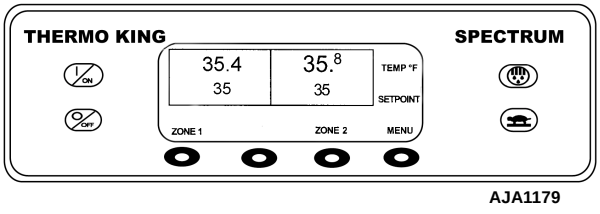


Figure 99: Single Temperature Operation Display

Display Brightness

The brightness of the HMI Control Panel display can be adjusted to allow for changing ambient light conditions. The choices available to the operator are HIGH, MEDIUM, LOW and OFF. OFF actually results in a very dim screen suitable for low light conditions.

Display brightness is adjusted using the Adjust Brightness Menu. From the Standard Display, press the MENU key.

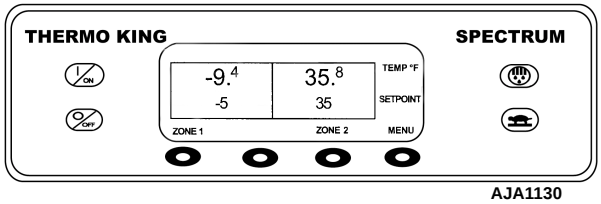


Figure 100: Standard Display

The Language Menu or Alarm Menu will appear. Press the NEXT key as required to show the Adjust Brightness Menu. When the Adjust Brightness Menu is shown press the SELECT key.

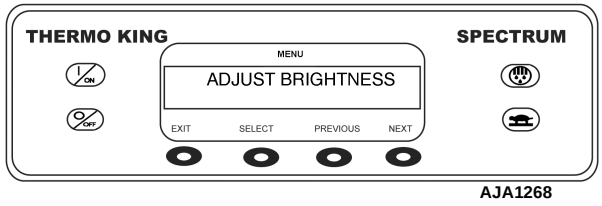


Figure 101: Adjust Brightness Display

The Display Brightness menu will appear as shown below. Press the + or - keys to select the desired display brightness. When the desired brightness is shown press the YES key to confirm the choice.

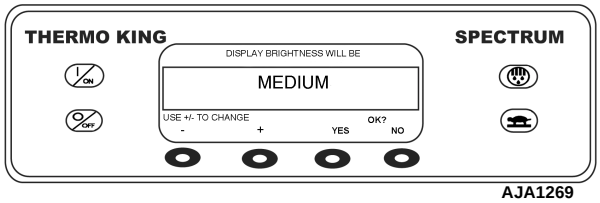


Figure 102: Medium Display

The display will briefly show ADJUSTING BRIGHTNESS-PLEASE WAIT.

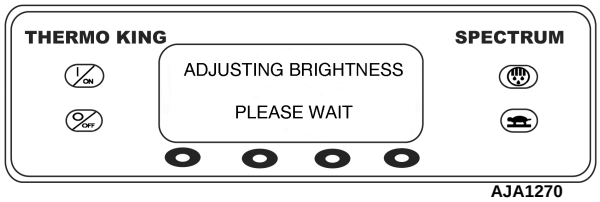


Figure 103: Adjusting Brightness Please Wait Display

Viewing Hourmeters

Hourmeters are displayed using the Hourmeter Display. From the Standard Display, press the MENU key.

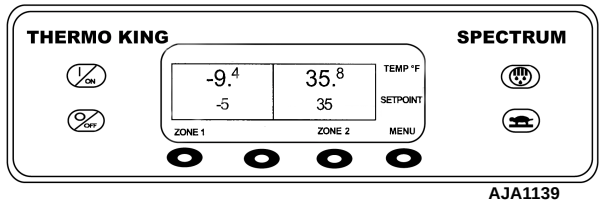


Figure 104: Standard Display

The Language Menu or Alarm Menu will appear. Press the NEXT key as required to show the Hourmeter Menu. When the Hourmeter Menu is shown press the SELECT key. The Hourmeter Display will appear.

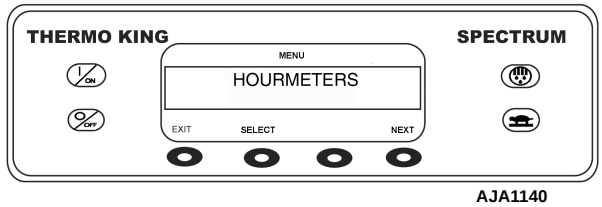


Figure 105: Hourmeters Menu Display

Press the NEXT or PREVIOUS key to scroll through the hourmeters.

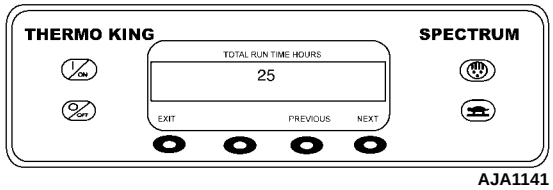


Figure 106: Hourmeter Display

Hourmeter names and definitions are shown below in the order they appear. To return to the Standard Display, press the EXIT key.

Hourmeter Names And Definitions	Hourmeter Name Definition
Total Hours	Total number of hours the unit has been turned on (protection hours).
Total Run Hours	Total number of hours the unit has run in both diesel and electric mode.
Engine Hours	Total number of hours the unit has run in diesel mode.
Electric House	Total number of hours the unit has run in electric mode.
Zone 1 Run Hours	Total number of hours that Zone 1 has run in both diesel and electric mode. Includes running null time.
Zone 2 Run Hours	Total number of hours that Zone 2 has run in both diesel and electric mode. Includes running null time.
Total Maintenance Hours 1	User Programmable - The number of hours before a Total Hours Maintenance Reminder 1 occurs.
Total Maintenance Hours 2	User Programmable - The number of hours before a Total Hours Maintenance Reminder 2 occurs.
Total Controller Hours	Total hours the controller and HMI control panel have been turned on.
Pretrip Reminder Hours	User Programmable - number of hours before a Pretrip Reminder occurs.
Engine Maintenance Hours 1	User Programmable - The number of hours before an Engine Hours Maintenance Reminder 1 occurs.
Engine Maintenance Hours 2	User Programmable - The number of hours before an Engine Hours Maintenance Reminder 2 occurs.
Electric Maintenance Hours 1	User Programmable - The number of hours before an Electric Hours Maintenance Reminder 1 occurs.
Electric Maintenance Hours 2	User Programmable - The number of hours before an Electric Hours Maintenance Reminder 2 occurs.

IMPORTANT: If a programmable hourmeter is not enabled and/or the view for that hourmeter is not turned on, it will not appear in the display sequence.

Viewing and Clearing Alarm Codes

Alarms may be one of four types as shown. If an alarm applies only to a specific zone, that zone will be displayed with the alarm code.

Log Alarms: are indicated at the top of the Standard Display for 30 seconds each time the unit is turned on. The alarm indication will go off after 30 seconds. The Alarm Display must be used to view the existing alarms. This level of alarm serves as a notice to take corrective action before a problem becomes severe. Maintenance items such as maintenance hourmeter time-outs are log alarms.

Check Alarms: are indicated at the top of the Standard Display with the statement [SERVICE REQUIRED WITHIN 24 HOURS]. The Alarm Display must be used to view the existing alarms. This level of alarm serves as a notice to take corrective action before a problem becomes severe. The unit will run with check alarms but some features and functions may be inhibited. If an alarm applies only to a specific zone, that zone will be displayed with the alarm code. On a multi-temp application if a zone specific problem is severe the zone will shut down but the alarm is set as a check alarm to allow the other zones to continue to run. If severe problems occur in all zones the unit will shut down.

Prevent Alarms:

are indicated at the top of the Standard Display with the statement [UNIT IN PREVENT MODE]. The Alarm Display must be used to view the existing alarms. The unit may wait a timed restart interval or until conditions allow and then restart. If the unit is in a restart interval Alarm Code 84 Restart Null will be present along with the Prevent Alarm. In other cases the unit may restart or run with reduced performance to determine if continued operation is possible. If the alarm does not reoccur with reduced performance the unit will then return to full performance. If the unit is operating with reduced performance Alarm Code 85 Forced Unit Operation will also be present. If the alarm condition reoccurs a set number of times the alarm is set as a shutdown alarm and no further restarts are possible. If an alarm applies only to a specific zone, that zone will be displayed with the alarm code.

Shutdown Alarms: replace the Standard Display with a flashing Alarm Display and the statement [UNIT NOT RUNNING – SERVIC REQUIRED]

. The flashing display shows the alarm that caused the shutdown. Shutdown alarms will force the unit into shutdown. The unit will remain in shutdown until the shutdown alarm is cleared. Exceptions are some engine and electric shutdown alarms that become log alarms when switched to the alternate operating mode (diesel to electric or electric to diesel).Special Considerations

Pretrip Alarm Codes: If an alarm occurs during a Pretrip Test the alarm code will be displayed as Pretrip Alarm XX, where XX is the alarm code.

Alarm Codes and switching modes from diesel to electric or electric to diesel:

If a shutdown alarm occurs that affects only diesel mode operation and the unit is switched to electric, the diesel mode shutdown alarm becomes an electric mode log alarm. This allows the unit to run in electric mode without clearing the shutdown alarm that is preventing diesel mode operation. If the unit is switched back to diesel mode, the alarm again become a diesel mode shutdown alarm and prevents unit operation. In the same manner, if a shutdown alarm occurs that affects only electric mode operation and the unit is switched to diesel, the electric mode shutdown alarm becomes a diesel mode log alarm to allow diesel mode operation. If the unit is switched back to electric mode, the alarm reverts to an electric mode shutdown alarm and prevents unit operation.

Displaying and Clearing Alarm Codes

Alarms are displayed and cleared using the Alarm Menu. From the Standard Display, press the MENU key.

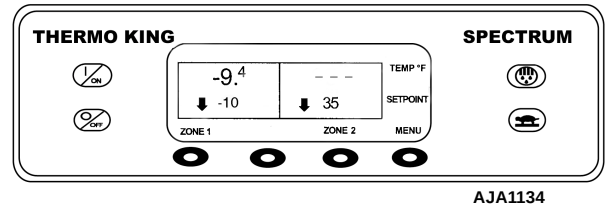


Figure 107: Standard Display

The Language Menu or Alarm Menu will appear. If the Language Menu appears press the NEXT key to show the Alarm Menu. When the Alarm Menu is shown press the SELECT key. The Alarm Display will appear.

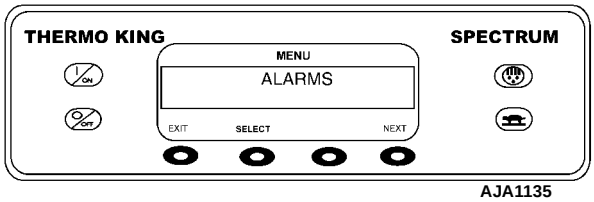


Figure 108: Alarms

If no alarms are present Alarm 00 is shown.

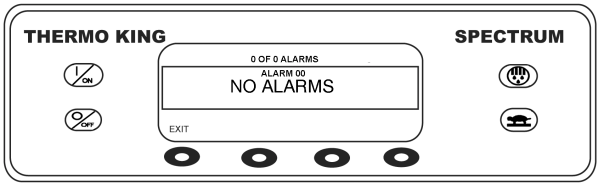


Figure 109: No Alarms Display

If alarms are present, the quantity of alarms (if more than one) and the most recent alarm code number will be shown. If the alarm pertains to a specific zone, that zone will be identified. In the example below, there are two alarms present. The most recent is Alarm Code 3 in Zone 2. It indicates a possible problem with the return air sensor.

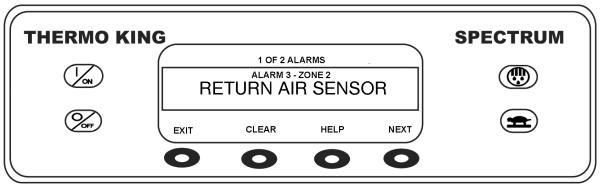


Figure 110: Alarms Present Display

If a serious alarm occurs, the unit will be shut down to prevent damage to the unit or the load. If this occurs, the display will show that the unit is shut down and display the alarm code that caused the shutdown. In the example below, the unit is shut down due to low oil level. For additional information regarding the alarm shown on the display press the HELP key.

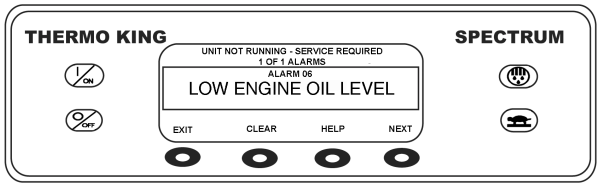


Figure 111: Serious Alarm Display

A help message will appear. For the alarm shown above, the message “CHECK OIL LEVEL. IF UNIT IS SHUTDOWN, REPAIR IMMEDIATELY. OTHERWISE, REPORT ALARM AT END OF THE DAY” will be shown on the display.

After Start Inspection

After the unit is running, the following items can be quickly checked in the Gauges Menu to confirm that the unit is running properly. Refer to the 51652 SPECTRUM™ TS Diagnostic Manual for detailed instructions.

Oil Pressure: Check the engine oil pressure in high speed by pressing the **SELECT** key to [OIL PRESS]. The oil pressure should be ok or low.

When first starting a cold engine, the oil pressure may be higher.

Compressor Oil: The compressor oil level should be visible in the sight glass.

Refrigerant: Check the refrigerant charge. See “Refrigerant Charge” in the Refrigeration Maintenance chapter of this manual.

Pre-Cooling: Make sure that the setpoint is at the desired temperature and allow the unit to run for a minimum of 1/2 hour (longer if possible) before loading the trailer.

This provides a good test of the refrigeration system while removing residual heat and the moisture from the trailer interior to prepare it for a refrigerated load.

Defrost: When the unit has finished pre-cooling the trailer interior, manually initiate a Defrost cycle. This will remove the frost that builds up while running the unit to pre-cool the trailer.

To manually initiate a Defrost cycle, press the **MANUAL DEFROST** key. See the Operation Manual for detailed information about Manual Defrost.

The Defrost cycle should end automatically.

NOTE: The unit will not defrost unless the evaporator coil temperature is below 42 F (7 C).

Loading Procedure

1. Make sure the unit is Off before opening the doors to minimize frost accumulation on the evaporator coil and heat gain in the truck. (Unit may be running when loading the truck).
2. Spot check and record load temperature while loading. Especially note any off-temperature product.
3. Load the product so that there is adequate space for air circulation completely around the load. *Do not* block the evaporator inlet or outlet.
4. Products should be pre-cooled before loading. Thermo King units are designed to maintain loads at the temperature at which they were loaded. Transport refrigeration units are not designed to pull hot loads down to temperature.

Post Load Procedure

1. Make sure all the doors are closed and locked.
2. Start the unit if it was shut off to load (see “Restarting Unit”).
3. Make sure the setpoint is at the desired setting.
4. One-half hour after loading, defrost the unit by momentarily pressing the Manual Defrost switch. If the evaporator coil sensor temperature is below 42 F (7 C), the unit will defrost. The microprocessor will terminate defrost automatically when the evaporator coil temperature reaches 52 F (14 C) or the unit has been in the Defrost mode for 30 to 45 minutes (depending on setting).

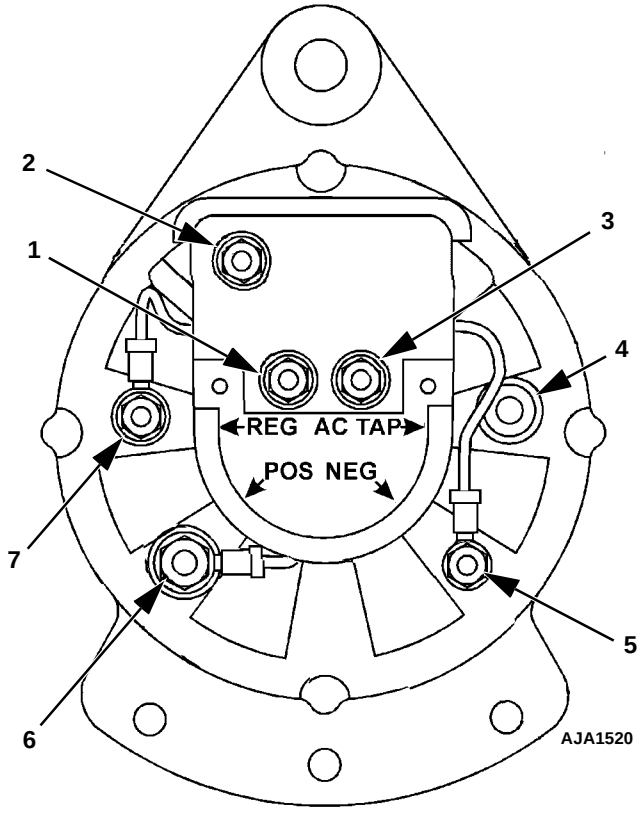
Post Trip Checks

1. Wash the unit.
2. Check for leaks.
3. Check for loose or missing hardware.
4. Check for physical damage to the unit.

Alternator (Prestolite) Charging System Diagnostic Procedures

NOTE: Units manufactured with CYCLE-SENTRY and alternators with integral regulators MUST use replacement alternators with integral regulators.

CAUTION: Full-fielding alternators with the integral regulator is accomplished by installing a jumper from terminal F2 to ground. Attempting to full-field the alternator by applying battery voltage to terminal F2 will cause voltage regulator failure.



1.	EXC Terminal	5.	NEG—B- Terminal
2.	F2 Terminal	6.	POS—B+ Terminal
3.	VOLT SENSE Terminal	7.	REG—D+ Terminal
4.	AC TAP Terminal		

Figure 112: Prestolite Terminal Locations

Complete the following checkout procedure before replacing the voltage regulator or the alternator.

- When testing alternators use accurate equipment such as a digital multimeter and an amp clamp or an equivalent. See the Tool Catalog.
- Make sure the drive belts and pulleys of the charging system are in good condition and are adjusted properly before testing the alternator. Worn belts and pulleys or loose belts will lower the output of the alternator.
- The battery must be well charged, the battery cable connections must be clean and tight, and the 2A and excitation circuits must be connected properly.

NOTE: All voltage readings should be taken between the negative battery terminal, or a good chassis ground, and the terminals indicated, unless stated otherwise.

1. Press the **OFF** key to make sure the unit is turned Off.
2. Check the battery voltage. If the battery voltage is less than 12 volts, the battery must be charged or tested to determine if it should be replaced.
3. Check the voltage at the B+ terminal on the alternator. Battery voltage must be present. If not, check the 2A circuit.
4. Check the voltage at the VOLT SENSE terminal on the alternator. Battery voltage must be present. If not, check the SENS circuit.
5. Use the Service Test mode to place the unit in high speed cool before the engine starts. See the SPECTRUM™ TS Diagnosis Manual for information about the Service Test mode.
6. Check the voltage at the EXC terminal on the alternator. Battery voltage must be present. If not, check the EXC circuit.
7. Use gauge screen in the maintenance menu to check amp draw on 2A wire connected to B+ terminal.
8. Use gauge screen in the maintenance menu to check voltage at B+ terminal.
9. Connect a jumper wire between the F2 terminal and a chassis ground. This will full field the alternator.

CAUTION: Never apply battery voltage to terminal F2 or voltage regulator failure will occur.

   a. Full alternator output (the alternators rated output) indicates the alternator is good but the voltage regulator needs replacement.

   b. If there is *low* or *no* output, the alternator is probably faulty. However, the following items are potential causes for not charging:

      - Check the alternator brushes.
      - Check the 2A circuit from the alternator to the battery.
      - Properly tension the alternator belt.
      - Check battery cable connections and the alternator ground. They must be clean and tight.
      - The battery must be in good condition and must accept a charge.
      - Check for excessive or unusual amperage draw by the unit control circuits.

Excessive Voltage Output

12 Volt Alternators With Internal Regular Setting:

When a Thermo King unit is installed on a truck, it is often connected to a truck battery. When both the Thermo King unit and the truck engine are running on the truck battery, the charging system with the higher voltage may automatically turn off the charging system with the lower voltage output.

If it is determined that the Thermo King regulator setting is higher than the truck charging system or the batteries are consuming more water than normal the following solution may help solve the problem.

- Remove the wire labeled SENSE and tape off.
- Add a jumper wire from 2A to the SENSE terminal on the back of the alternator.

This should reduce the voltage to the battery by 0.2 to 0.3 of a volt.

Battery

NOTE: The Microprocessor Power switch must be placed in the Off position before connecting or disconnecting the battery terminals. The Microprocessor Power switch is located on the control box side of the unit.

Inspect/clean the battery terminals and check the electrolyte level during scheduled maintenance inspections. A dead or low battery can be the cause of an ammeter indicating discharge due to lack of initial excitation of the alternator even after the unit has been boosted for starting. The

minimum specific gravity should be 1.235. Add distilled water as necessary to maintain the proper water level.

Unit Wiring

Inspect the unit wiring and the wire harnesses during scheduled maintenance inspections for loose, chafed or broken wires to protect against unit malfunctions due to open or short circuits.

Electrical Contacts

Inspect all relay contacts for pitting or corrosion every 1,000 operating hours, and repair or replace as necessary.

Charging System (12 Vdc)

Immediately after start-up, the voltmeter may show a low voltage condition on systems with brush type alternators. This is due to a light film build-up on the alternator slip rings. The film build-up occurs primarily on units that have been sitting unused for long periods of time. The film should disappear after a minute or two, and the voltmeter should show a high voltage that will continue until the battery voltage is brought back up to normal. If the voltmeter shows low voltage after start-up, check the alternator belt tension and all charging circuit connections including the battery.

NOTE: On installations where the unit is connected to the truck battery and both units are running—it is normal for the unit to indicate a discharge condition while the truck engine is running because of the truck's higher voltage charge rate.

Preheat Buzzer

The preheat buzzer module on the circuit board is designed to indicate preheat is in operation.

RPM Sensor

The RPM sensor is in the engine bell housing adjacent to, but not touching, the flywheel (backed off 1/2 turn).

The RPM sensor is a device containing an inductance coil and magnet. When the magnetic field is distorted by the passing ring gear teeth, the inductance coil generates an ac electrical signal that has a voltage and frequency variation proportional to the engine RPM.

By monitoring the frequency of this signal with the microprocessor, the timing of the starter disengagement can be precisely controlled.

If the RPM sensor fails, the starter may not disengage or engage properly and a fault code will be generated to the microprocessor.

Testing the RPM Sensor:

The following equipment is required:

- AC voltmeter capable of reading up to 10 volts
- Ohmmeter

The flywheel (RPM) sensor may be checked as follows:

1. Install the flywheel (RPM) sensor into the flywheel; bracket of the start-stop unit until it contacts the ring gear. Back out the sensor 1/2 turn and tighten the locknut.

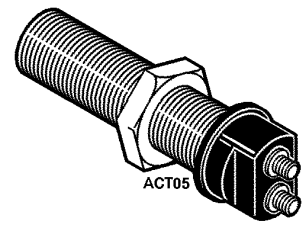


Figure 113: Flywheel (RPM) Sensor

2. Disconnect wires RPM+ and RPM- from the sensor.

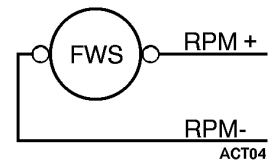


Figure 114: RPM+ and RPM- Wires

3. Place the unit in Continuous Run. Run the unit on low speed and high speed. Check the AC voltage output across the sensor terminals. Use a meter with a high ohms per volt internal resistance. A Simpson 260, Fluke digital or

any good VOM will work. However, an automotive type meter may not give an accurate reading because the meter may load the circuit heavily and cause the voltage level to appear lower than it actually is.

a. The output voltage should be 1.0 to 2.0 Vac on low speed.

b. The output voltage should be 2.0 to 2.5 Vac on high speed.

NOTE: If the voltage is slightly off, the voltage may be increased by turning the sensor in more, and the voltage may be lowered by turning the sensor out more.

4. Reconnect RPM+ and RPM- wires on RPM sensor.

If the RPM sensor passes the above test, the sensor may be considered good.

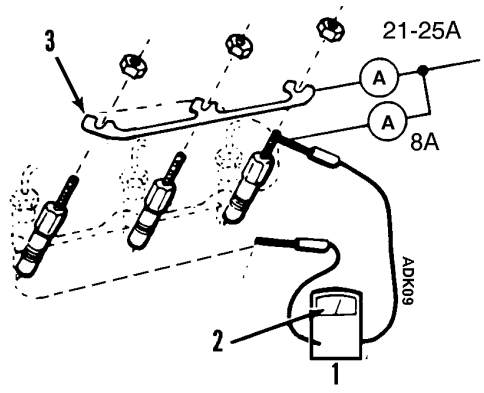
If the unit is not available, an alternate less reliable test may be performed as follows:

Disconnect the sensor from all wires, and measure the resistance across the terminals and from each terminal to the aluminum case. The resistance should be 250 to 300 ohms across the terminals, and there should be no continuity from each terminal to the case.

Glow Plugs

Glow plugs heat the combustion chamber to aid in quick starting. The glow plugs are energized when the microprocessor initiates unit start-up. A defective glow plug (burned out) can be detected by placing an external ammeter in series with the plugs. Normal current draw is approximately 21 to 25 amps when preheating. A current draw of 21 to 25 amps means all three glow plugs are working. If the current draw is less than 21 amps on Preheat, at least one glow plug is bad.

To isolate an open circuit glow plug, remove the jumper bar and test each glow plug individually with an ohmmeter or a jumper wire and ammeter. Each glow plug should have a resistance of approximately 1.5 ohms or a current draw of about 8 amps.



1.	Ohmmeter
2.	1.5 Ohms
3.	Remove Bar

Figure 115: Glow Plug Test

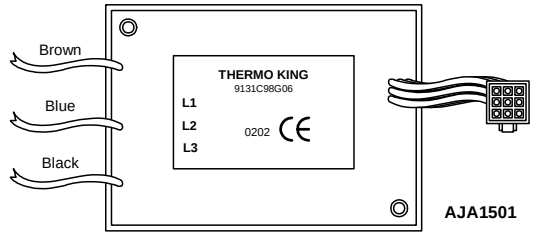
With an external ammeter connected in series, a shorted glow plug will show excessive current flow (more than 12 amps) when the Preheat is initiated. When fuse F6 is blown, check each plug.

Condenser Fan Rotation (Electric Standby Operation)

The condenser fan is belt driven. On electric standby operation, check for correct fan rotation by placing a small cloth or sheet of paper against the condenser fan grille on the front of the unit. Correct rotation will hold the cloth or paper against the grille. Improper rotation will blow the cloth or paper away from the grille. To correct check motor and motor contactor wiring as per wiring diagram.

Phase Detect Module for Truck Unit Model 50 Applications

The new phase detect module is designed to monitor both single and 3 phase voltages from 160 volts AC thru 510 volts AC.



Operation

The Phase Detection Module will detect missing phases, phase rotation and low voltage on three phase or single phase power. The brown, blue and black wires are used to sample the power at L1, L2 and L3 respectively. Operating power from 12 to 24 volts is supplied to the module via the #8 wire and CH wire.

When the voltage sensed rises above 180 volts AC and all three phases are present the module ER wire will output 12-24 volts DC after the conditions exist for 2 to 4 seconds. This signal informs the microprocessor that electric standby operation is possible. If the voltage drops below 160 volts AC or a phase is lost, the ER output is turned off after the condition exists for 8 to 10 seconds. The module continues to monitor the power and the module ER wire will again output 12-24 volts DC within 2 to 4 seconds after the voltage rises above 180 volts AC and all three phases are present.

If phase rotation is L1, L2, L3 the 7EB wire will output the 7EA voltage to energize the appropriate phase rotation contactor. If phase rotation is L1, L3, L2 the 7EC wire will output the 7EA voltage to energize the appropriate phase rotation contactor. The 7EB and 7EC wires are interlocked to prevent both phase contactors from being energized at once.

If the unit printed circuit board jumper J500 is set to single phase or the SP input is grounded, the module will now be set for single-phase operation. In this case only the Brown and Blue wires are used and the Black wire is taped off.

Connections to the module are shown in the tables below.

Power Connections

Input	Description
8	Nominal 12-24 volt DC power to the phase detect module.
CH	Chassis ground

Inputs

Input	Description
L1	This brown wire supplies standby power L1 to the phase detect module.
L2	This blue wire supplies standby power L2 to the phase detect module.
L3	This black wire supplies standby power L3 to the phase detect module.
7EA	If grounded, then outputs 7EB and 7EC are grounding circuits. If 12-24 volts DC is supplied, then outputs 7EB and 7EC will be at 12-24 volts DC
SP	If this wire is connected to chassis ground the module will operate in single-phase mode.
SP-GRND	This is an internal ground for the module. If SP-GRND is jumpered to SP then the module will be set to operate on single phase.

Outputs

Output	Description
7EB	If phase rotation is L1, L2, L3 then this wire will provide either a chassis ground or 12-24 volts DC to energize the appropriate phase rotation contactor. The 7EC wire is interlocked to prevent both phase contactors from being energized at once.

Outputs

Output	Description
7EC	If phase rotation is L1, L3, L2 then this wire will provide either a chassis ground or 12-24 volts DC to energize the appropriate phase rotation contactor. The 7EB wire is interlocked to prevent both phase contactors from being energized at once.
ER	This wire will output 12-24 volts DC 2 to 4 seconds after the voltage rises above 180 volts AC and all three phases are present. If the voltage drops below 160 volts AC or a phase is lost and the condition remains for 8 to 10 seconds, the output is turned off. The module continues to monitor and will again output 12-24 volts DC 2 to 4 seconds after the power returns to normal (voltage rises above 180 volts AC and all three phases are present).

Connector Pinout

Pin	Wire	Description
1	8	Power to Module
2	CH	Chassis ground
3	ER	AC Power OK
4	7EA	Power or ground input for 7EB or 7EC output
5	7EB	Phase A-B-C
6	7EC	Phase A-C-B
7	SP-GRND	Internal ground to enable a jumper circuit for SP logic
8	SP	Grounded for single phase mode
9	Unused	

Removal and Replacement

Procedure

1. Turn unit off.
2. Disconnect the unit battery.
3. Disconnect the standby power.
4. Remove the high voltage cover.
5. Disconnect the three wires from the phase detect module at the motor contactor.
6. Unplug the phase detect module harness.
7. Remove the old phase detect module.
8. Install the new phase detect module.
9. (3 Phase Applications) Connect the new phase detect module wires to the upper contactor as follows:

   Connect the brown wire to L1 on the contactor.

   Connect the blue wire to L2 on the contactor.

   Connect the black wire to L3 on the contactor.

   Use crimp-on terminals as required.
10. (Single Phase Applications) Connect the new phase detect module wires to the upper contactor as follows:

    Connect the brown wire to L1 on the contactor.

    Connect the blue wire to L2 on the contactor.

    Use crimp-on terminals as required.

    Tape the black wire back onto itself. It is not used on single-phase installations.
11. Connect the plug on the short harness from the phase detect module.
12. Install the high voltage cover.
13. Secure wires and wire harnesses as required using cable ties.
14. Connect the unit battery.
15. Perform a Unit Self Check test to verify proper operation.

Diagnostics - Truck SPECTRUM™ TS Applications

1. Plug the standby power cord into a know good power supply and turn the unit on.
2. Using a Fluke Meter, test the L1, L2, and L3 circuits at the input to the terminals where the Brown, Blue and Black wires are connected. The voltage should be between 200-500 VAC between the circuits. If not, repair as necessary to supply the needed voltage to the unit.
3. Check the 8 circuit to the Phase Detect Module for 12-24 VDC. If voltage is not present, check the Phase Select Module connector and the Interface Board connector for secure connections.
4. If correct AC power is present in test #2 above, then the ER output should measure 12-24 VDC. If no voltage is present, replace the Phase Detector Module.
5. If voltage is present no the ER output, then the D/E LED on the Interface Board should be on. If not, check the Diesel/Electric Relay circuit on the Interface Board.
6. If voltage is measured on the ER output, and the D/E LED is on, then the 7EA input should measure 12-24 VDC. If voltage is not present, check the Phase Select Module connector and the Interface Board connector for secure connections.
7. If voltage is present on the ER output and the 7EA input, and the D/E LED is on, then either the 7EB or 7EC output should measure 12-24 VDC and one of the phase select contactors should be on. If voltage is not present on either the 7EB or 7EC output, replace the Phase Select Module.

EMI 2000

EMI 2000 is an extended maintenance interval package. The EMI 2000 package consists of the following key components:

- New EMI 2000-Hour Cyclonic Air Cleaner Assembly and Air Cleaner Element (Standard equipment on all TS units)
- New EMI 2000-Hour Fuel Filter (black with gold lettering)
- New EMI 2000-Hour By-Pass Oil Filter (black with gold lettering)
- API Rating CG-4 Mineral Oil
- Five Year or 12,000 Hour ELC (Extended Life Coolant).

The EMI package allows standard maintenance intervals to be extended to 2,000 hours, or 1 year, whichever occurs first.

NOTE: Units equipped with the EMI 2000 package do require regular inspection in accordance with Thermo King's maintenance recommendations.

Engine Lubrication System

The TK 3.95 diesel engine has a pressure lubrication system. Oil is circulated by a trochoid type oil pump driven by the crankshaft timing gear and has several times the capacity required by the engine. Oil is picked up through a suction tube with a screened inlet. Oil to the rocker arm shaft flows through a tube on the outside of the engine and into the head through a restrictor fitting.

Oil pressure is affected by oil temperature, viscosity and engine speed. Subnormal oil pressures usually may be traced to lack of oil, faulty relief valve or worn bearings. The use of improper viscosity oil will also produce low oil pressure shutdowns.

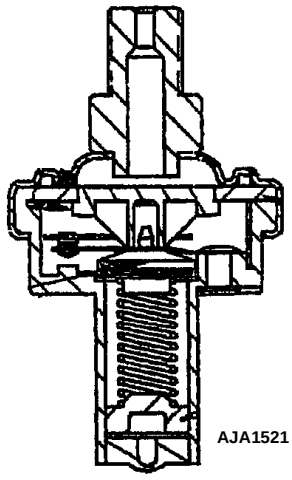


Figure 116: Engine Oil Pressure Switch

Engine Oil Pressure Switch

Engine oil pressure switch should rise immediately on starting. If engine oil pressure drops below 10 ± 2 psig (69 ± 14 kPa), the switch closes and signals the microprocessor to stop the engine. See SPECTRUM™ TS Microprocessor Controller Diagnosis Manual.

Engine Oil Change

The engine oil should be changed according to the "Maintenance Inspection Schedule". Drain the oil only when the engine is hot to ensure that all the oil drains out. When changing oil, try to make sure that the trailer is not tipped away from the direction that the oil is supposed to flow from the oil pan. It is important to get as much of the residual oil out as possible because most of the dirt particles are in the last few quarts of oil to drain out. Refill the pan with oil (see the "Specifications" chapter) and check the dipstick level. Run the unit, and then recheck the oil level.

NOTE: Fill the crankcase slowly so oil will not run into the breather hose, thus filling up an open cylinder. Leaving the dipstick out while adding engine oil will vent the crankcase.

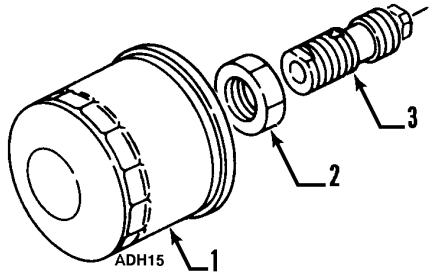
Add oil as necessary to reach the full mark. See Specifications chapter of this manual for correct type of oil.

Oil Filter Change

The oil filters should be changed along with the engine oil.

Spin-on Filters:

1. Remove the filter.
2. Apply oil to rubber ring of new filter and install filter.
3. Tighten the filter until the rubber ring makes contact, then tighten 1/2 turn more.



1.	Spin-on Oil Filter
2.	Pressure Valve Nut
3.	Oil Pressure Valve

Figure 117: Oil Filter Parts

Crankcase Vent

The crankcase vent system ducts crankcase gases formed in the crankcase directly to the intake elbow. Harmful vapors that would otherwise collect in the crankcase and contaminate the oil or escape to the outside, are now drawn back into the engine and burned. The breather hose should be inspected yearly to make sure it is not plugged.

Engine Low Oil Pressure Switch (LOP)

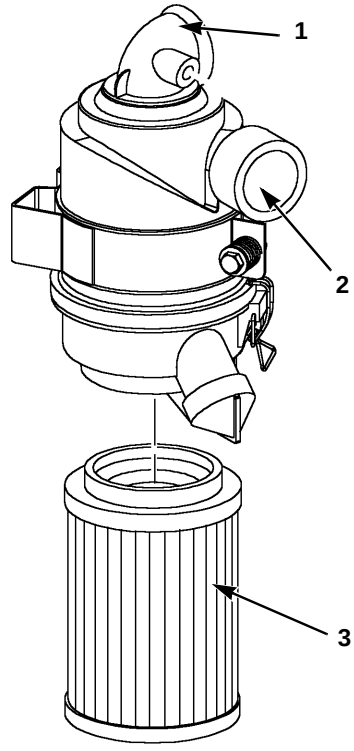
Engine oil pressure should rise immediately on starting, causing the OIL PRESSURE switch to open. If the oil pressure drops below 10 ± 3 psig (69 ± 12 kPa), the switch will close and trip the RESET switch and stop the engine.

The switch can be tested with the HMI. Refer to the TK 51662 Diagnostic Manual for details.

Engine Air Cleaner (EMI 2000)

The EMI 2000 air cleaner used with this unit is a dry element air cleaner. The air cleaner filters all of the air entering the engine. Excessive restriction of the air intake system affects horsepower, fuel consumption and engine life. Inspect the element at every oil change.

Replace the EMI 2000 air cleaner element at 2,000 hours, or 1 year, whichever occurs first. It cannot be interchanged with air filter elements used on previous Thermo King truck units.



1.	Output Connection
2.	Intake Hose Connection
3.	Dry Filter Element

Figure 118: Dry Type Air Cleaner

Engine Cooling System

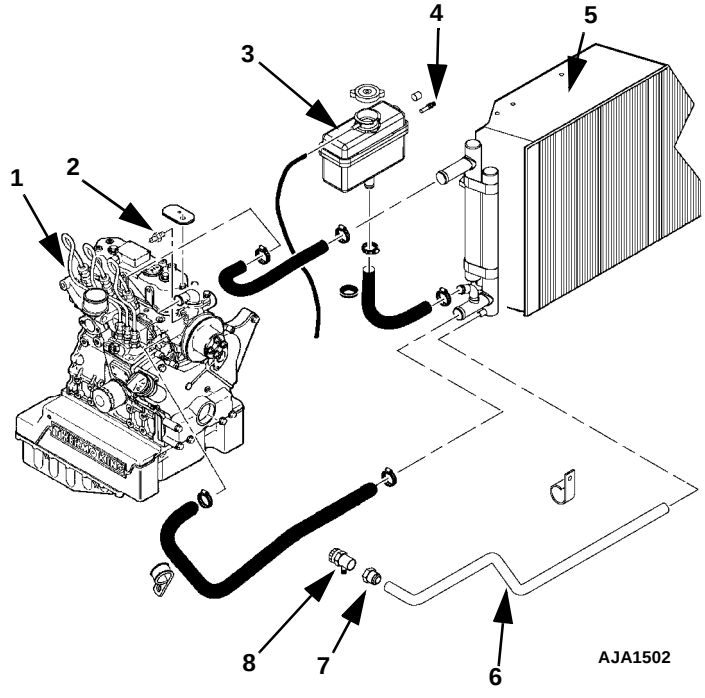
General Description

The engine employs a closed, circulating type, pressurized cooling system. Correct engine temperatures are controlled and maintained by a radiator, fan and thermostat. The coolant is circulated through the system by a belt-driven centrifugal pump. The pump draws the coolant from the side of the radiator (large header), circulates it through the cylinder block and head, then back to the radiator. A thermostat mounted in the water outlet from the cylinder head to the radiator automatically maintains coolant temperature within the specified temperature range.

All water-cooled engines are shipped from the factory with a mixture of 50% permanent type antifreeze concentrate and 50% water in the engine cooling system.

This provides the following:

1. Prevents freezing down to -30 F (-34 C).
2. Retards rust and mineral scale that can cause engine overheating.
3. Retards corrosion (acid) that can attack accumulator tanks, water tubes, radiators and core plugs.
4. Provides lubrication for the water pump seal.



1.	Engine	5.	Radiator
2.	Water Temperature Sensor	6.	Drain Tubing
3.	Coolant Expansion Tank	7.	Drain Cock Adaptor
4.	Coolant Level Sensor	8.	Drain Cock

Figure 119: Engine Cooling Components

ELC (Extended Life Coolant)

ELC has been phased into these units as of the first quarter of 2001. The maintenance interval for ELC is 5 years or 12,000 hours. A nameplate on the coolant expansion tank identifies units with ELC.

NOTE: The new engine coolant, Texaco Extended Life Coolant, is Red in color instead of the current Green or Blue-Green colored coolants.

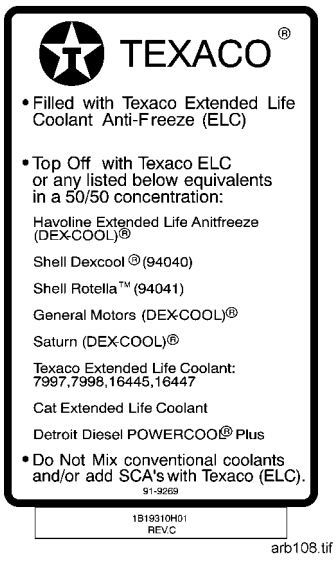


Figure 120: ELC Nameplate—Located On Expansion Tank

The following are the Extended Life Coolants currently approved by Thermo King for use in ELC units for five years or 12,000 hours:

- Texaco ELC #16445 (nitrite free) 100% concentrate.
- Texaco ELC #16447 premixed 50/50% concentrate.
- Havoline Dex-Cool #7994 (nitrite free) 100% concentrate, or #7997 (with nitrites) 100% concentrate.
- Havoline Dex-Cool #7995 (nitrite free) premixed 50/50% concentrate.
- Shell Dexcool #94040.
- Shell Rotella #94041.
- Havoline XLC #30379 (Europe) 100% concentrate.
- Havoline XLC #33013 (Europe) premixed 50/50% concentrate.
- Saturn/General Motors Dex-Cool.
- Caterpillar ELC.
- Detroit Diesel POWERCOOL Plus.

CAUTION: NEVER add Red Extended Life Coolants to cooling systems using Green or Blue-Green coolants. NEVER add Green or Blue-Green coolants to cooling systems using Red Extended Life Coolants.

NOTE: The use of 50/50% pre-mixed Extended Life Coolant (ELC) is recommended to assure that de-ionized water is being used. If 100% full strength concentrate is used, de-ionized or distilled water is recommended over tap water to insure the integrity of the cooling system is maintained.

ELC cannot be used in all older units. The water pump seal bellows and o-rings used on older units are not compatible with ELC.

To upgrade new production engines for ELC use, all water pump seal bellows were changed from NBR to HNBR elastomer, and the o-rings upgraded from NBR to EPDM elastomer. These changes were made as of TK 3.95 engine serial number K19855.

Units with engine serial numbers K19855 and after can be changed over to ELC coolant. The cooling system must be flushed until all traces of green or blue-green coolant dye are gone, and the discharge fluid (water) is clear. The system can then be filled with extended life coolant (ELC).

Units with engine serial numbers before K19855 must have the water pump replaced to change over to ELC coolant. See Service Bulletin T&T 275 for information about retrofitting the new water pump.

Antifreeze Maintenance Procedure

As with all equipment containing antifreeze, periodic inspection on a regular basis is required to verify the condition of the antifreeze. Inhibitors become worn out and must be replaced by changing the antifreeze. Change green or blue-green engine coolant every two years. Change ELC (red) engine coolant every five years or 12,000 hours (whichever occurs first).

Do not mix green or blue-green engine coolant with ELC (red) engine coolant. See “ELC (Extended Life Coolant)” on page 86 for more information about ELC.

The factory recommends the use of a 50/50% antifreeze mixture in all units even if they are not exposed to freezing temperatures. This antifreeze mixture will provide the required corrosion protection and lubrication for the water pump.

Checking the Antifreeze

Check the solution concentration by using a temperature compensated antifreeze hydrometer or a refractometer designed for testing antifreeze. Maintain a minimum of 50% permanent type antifreeze concentrate and 50% water solution to provide protection to -30 F (-34 C). Do not mix antifreeze stronger than 68% permanent type coolant concentrate and 32% water for use in extreme temperatures.

Changing the Antifreeze

1. Run the engine until it is up to operating temperature. Stop the unit.
2. Open the drain cock (see Figure 121 on page 88) and completely drain coolant. Observe coolant color. If the coolant is dirty, proceed with a, b, and c. Otherwise go to step 3.

CAUTION: Avoid direct contact with hot coolant.

   a. Run clear water into radiator and allow it to drain out of the drain cock until it is clear.
   b. Close the drain cock and install a commercially available radiator and block flushing agent, and operate the unit in accordance with instructions of the flushing agent manufacturer.
   c. Open the drain cock to drain water and flushing solution.

CAUTION: Avoid direct contact with hot coolant.

3. Run clear water into the radiator, and allow it to drain out of the drain cock until it is clear. When water has finished draining, close drain cock.
4. Inspect all the hoses for deterioration and the hose clamp tightness. Replace if necessary.
5. Loosen the water pump belt. Check the water pump bearing for looseness.
6. Inspect the radiator cap. Replace the cap if the gasket shows any signs of deterioration.
7. Mix one gallon of the appropriate permanent type antifreeze concentrate and one gallon clean water in a container to make a 50/50 mixture. (Do not add antifreeze and then add water to the unit. This procedure may not give a true 50/50 mixture because the exact cooling system capacity may not always be known).
8. Refill the radiator with the 50/50 mixture.

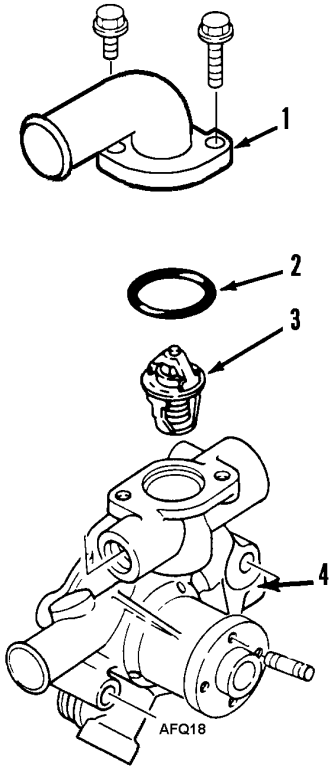
Bleeding Cooling System

After filling the radiator, run the unit up to operating temperature to check for overheating and coolant level and allow the air to be purged for a few minutes.

CAUTION: Do not remove the radiator cap while the engine is hot.

Engine Thermostat

For the best engine operation, use a 180 F (82 C) thermostat year round.



1.	Thermostat Housing
2.	Gasket
3.	Thermostat
4.	Water Pump

Figure 121: Water Pump Assembly and Thermostat

Engine Fuel System

The fuel system used on the Thermo King TK 3.95 diesel is a high pressure system used in conjunction with a prechamber.

The components of the fuel system are:

- Fuel tank (may be the truck fuel tank)
- Electric Fuel pump
- Fuel filter
- Injection pump
- Injection nozzles.

A 10 psig (69 kPa) electric fuel pump pulls fuel from the fuel tank through a fuel pump filter, then pushes it to the fuel filter, and to the injection pump. The prefilter is designed for diesel fuel and is the only type that should be used.

The injection pump plungers are activated by its own gear driven camshaft. The governor sleeve and weight assembly is mounted on the end of the camshaft with governor's speed requirements being relayed to the injection pump through a linkage arrangement located in the front timing cover. The injection pump raises the pressure of the fuel and meters the correct amount of fuel to the nozzle at the correct time. The increased fuel pressure will lift the spring loaded nozzle to admit fuel into the combustion chamber.

The fuel system is relatively trouble free, and if properly maintained will usually not require major service repairs between engine overhauls.

The most common cause of fuel system problems is contamination. It cannot be stressed enough that the fuel must be clean, fuel tanks must be free from contaminants, and the fuel filter must be changed regularly. Any time that the fuel system is opened up, all possible precautions must be taken to keep dirt from entering the system. This means all fuel lines should be capped when open. The work should be done in a relatively clean area, if possible, and the work should be completed in the shortest time possible.

Thermo King recommends that any major injection pump or nozzle repairs be done by a quality diesel injection service specialty shop. The investment in equipment and facilities to service these components is quite high. Therefore, this equipment is not found in most repair shops.

The following procedures can be done under field conditions:

- Bleeding air from the fuel system.
- Maintenance involving the fuel tank and filter system.
- Speed and governor adjustments.
- Electric transfer pump replacement or repair (10 psig [69 kPa] pump with diesel filter).
- Injection line replacement.
- Pump timing.
- Nozzle spray pattern testing and adjustment.
- Minor rebuilding of nozzles.

Bleeding the Fuel System

The fuel system will have to have the air bled out if the engine runs out of fuel, if repairs are made to the fuel system, or air gets into the system for any other reason.

NOTE: MAKE SURE to keep the fuel tank vent open. If the vent becomes clogged, a partial vacuum develops in the tank, and this increases the tendency for air to enter the system.

Proceed as follows:

1. Loosen the bleeder screw on the inlet fuel fitting of the injection pump.
2. Turn on the electric fuel pump. The electric fuel pump is energized when the **ON** key is pushed. Tighten the bleeder screw on the injection pump when clear flow of fuel appears.

   NOTE: At initial start-up, open the bleeder screw at the injection pump and bleed fuel until a clear flow is noted.
3. Loosen the injector lines on the injection nozzles.
4. Crank the engine until fuel appears at the nozzles. Tighten the injector lines, and start the engine.

   NOTE: Fuel will not appear at the nozzles by merely running the electric pump. The engine must be cranked.

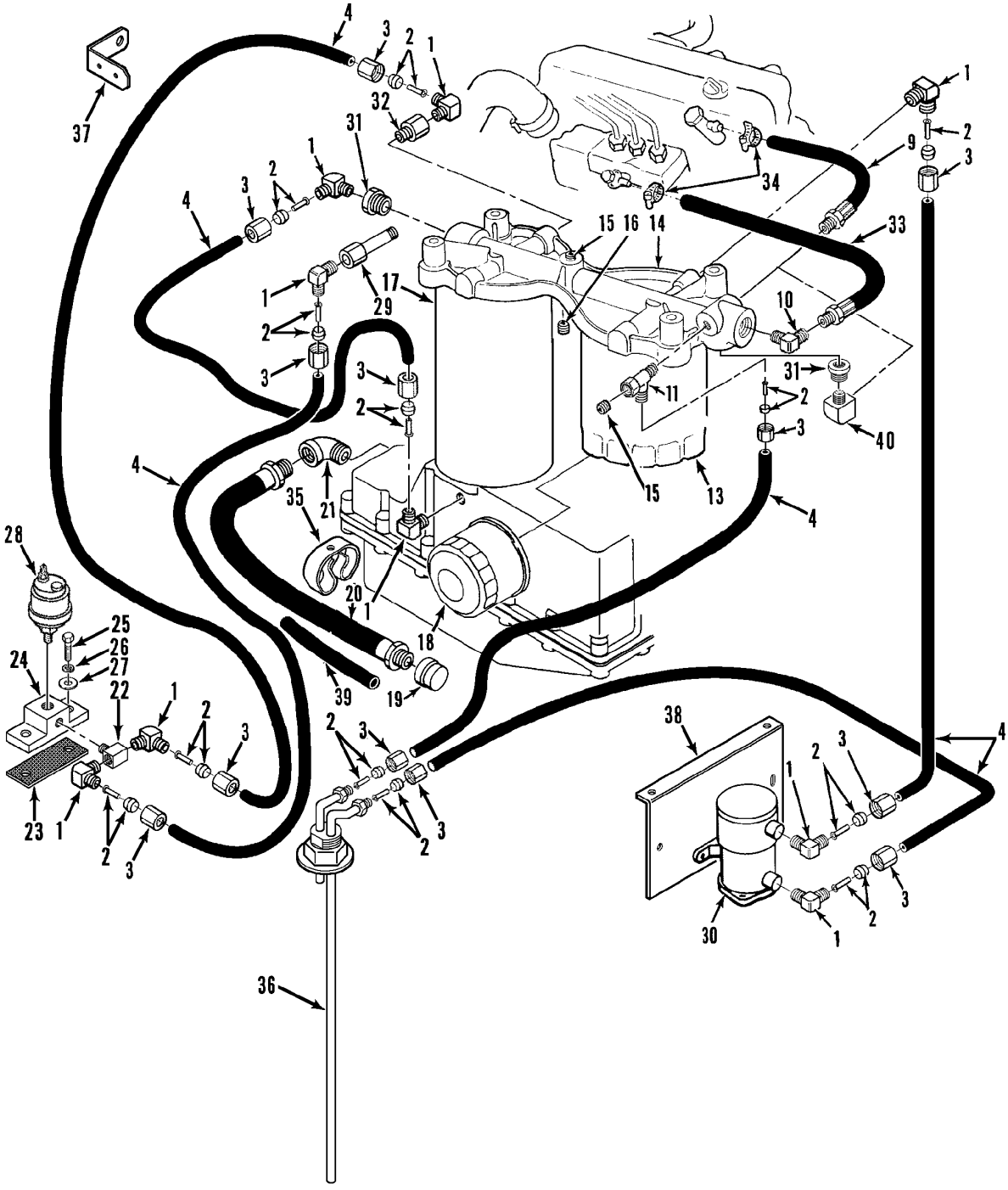


Figure 122: Fuel and Oil System Components

1.	Elbow—hose fitting (3/8)	26.	Lockwasher
2.	Kit—sleeve & eyelet (3/8)	27.	Flatwasher
3.	Nut (3/8)		Washer (nylon)
4.	Hose (3/8 od x 35 ft lg)	28.	Switch—oil pressure
5.	Not Used		Nut—switch
6.	Kit—sleeve & eyelet (1/4)		Lockwasher
7.	Nut (1/4)		Flatwasher
8.	Elbow	29.	Fitting—engine (3.0 in lg)
9.	Hose	30.	Pump—fuel (12V)
10.	Elbow		Pump—fuel (24V)
11.	Tee		Kit—filter
12.	Plug		Gasket—fuel pump
13.	Filter—fuel	31.	Bushing
	Filter—fuel (EMI 2000)	32.	Fitting—restricted
	Adapter—fuel pickup	33.	Hose
14.	Bracket—fuel filter	34.	Clamp—fuel hose
	Screw	35.	Clip—oil drain hose
	Flatwasher	36.	Tube—fuel pickup
	Nut	37.	Bracket—connector
15.	Plug—pipe		Screw—bracket
16.	Plug—pipe		Flatwasher
17.	Filter—oil bypass		Nut
	Filter—oil bypass (EMI 2000)	38.	Bracket—fuel filter & pump
	Stud—bypass filter		Screw—bracket
18.	Filter—oil (full flow)		Flatwasher
19.	Cap—oil hose		Nut
20.	Hose—oil drain (28 in)	39.	Tee (after 2/97)
	Hose—oil drain (23 in)	40.	Valve (after 2/97)
21.	Elbow—oil drain		Body (after 2/97)
22.	Tee		Valve (after 2/97)
23.	Mat—isolator (oil pressure sensor)		Cap (after 2/97)
24.	Elbow—flange		
25.	Screw—elbow		

Fuel and Oil System Components for Figure 122

Draining Water from Fuel Tank

Water run through the system may damage the injection pump or nozzles. Damage to the fuel system will subsequently cause more expensive damage to the engine. A large accumulation of water in the bottom of the fuel tank will stop a diesel engine. Water should be drained off during scheduled maintenance inspections to prevent breakdowns. Drain the water off after the fuel tank and unit have remained idle for an hour.

1. Place a container under the fuel tank to catch the draining water and fuel.
2. Remove the drain plug from the bottom of the fuel tank.

   NOTE: Some fuel tanks have a check valve in the drain plug fitting. Push the check valve open with a small screw driver to drain the tank.
3. Let the water and fuel drain into the container until no water is visible in the fuel draining from the tank. If the water and fuel do not drain freely, the vent may be plugged. If so, clean or replace the vent.
4. Install the drain plug.

Fuel Filter Replacement

Replace the fuel filter at intervals according to the Maintenance Inspection Schedule.

1. Remove the filter and discard.
2. Lubricate rubber ring of new filter with fuel.
3. Install the filter and tighten until the filter is slightly loose (rubber ring not making contact).
4. Bleed the air from the filter by operating the electric pump until fuel bubbles appear at the top of filter.
5. Tighten the filter until the rubber ring makes contact, then tighten 1/2 turn more.

Reassembly

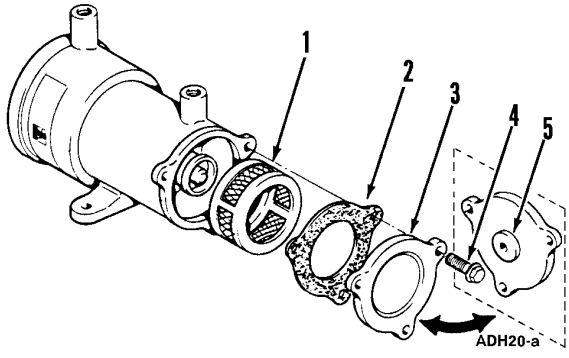
Place the cover gasket on the bottom cover and install the filter and cover assembly. Replace the three screws.

Electric Fuel Pump

Operation

The electric fuel pump must be mounted next to the fuel tank. This pump is designed to push rather than pull fuel.

Make sure the pump completes a good ground with the battery. The pump will not operate at less than 9 Vdc. The pump is self priming as long as it is not higher than 30 in. (762 mm) from the fuel in the fuel tank.



1.	Filter
2.	Gasket
3.	Cover
4.	Screw (3)
5.	Magnet

Figure 123: Electric Fuel Pump

Maintenance

Field service is limited to cleaning the bottom cover and filter. The filter and cover gasket are replaceable.

Disassembly

1. Remove the three screws from the cover.
2. Remove the filter, cover and cover gasket. Wash the filter in cleaning solvent and blow out the dirt and cleaning solvent with compressed air. Check the cover gasket and replace if damaged. Clean the cover.

If pump does not operate, check for:

1. The ground to the frame of the unit.
2. Clean and tighten electrical connections.
3. The pump voltage and polarity. It must be the same as the unit system.

If pump operates but does not deliver fuel, check for:

1. Air leaks in the fuel lines or connections.
2. Kinked fuel lines or other restrictions in the line.
3. A leaking or distorted cover gasket.
4. A dirty filter.
5. A stuck seat in the outlet fitting.

Injection Pump

Injection Pump Adjustments

When the diesel engine fails to maintain the correct engine speed, check the following before adjusting the speed:

1. Check the prefilter screen. Recheck the speed.
2. Bleed air out of the fuel system. Recheck the speed.
3. Bleed air out of the nozzles. Recheck the speed.
4. Operation of electric transfer pump.

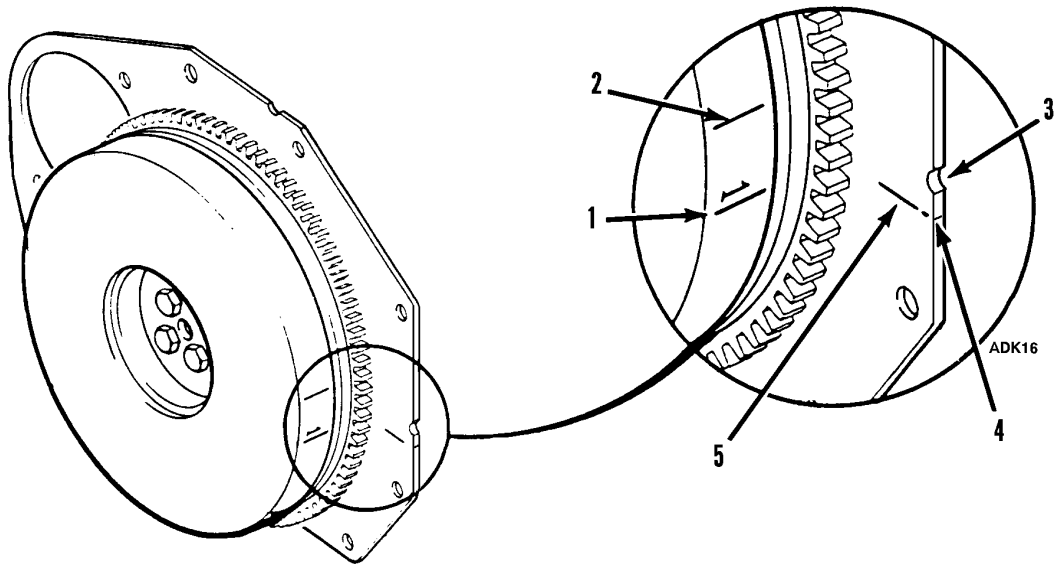
Make the engine speed adjustments with the engine fully warmed up.

The unit has one solenoid to control the high speed function. The speed of the engine should be checked with the use of a stroboscope tachometer (see Tool Catalog).

Timing the Injection Pump to the Engine

There are two different types of timing procedures used on the engine. One procedure involves checking to make sure the cylinders are timed correctly to each other, and the second procedure times the injection pump correctly to the engine. If the cylinders are not timed correctly to each other, it is of no value to time the injection pump to the engine because one or two of the three cylinders would be out of time. The individual plungers in the injection pump are timed to each other by the use of spacers in the pump plunger base. It is rare that an injection pump would change individual cylinder timing unless it had been through some type of repair process, but if all other possible problems with a rough running engine have been checked, and especially if the engine's injection pump has been replaced or repaired recently, it may be beneficial to check individual cylinder timing. Because the possibility of incorrect individual cylinder timing is so minimal, the procedure for timing the pump to the engine will be covered first. The procedure for individual cylinder timing is very similar to timing the injection pump so it will be covered last.

CAUTION: The cylinders on the engine are numbered from the flywheel end to the water pump end. The number 1 cylinder is next to the flywheel. The number 2 cylinder is the center cylinder. The number 3 cylinder is next to the water pump. The timing marks on the flywheel are matched to this system.



1.	TDC Mark	4.	File V-Notch Here
2.	Injection Timing Mark	5.	Timing Mark
3.	Round Notch		

Figure 124: Timing Marks

1. Rotate the engine in the direction of rotation (clockwise as viewed from the water pump end) until the number 1 cylinder (closest to flywheel) is at approximately top dead center of the compression stroke. The valve cover should be removed to identify the compression stroke. Both rocker arms of the number 1 cylinder will be loose. Check to see that the number 1 cylinder top dead center mark on the flywheel is aligned with the timing mark on the starter mounting plate.

   NOTE: The timing marks for each of the three cylinders are stamped 120 degrees apart. Top dead center marks are identified by the number of the cylinder stamped next to them. Injection timing marks are unmarked. The timing marks on the engine can be difficult to align. This is because the timing mark on the starter mounting plate is near the air cleaner, on the side of the plates that faces the flywheel. It cannot be seen when looking through the engine side door opening unless you use a mirror.

   The timing mark on the starter mounting plate is a line stamped on the side of the plate facing the flywheel. To locate the timing mark, feel the back side of the plate 0.4 in. (10 mm) below the center of round notch in the edge of the plate. To make it easier to align the timing marks, file a V-notch in the edge of the plate in line with the timing mark on the plate.

2. Remove the injection line from the number 1 injector and the injection pump. Remove the delivery valve holder, delivery valve and spring. Care must be taken to prevent dirt from entering the fuel injection system. Replace the delivery valve holder and delivery valve.

3. Install a drip valve on the nozzle holder.

4. Activate the run solenoid and the fuel pump by pushing the **ON** key. Make sure the Diesel/Electric switch is in the Diesel position. See the µP-T Microprocessor Diagnosis Manual, for information about the Interface Board Test mode.

CAUTION: The 8S wire on the starter motor should be disconnected.

CAUTION: Loosen the injection lines on the injection nozzles of the number 2 and 3 cylinders to prevent any possibility of the engine firing.

5. The engine should be close to the top dead center position with the plunger port in the pump closed. No fuel should flow from the drip tube.
6. Turn the engine backwards past the injection timing mark until fuel flows from the drip tube.
7. Slowly rotate the engine in the direction of rotation while watching the drip tube. When the fuel flow slows to approximately one drip every 10 to 15 seconds, check the timing marks. They should be lined up.
8. ***If the timing marks did not line up, a shim or shims will have to be added or subtracted from the injection pump. Adding shims will retard the injection timing, subtracting shims will advance the timing. Increasing or decreasing shim thickness by 0.004 in. (0.1 mm) will change the timing by 1 degree***.
9. After shims have been added or subtracted, recheck the timing.
10. When the injection pump has been correctly timed to the engine, remove the pump and put a light coat of silicone gasket sealer on the shim pack and the pump, or dip the new shims in lacquer thinner to activate the sealer.
11. Reinstall the pump, and torque the nuts to 18 to 20 ft-lb (24 to 27 N•m).
12. Reinstall the delivery valve and spring. Torque the delivery valve holder to 30 ft-lb (41 N•m).
13. Reinstall the injector lines, bleed the air from the nozzles, and test run the engine.

Timing Individual Cylinder Injection

This procedure should be used when a poor running engine has had all possible problems checked but continues to run badly. If the injection pump has been repaired or replaced, the chance of individual cylinder timing problems has a greater possibility of occurring.

To check individual cylinder timing, follow the pump timing procedure but instead of changing shims to adjust pump timing, check the timing of number 2 and number 3 injector to the engine after checking number 1. The cylinders should time on their respective flywheel timing marks.

If the injection pump plungers are not correctly timed to each other, the pump must be removed and sent to a diesel injection equipment repair shop for calibration.

NOTE: The order of the flywheel timing marks is 1, 2, 3, but the firing order is 1, 3, 2. This is because the engine fires every 240 degrees of crankshaft rotation. Therefore, when checking individual cylinder timing check number 1 first then rotate the engine past number 2 to number 3 and check number 3. Then rotate the engine past number 1 to number 2 and check number 2.

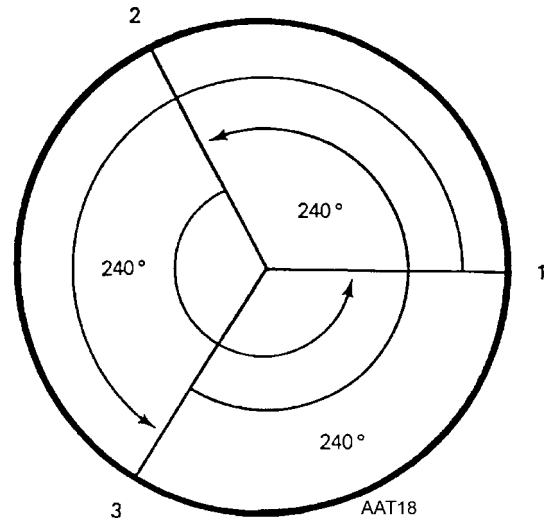


Figure 125: Individual Cylinder Timing and Firing Order

Adjust Engine Valve Clearance

1. Remove the valve cover. Torque 18 mm diameter head bolts prior to adjusting the valves: 26.8 ft-lb (36.3 N•m). Valve clearance should be checked after every 2000 operating hours, maximum. It is very important that valves be adjusted to the correct specifications for satisfactory engine operation. Insufficient valve clearance will result in compression loss and misfiring of cylinders resulting in burned valves and seats. Excessive valve clearance will result in noisy valve operation and abnormal wear of the valves and rocker arms. The intake and exhaust valves are adjusted with the valve in the closed position.
2. The intake valve and exhaust valve are adjusted to 0.006 to 0.010 in. (0.152 to 0.254 mm) with the temperature at 70 F (21 C).

   Turn the engine by using the belt on the crankshaft pulley. Rotate the engine in the direction of rotation (clockwise as viewed next to the flywheel) from the water pump end.

CAUTION: Make sure the fuel rack is off to prevent the engine from starting.

   a. Turn the engine so number 1 cylinder is on compression with piston to TDC. Both push rods should turn freely. Adjust both valves on number 1 cylinder.

   b. Revolve the crankshaft 240° to TDC mark on number 3 cylinder, and adjust both valves.

   c. Turn the crankshaft 240° to align TDC mark of number 2 cylinder, and adjust both valves.

   d. *Be sure* to tighten locking nut while holding the ball head screw in position.

3. Install the valve cover making sure that the gasket is in position.

Fuel Limit Screw

The fuel limit screw is not adjustable. It is equipped with an anti-tamper cap to fulfill requirements for CARB (California Air Resources Board) emission regulations. Service technicians must be CARB certified to perform service on fuel limit screw for equipment operating in California. All other equipment can be serviced per recent service bulletins with special tools and procedures. California service technicians should see your local Thermo King dealer for recent bulletins.

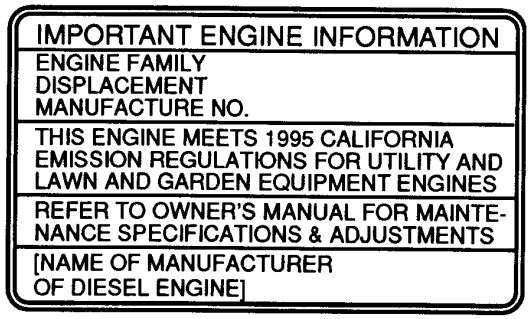


Figure 126: Emission Control Label

Engine Mounts

The engine mounting system contains three vibration mounts, two snubber mounts, and a chain restraining mount.

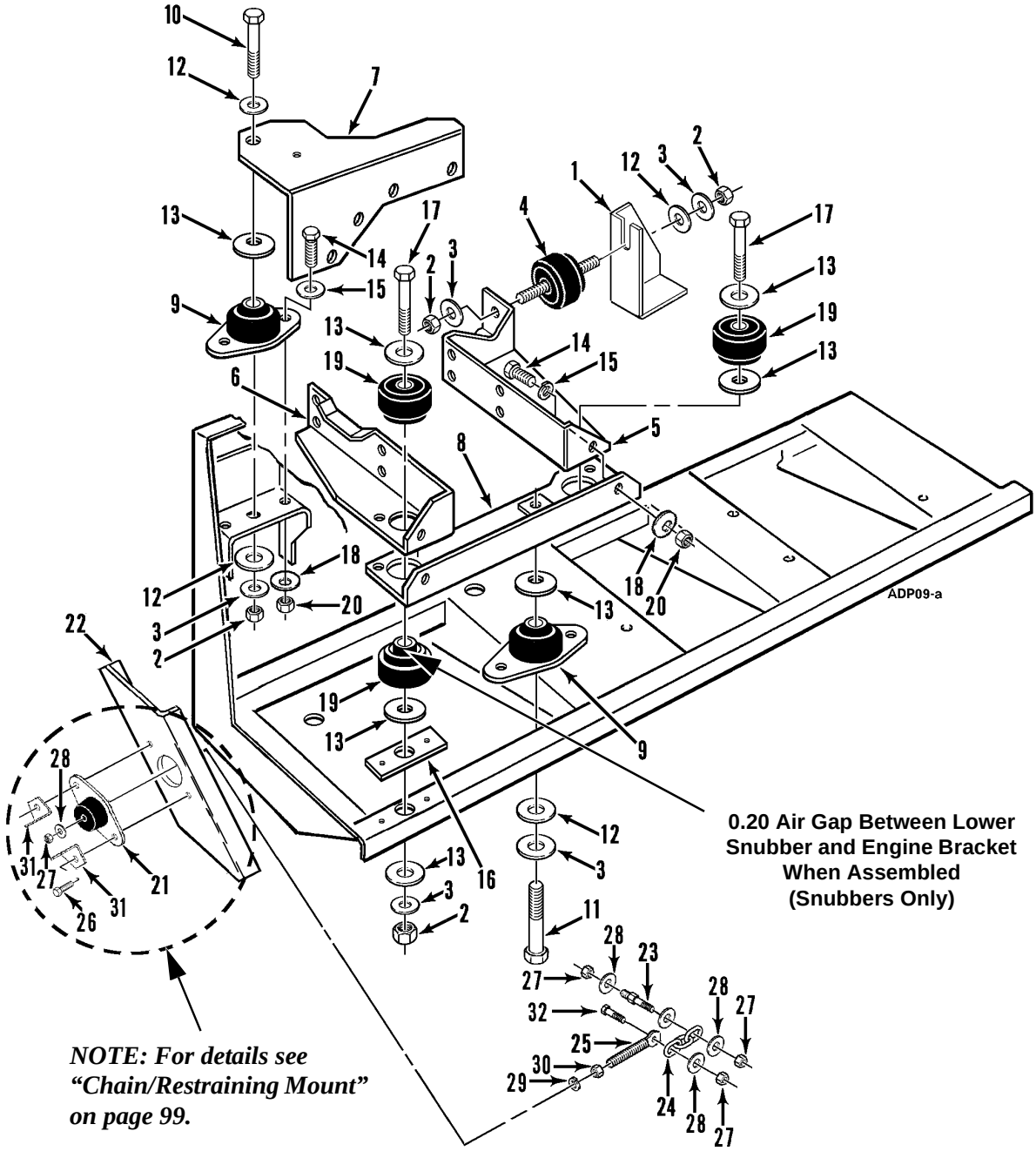


Figure 127: Engine Mounting Components

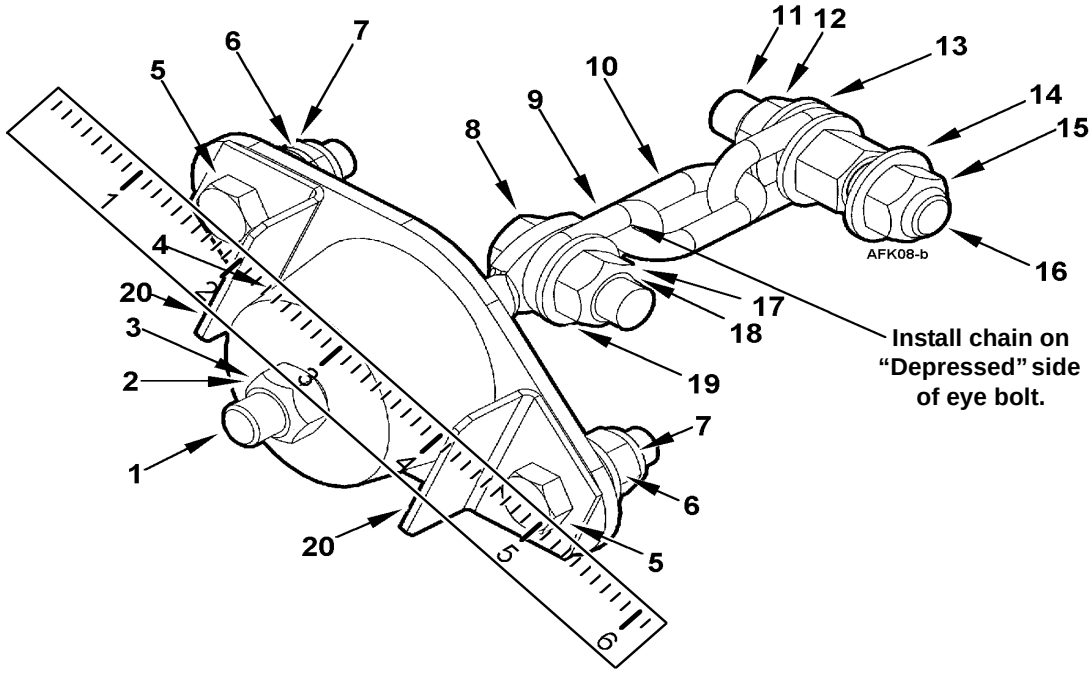
1.	Restraining Bracket	14.	Mount Screw
	Bracket Screw	15.	Flatwasher
	Belleville Washer	16.	Wear Plate Mount
	Nut		Wear Plate Rivet
2.	Nut	17.	Engine Screw
3.	Belleville Washer	18.	Belleville Washer
4.	Vibration Mount	19.	Vibration Engine Mount (set of two)
5.	Engine Mount (roadside)	20.	Nut
6.	Engine Mount (curbside)		Thread (Blue) Sealer
7.	Engine Mount (upper)	21.	Vibration Mount
	Screw (socket head, 10 x 1.5, 25 mm lg)	22.	Bracket
	Screw (socket head, 10 x 1.25, 20 mm lg)	23.	Stud
	Screw (hex head, 10 x 1.25, 20 mm lg)	24.	3-Link Chain
	Belleville Washer	25.	Eye Bolt
8.	Engine Mount (front)	26.	Mount Screw
	Mount Screw		Flatwasher
	Flatwasher		Nut
	Belleville Washer	27.	Nut
	Nut	28.	Flatwasher
9.	Vibration Mount	29.	Lockwasher
10.	Engine Screw	30.	Nut
11.	Engine Screw	31.	Gauge Bracket
12.	Special Washer	32.	Chain Screw
13.	Special Washer		

Components for “Engine Mounting Components” on page 97

Restraining Mount Adjustment

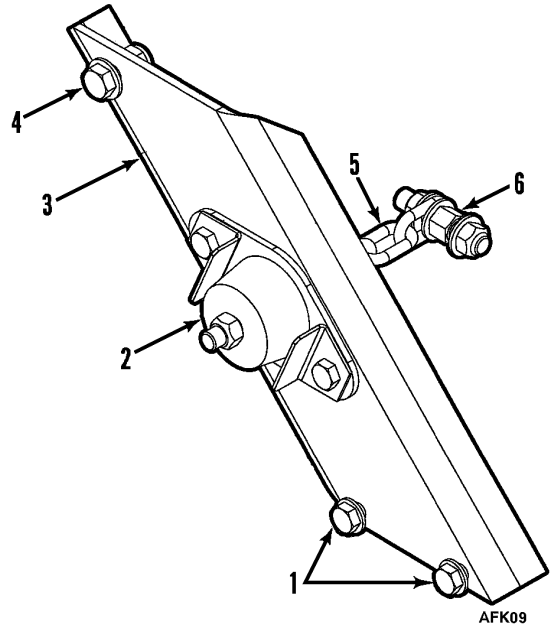
Install belts and remove slack. After belt tension has been set (no slack). Check seating in pulleys. Then proceed to tighten locknut (#2) to compress the mount until the top of mount is in the same plane as the gauge brackets (#20). Use straight edge.to verify. Next, retighten belts using TK Gauge (see Took Catalog). Set belt tension to a reading of 55 to 60. Recheck restraining mount alignment using a straight edge.

This is a blowup of balloon items for “Engine Mounting Components” on page 97.



1.	Eye Bolt	11.	Stud
2.	Locknut (3/8 in.)	12.	Locknut (HH)
3.	Belleville Washer (3/8 in.)	13.	Flatwasher (3/8 Galv.)
4.	Vibration Mount	14.	See Note 18.
5.	Screw	15.	Locknut (HH)
6.	Flatwasher	16.	This End Through Existing Hole In Engine Flange
7.	Nyloc Nut	17.	Locknut (HH)
8.	Screw (3/8 in. SS)	18.	***NOTE: Do not torque nuts to the normal 3/8 torque specification. This would cause unnecessary distortion of the flatwashers. A snug fit is all that is required.***
9.	***NOTE: Always install chain on indented side of eye bolt***	19.	Flatwasher (3/8 Galv.)
10.	3-Link Chain	20.	Gauge Bracket

Figure 128: Chain/Restraining Mount



1.	Screw (5/16-18 SS); Flatwasher (5/16); Nylock Nut (5/16-18 SS)	4.	Screw (3/8-16 SS); Flatwasher (3/8); Nylock Nut (3/8-16 SS)
2.	Vibration Mount	5.	3-Link Chain
3.	Mount Frame Bracket	6.	This End Through Existing Hole In Engine Flange

Figure 129: Chain/Restraining Mount Bracket

Integral Fuel Solenoid

The fuel solenoid is located on the end of the fuel injection pump.

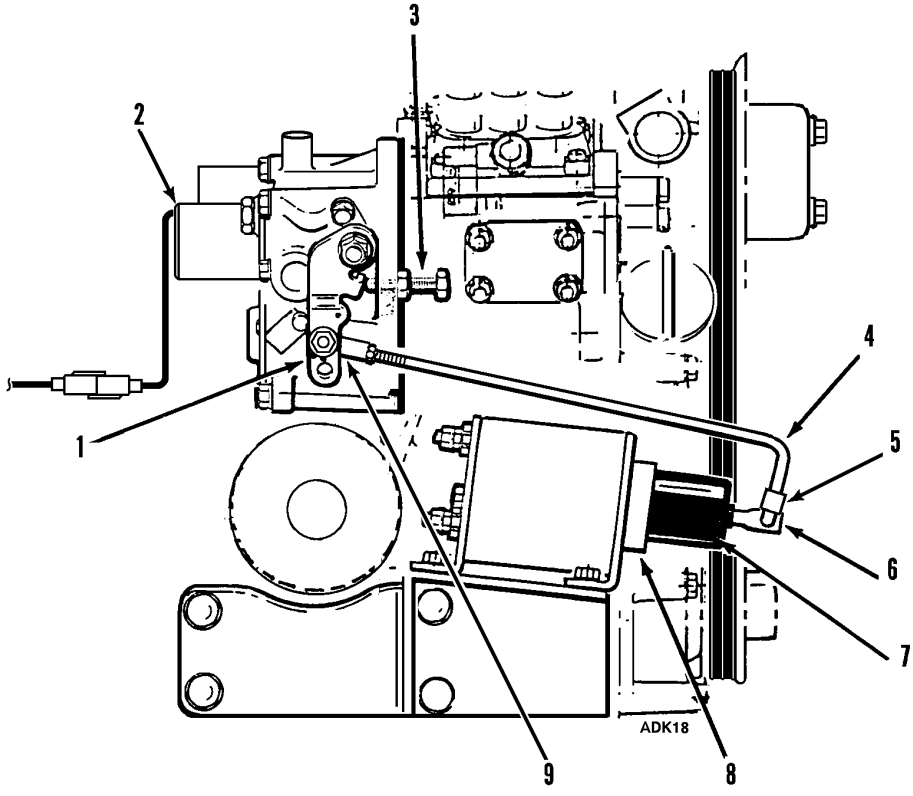
Operation of the engine is controlled by the operation of the fuel solenoid and the throttle (high speed) solenoid. The fuel solenoid consists of a spring loaded plunger and electro-magnetic coil. When the engine is Off, spring tension on the plunger maintains the plunger's "out" position. When pushed out, this causes the governor linkage to move the injection pump rack to the "Fuel Off" position.

When the fuel solenoid is energized, current is applied to the coil creating an electro-magnetic field, which pulls the plunger in. When in the "pulled-in" position, the plunger releases tension on the governor linkage. The governor linkage then moves the fuel injector rack, thus controlling the fuel flow and placing it in the "Fuel On" position.

Adjustments made to the throttle (high) speed solenoid change governor spring tension which in turn adjust speed settings.

Fuel Solenoid Diagnostic and Replacement

See the Interface Board diagnostic procedures in the SPECTRUM™ TS Microprocessor Controller Diagnosis Manual.



1.	Throttle Lever	6.	Eye Bolt
2.	Fuel Solenoid	7.	Boot
3.	Low Speed Adjustment Screw	8.	Throttle Solenoid
4.	Rod	9.	Ball Joint
5.	Clip		

Figure 130: Integral Fuel Solenoid Components

Engine Speed Adjustments

Low Speed Adjustment

1. Start the unit and let it run until the engine is warmed up.
2. Set the thermostat to make the engine run in low speed and check the engine speed. The engine speed should be 1800 ± 25 rpm.
3. If the engine speed is not correct, loosen the jam nut on the low speed adjustment screw.
4. Turn the low speed adjustment screw to change the engine speed. Turn the screw in to increase the engine speed. Turn the screw out to decrease the engine speed.
5. Set the engine speed at 1800 ± 25 rpm and tighten the jam nut.

High Speed Adjustment

1. Start the unit and let it run until the engine is warmed up.
2. Set the thermostat to make the engine run in high speed and check the engine speed. The engine speed should be 2425 ± 25 RPM.
3. If the engine speed is not correct, loosen the jam nut at the end of the adjuster.
4. Unbolt the adjuster from the throttle lever and turn to adjust the engine speed. Reinstall on the throttle lever.
5. Set the engine speed at 2425 ± 25 RPM and tighten the jam nut.

Belts

The unit uses only two belts to transfer power from the engine and the electric motor to the alternator and compressor.

Engine/Electric Motor Belt

The engine/electric motor belt is a 3V belt. Use the following procedure to adjust this belt.

1. Loosen the idler pulley mounting bolt.Loosen the locknut on the idler pulley adjustment bolt. This bolt is located directly above the idler pulley on the idler pulley mounting bracket.
2. Turn the idler pulley adjustment bolt to obtain the proper belt tension (field reset—55 to 60 on TK gauge, see Tool Catalog).

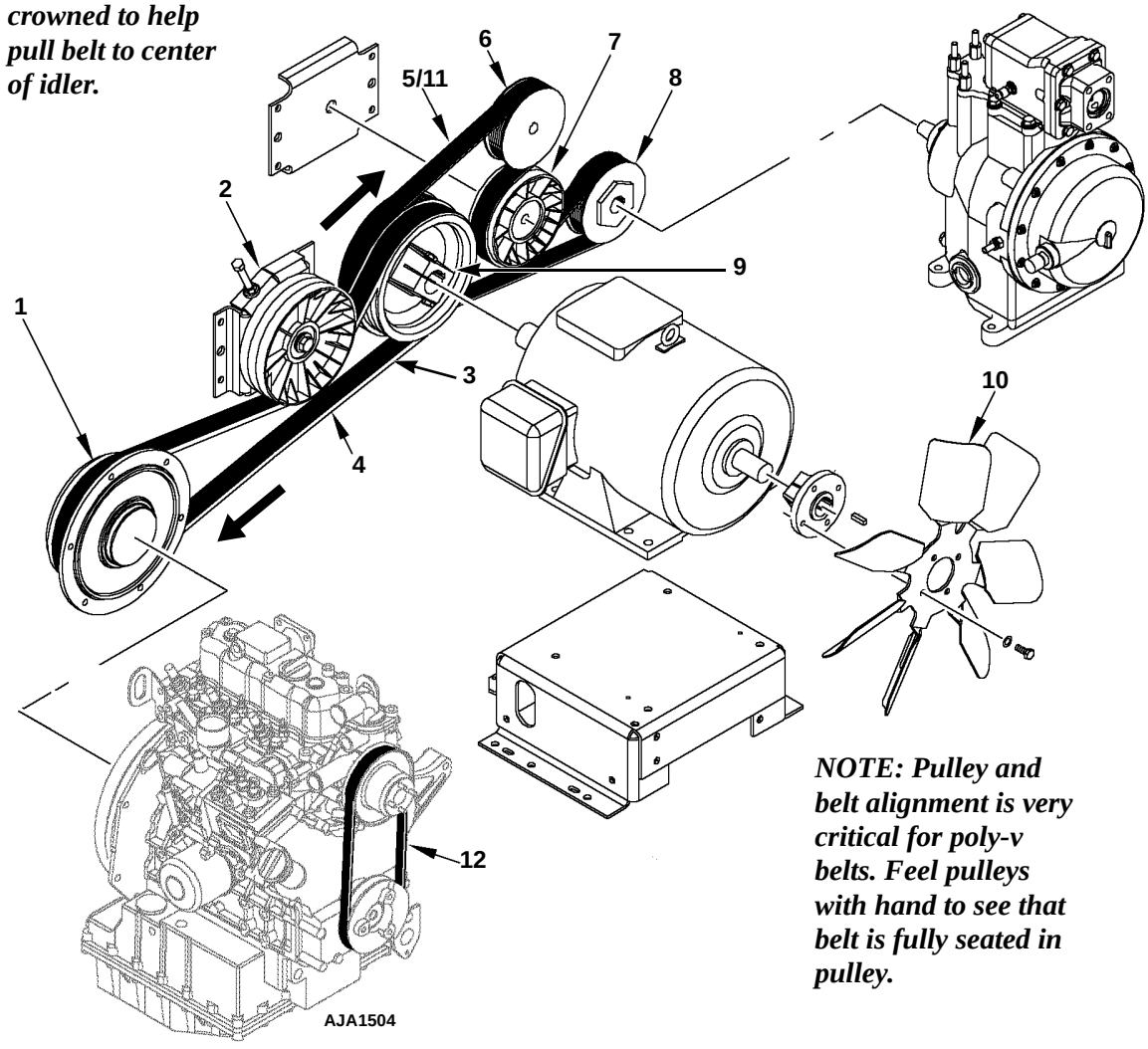
Tighten the locknut on the idler pulley adjustment bolt and tighten the idler pulley mounting bolt.

Electric Motor/Compressor Belt

The electric motor/compressor belt is a polyvee belt that also drives the alternator. Use the following procedure to adjust this belt.

1. Loosen the alternator pivot bolt.
2. Loosen the locknut below the mounting tab on the alternator adjustment bolt. This bolt is located directly to the compressor side of the alternator.
3. Turn the locknut above the mounting tab on the alternator adjustment bolt to obtain the proper belt tension (field reset—55 to 60 on TK gauge, see Tool Catalog).
4. Tighten the lower locknut on the alternator adjustment bolt and then tighten alternator pivot bolt.

idler pulleys are crowned to help pull belt to center of idler.



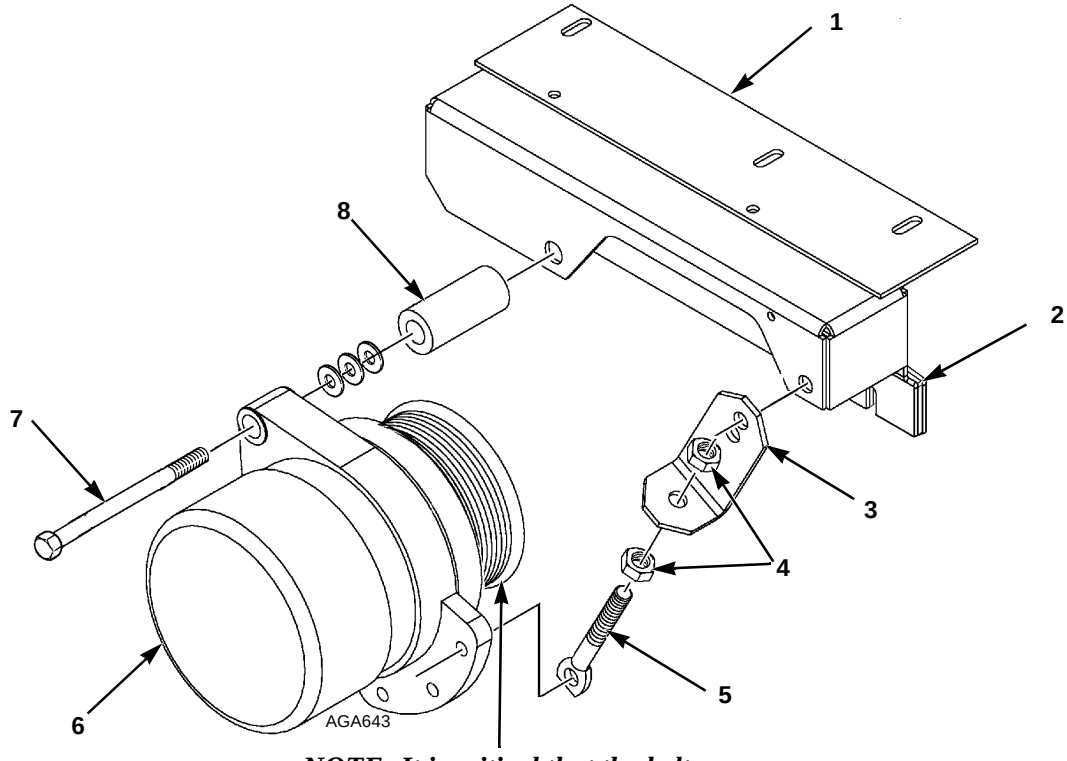
NOTE: Pulley and belt alignment is very critical for poly-v belts. Feel pulleys with hand to see that belt is fully seated in pulley.

1.	Clutch	7.	Idler Pulley (5.5 Inch)
2.	Idler Pulley (7-Inch)	8.	Compressor Pulley
3.	Engine to Motor 3V Belt	9.	Motor Pulley
4.	Locate Belt Tension Gauge Here	10.	Condenser fan
5.	Motor to Compressor Poly vee Belt	11.	Locate Belt Tension Gauge Here
6.	Alternator Pulley	12.	Water Pump Belt

Figure 131: Front View Belt Arrangement

Alternator Adjustment

Shims may be used to facilitate alignment during alternator installation. Use adjustment strap and eye bolt to ensure belt tension reading is between 55 to 65 on TK gauge.



NOTE: It is critical that the belt be correctly seated in pulley. First and last edge of grooves are higher to improve seating of belts.

1.	Mounting Bracket	5.	Eye Bolt ***NOTE: Use the hole on the alternator that allows proper belt tension and shortest length of eye bolt extended.***
2.	Shims	6.	Alternator
3.	Adjusting Bracket	7.	Pivot Bolt
4.	Locknuts	8.	Spacer

Figure 132: Alternator Mounting and Belt Tension Adjustment

Evacuation

Evacuation is Important and is Critical to System Performance!

It has been determined through testing and system analysis that refrigeration systems which contain non-condensables such as nitrogen and/or air can be overcharged with refrigerant when charged using the sight glass method. An overcharge of refrigerant will cause compressor damage.

Therefore, Thermo King recommends that all repairs to the refrigeration system include the removal and reclamation (cleaning) of the refrigerant, followed by a thorough evacuation using the proper tools and procedures. (See attached tool list and evacuation procedures.)

The primary objective of evacuation is to bring the system's pressure to a low micron level to ensure the removal of moisture and non-condensables. There are however, certain other principles which must be observed. These are:

- Evacuate from 3-points to access both sides of check valves and solenoids. Energize solenoids during evacuation to prevent trapping of refrigerant or non-condensables.
- Always leave service valve caps on during evacuation and do not exercise the valve stems while the unit is in a deep vacuum. Packing glands on older valves are prone to leak.
- Never attempt evacuation without a micron or vacuum gauge. The micron gauge will help determine:
  a. If the pump is capable of pulling a deep vacuum.
  b. When the vacuum pump oil is contaminated.
  c. If the vacuum hoses and valves are leak free.
  d. If the unit is leak free.
  e. How long you should evacuate the unit.
  f. That the unit is still in a deep vacuum before any lines are disconnected or refrigerant is added.

NOTE: The attached evacuation procedures have been written to be used with the Thermo King Evacuation System (see Tool Catalog). However, the principles of 3-point evacuation and the use of a micron gauge during evacuation should always be practiced.

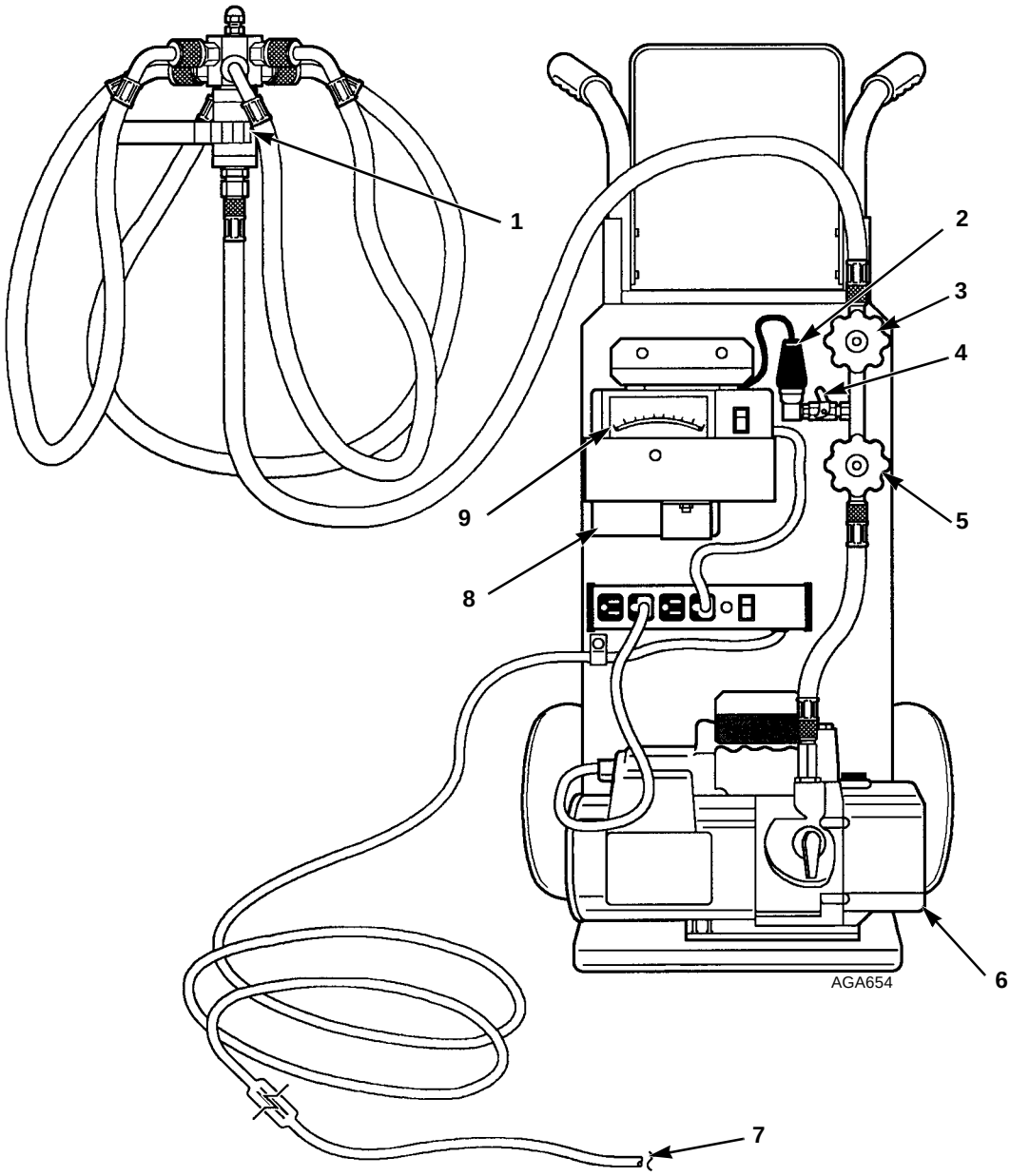
See the diagram of the Thermo King Evacuation Station and note the location of the valves.

Valve #1 (V-1): Is in the open position when the pump is running to evacuate the hoses and/or the unit. When V-1 is closed, the pump has been isolated from the hoses and/or the unit.

Valve #2 (V-2): Is in the open position during unit evacuation. In the closed position, V-2 isolates the micron gauge and thermistor assembly from the hoses and/or the unit.

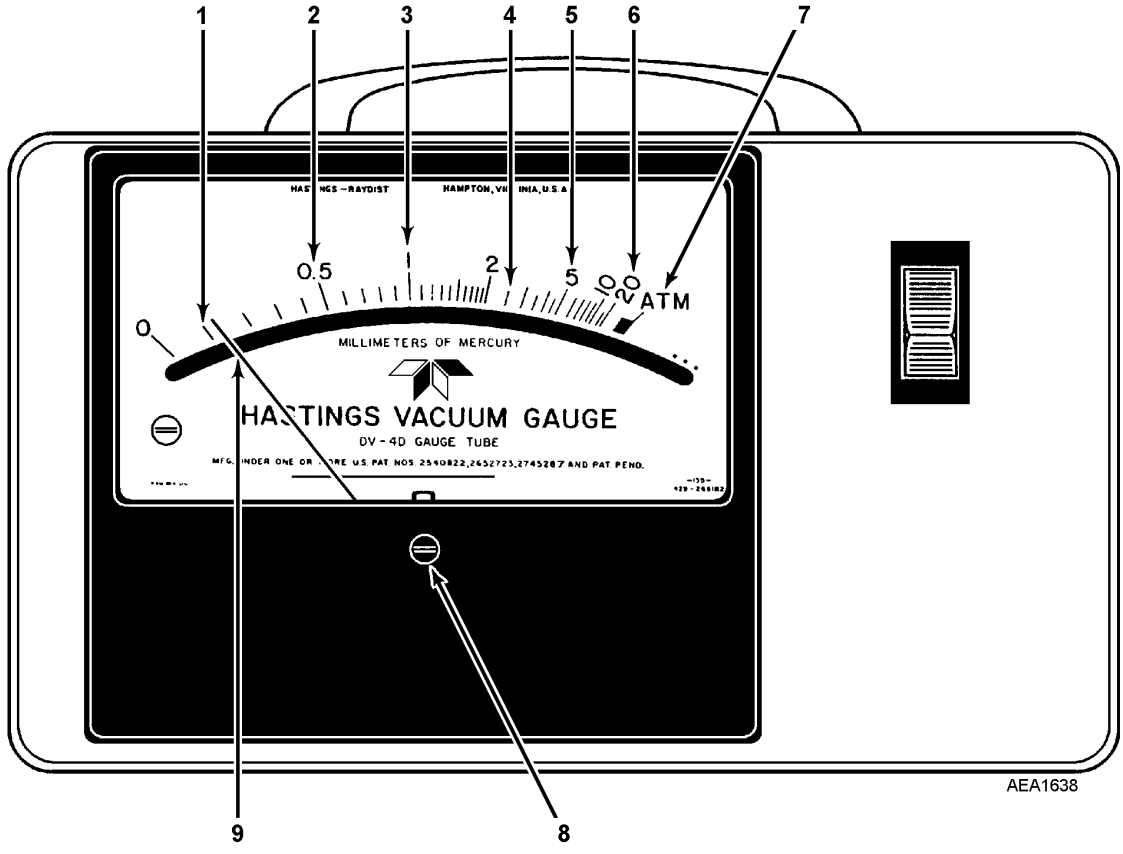
Valve #3 (V-3): Is in the open position during unit evacuation. When closed, V-3 isolates the micron gauge and the vacuum pump from the other evacuation hoses.

Valve #4 (V-4): Is in the open position during unit evacuation. When closed, V-4 isolates the evacuation hoses and the unit from the evacuation system.



1.	V-4	6.	Two Stage Vacuum Pump
2.	Thermistor	7.	To 110 Vac Power
3.	V-3	8.	Calibration Standard
4.	V-2	9.	Vacuum or Micron Gauge
5.	V-1		

Figure 133: Evacuation Station



1.	100 Microns
2.	500 Microns
3.	1000 Microns
4.	2500 Microns
5.	5000 Microns
6.	20,000 Microns
7.	Atmospheric Pressure
8.	Calibration Adjustment Screw
9.	Example: Meter needle shown at calibration position when Calibration Standard specifies 0.15 mm Hg.

Figure 134: Vacuum Gauge

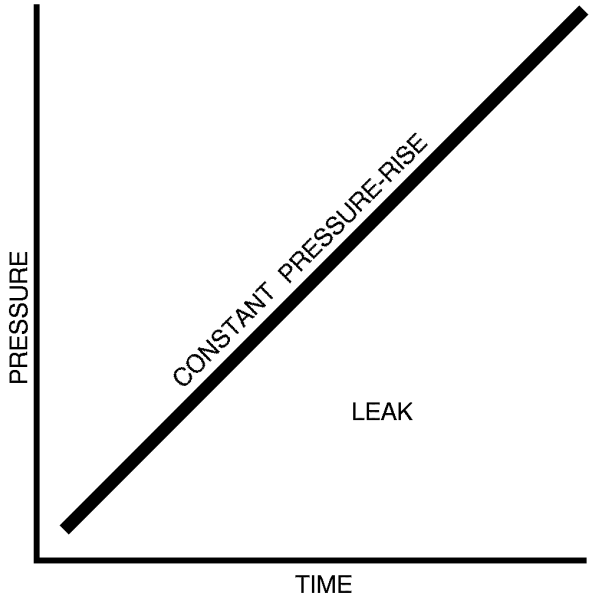
Set Up and Test of Evacuation Equipment

NOTE: See the previous two pages for the following discussion.

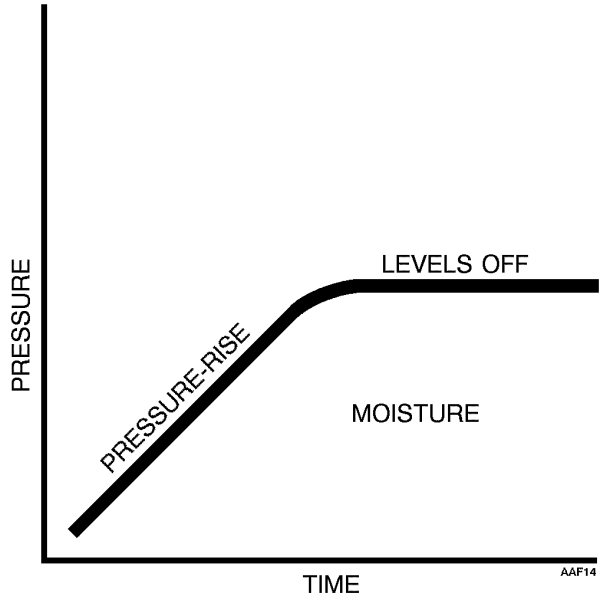
1. Connect the evacuation system to a 110 Vac power supply. Connect a gauge manifold and refrigerant supply to the fitting above valve V-4. Turn the micron gauge On.
2. Close valves V-1, V-3 and V-4. Valve V-2 is open.
3. Turn the vacuum pump On.
4. Open valve V-1 at the pump. The micron gauge needle will move to the left. (See micron gauge scale diagram—previous page).

NOTE: If the vacuum pump is okay, and there are no leaks between V-1 and V-3, the micron gauge should show less than 500 microns. If not, locate and correct the problem.

5. With the pump still operating, open valve V-3. If the micron reading does not return to a level of less than 500 microns, locate and correct the problem before continuing.
6. With the vacuum pump still operating, open valve V-4. The micron level will rise momentarily. If the micron reading does not return to a level of less than 500 microns, locate and correct the problem before continuing.



Leak



Moisture

Isolate the pump from the system by closing the proper valve. Watch the movement of the vacuum gauge needle. If the needle continues to rise, this is an indication that a leak exists in the unit or the connecting line. The leak must then be located and eliminated.

Should the needle show a pressure rise but finally level off to practically a constant mark, this is an indication that the system is vacuum tight but is still too wet, requiring additional dehydration and pumping time.

7. Evacuate hoses to 100 microns or lowest achievable level below 500 microns.
8. Once 100 microns is reached, close valve V-1 at the pump. Turn the vacuum pump Off.
9. Observe the micron gauge reading. The vacuum rise should not exceed 1500 microns in 5 minutes.
10. If the rise is above 1500 microns in 5 minutes, check all hoses and connections for leaks. Hoses with moisture present will require additional evacuation time to achieve satisfactory results.

    NOTE: Dirty vacuum pump oil or a defective vacuum pump will prevent a low micron reading. Hoses and fittings can be isolated individually to identify leaks.

Using The Evacuation Mode Menu

Evacuation Mode opens the system by energizing all normally closed refrigeration valves. This allows the entire refrigeration system to be evacuated.

Evacuation mode is only used with the unit off. Since a number of refrigeration valves must be energized for an extended period of time, the operator is prompted to connect a battery charger to the unit battery. This maintains the unit battery in a charged condition and insures ample voltage to hold all refrigeration valves in the open position during the evacuation process.

WARNING: Do not set battery charger to the "crank" or "start" position, otherwise the HMI display will be damaged.

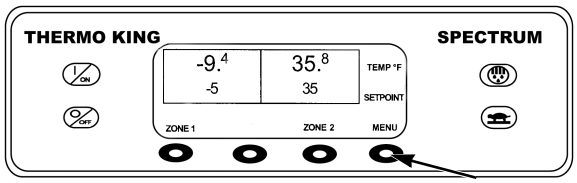


Figure 135: Press Menu Key

The Maintenance Menu is accessed from the first Operator Menu screen that appears; either the Language Display or the Alarms Display. The Alarms Display is shown here. Press and hold both the unlabeled soft key and the Exit key for 5 seconds.

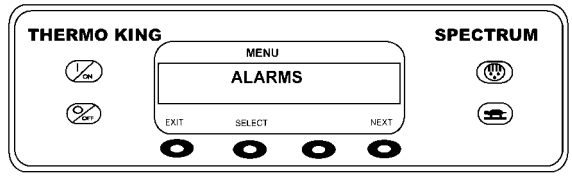


Figure 136: Press and Hold Exit and Unlabeled Key

The Maintenance Hourmeter Menu will appear. Press the NEXT key as required to show the Evacuation Mode

Menu. When the Evacuation Mode Menu is shown press the SELECT key.

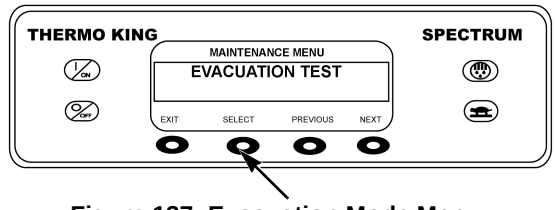


Figure 137: Evacuation Mode Menu

The display will indicate that the Evacuation Mode is being programmed.

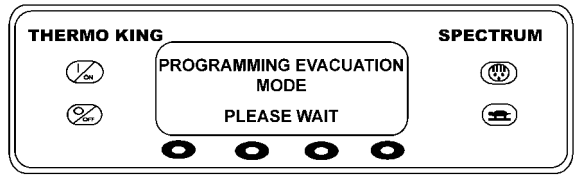


Figure 138: Programming

The operator is prompted to connect a battery charger capable of 20 amps to the unit battery. This maintains the unit battery in a charged condition and insures ample voltage to hold all refrigeration valves in the open position during the evacuation process.

WARNING: Do not set battery charger to the "crank" or "start" position, otherwise the HMI display will be damaged.

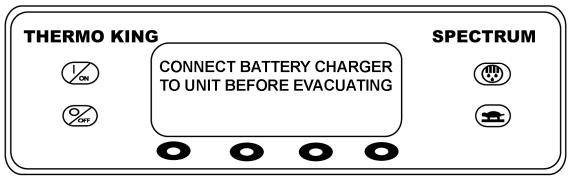


Figure 139: Connect Battery

The battery voltage is shown and all normally closed refrigeration valves are opened. They will remain open until the EXIT key is pressed or the battery voltage falls below a minimum voltage.

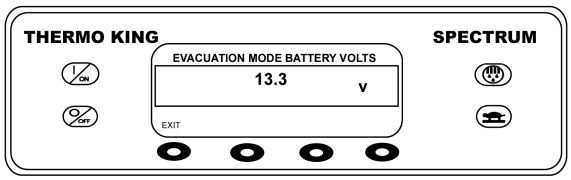


Figure 140: Battery voltage

Proceed with system evacuation.

Unit Evacuation

NOTE: Do not attempt to evacuate the unit until the evacuation equipment has been tested and its performance has been verified.

1. Prepare the unit for evacuation. Recover refrigerant to 0 psig (0 kPa).

   NOTE: New Federal Regulations may require your recovery machine to pull the system's pressures lower than 0 psig [0 kPa].

   CAUTION: Do not attempt to evacuate a unit until you are certain that the unit is leak free. A unit with less than a full refrigerant charge should be thoroughly leak checked and all leaks must be repaired.

2. Install hoses on the receiver tank, suction service valve and discharge service port.
3. Connect a gauge manifold and refrigerant supply to the spare access port on valve V-4. Bottle valve closed.
4. Start the vacuum pump and open valves V-1, V-2, V-3, V-4.
5. Evacuate the system to 500 microns or the lowest achievable level between 500 and 1000 microns.

   NOTE: The presence of refrigerant in the compressor oil may prevent a low micron reading from being achieved. The oil can continue to "outgas" for long periods of time. If the micron level appears to stall after 1/2 hour or 45 minutes between 1000 and 1500 microns, back seat the suction service valve and observe the micron gauge. A sharp drop in the micron reading (300 to 500 microns) would indicate that refrigerant is present in the oil or a leak exists in the compressor area.

6. When the desired micron level has been achieved (500 to 1000 microns), close valve V-1 at the pump. Turn the pump to Off.
7. Observe the reading on the micron gauge after 5 minutes have elapsed. The vacuum rise should not exceed 2000 microns. If the vacuum level exceeds 2000 microns after 5 minutes, a leak is present or additional evacuation time is required.
8. If the vacuum level is acceptable, start the pump and open valve V-1 to evacuate the pressure rise (5 minutes).
9. Close valve V-1 and stop the pump. Observe the micron gauge to confirm that the system remains in a deep vacuum. Close valve V-4. The unit is ready to charge.

Leak Check System

NOTE: Refer to Diagnosing Thermo King Refrigeration Systems (TK-5984-10) for leak detection procedures.

1. Put unit into Evacuation Mode with HMI.
2. Connect leak test gas (R-404a) supply to center hose of gauge manifold.
3. Attach gauge manifold hoses to the suction service valve and the discharge service port.
4. Pressurize the system with leak test gas. If desired, system pressure may be boosted using nitrogen gas.
5. Check connections made during installation for leaks using electronic leak detector and/or soap bubbles.

6. Recover test gas to repair leaks. System must be vented while repairing solder joint leaks. Pressurize system and check again after a leak has been repaired.
7. If no leaks are found recover test gas to 0 psi.

Unit Charging

NOTE: Unit must be leak checked and fully evacuated before charging.

1. Install a gauge manifold. Attach the low side gauge to the service port on the suction service valve. Attach the high side gauge to the service port on the discharge line near the condenser inlet solenoid.
2. Close the valves on the gauge manifold.
3. Mid seat the compressor suction service valve.
4. Connect a refrigerant supply to the gauge manifold service line and purge the line.
5. Set the refrigerant supply bottle to liquid and open the hand valve.
6. Open the high side gauge manifold valve. Add a partial charge of 10 lbs (4.5 kg) of liquid refrigerant and close the high side gauge manifold valve. The remainder of the charge will be added as a liquid through the low side gauge manifold valve.
7. Set both zones to High Speed Cool through the HMI Service Test Mode.
8. Observe the suction pressure and slowly open the low side gauge manifold valve to allow liquid refrigerant to flow into the compressor suction service valve.
9. Control the liquid flow so the suction pressure increases approximately 20 psig (138 kPa).
10. Maintain a discharge pressure of at least 300 psig (2068 kPa) while adding refrigerant.
11. Close low side gauge value when the receiver sight glass shows 1/2 to 3/4 full.
12. Establish a return air temperature of 0 F (-18 C), a suction pressure of 13 to 18 psig (90 to 124 kPa), and a discharge pressure of 300 psig (2069). See See “Testing the Refrigerant Charge with an Empty Box” on page 112.
13. Check the receiver tank sight glass. The refrigerant level should remain between 1/2 and 3/4 full over a period of no less than five minutes.
14. When the correct amount of charge has been added, close the gauge manifold hand valve.

NOTE: At these conditions the Liquid Injection Valve will cycle on and off. As this happens the refrigerant level in the receiver tank sight glass will raise and lower. Therefore, monitoring the receiver tank sight glass for a period of five minutes to make sure that the average level of the refrigerant over this five-minute period is between 1/2 and 3/4 full is required.

Remove Refrigerant Hoses

1. A low leak fitting must be used on hoses when Schrader port fittings are encountered on units (unit Off).
2. With a low leak fitting on the discharge gauge line, remove this line from the unit.
3. Back seat the receiver tank service valve (run the unit until a 3 to 5 psig [21 to 35 kPa] reading is obtained on the suction gauge). Stop the unit.
4. Back seat the suction service valve and remove all remaining hoses.
5. Install and tighten service port and valve stem caps.
6. Unit is ready for a functional check out.

Refrigerant Leaks

Use a reliable leak detector (e.g., electronic detector) to leak test the refrigeration system. Inspect for signs of oil leakage which is the first sign of a leak in the refrigeration system.

NOTE: It is normal for compressor shaft seals to have a slightly oily film.

Refrigerant Charge

Testing the Refrigerant Charge with an Empty Box

If the unit has an insufficient charge of refrigerant, the evaporator will be "starved" and the box temperature will rise even though the unit is operating. The suction pressure will drop as the refrigerant charge decreases. The charge may be determined by inspection of the refrigeration through the receiver tank sight glass with the following conditions established:

1. Place compartment bulkheads to separate zones.
2. Install the gauge manifold.
3. Run the unit on high speed cool until the air in the box indicates 0 F (-18 C). By allowing the box to leak a small amount, you will be able to maintain 0 F (-18 C).
4. The discharge or head pressure gauge should read 275 psig (1896 kPa).

   If the pressure is below this, it can be raised by covering a portion of the condenser coil with a piece of cardboard.
5. The compound gauge should be indicating 13 to 18 psig (90 to 124 kPa) gauge pressure.

   If there is any doubt about the unit gauge, check the calibration.
6. Under these conditions, the ball in the receiver tank sight glass should be floating. If there is no indication of refrigerant in the receiver tank sight glass, the unit is low on refrigerant.

Testing the Refrigerant Charge with a Loaded Box

1. Install a gauge manifold (optional).
2. Run the unit on the Cool cycle.
3. Cover at least three quarters of the condenser to drive any excess refrigerant from the condenser into the receiver tank.
4. As the head pressure is rising, check the receiver tank sight glass. The ball should be floating. If there is no indication of refrigerant in the receiver tank sight glass, the unit is low on refrigerant.

   NOTE: If the ball floats, there is sufficient refrigerant in the unit for that load at that particular box temperature. This test does not determine if the unit contains a full charge of refrigerant.

Checking Compressor Oil

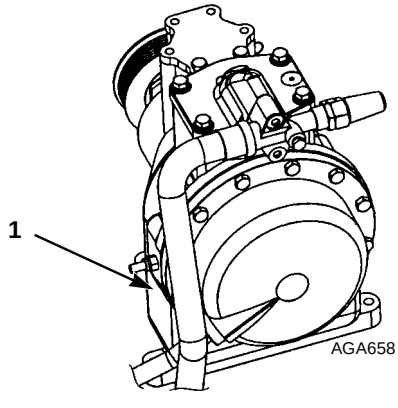
The compressor oil should be checked when there is evidence of oil loss (oil leaks) or when components in the refrigeration system have been removed for service or replacement. The oil level in the compressor oil sight glass should be 1/2.

To check compressor oil level with an ambient air temperature above 50 F (10 C):

Install a gauge manifold.

Operate the unit on high speed cool with a 10 psig (69 kPa) minimum suction pressure and 185 psig (1275 kPa) minimum discharge pressure for 15 minutes or more.

After the unit has maintained the above conditions for 15 minutes, observe the oil level. The oil should be 1/2 up in the sight glass.



1.	Compressor Oil Sight Glass Location

Figure 141: Scroll Compressor

CAUTION: Oil is under pressure. See instructions for adding oil.

To check compressor oil level with an ambient air temperature below 50 F (10 C):

Run the unit through a complete Defrost cycle. After completing the Defrost cycle, run the unit on Cool for ten minutes. Observe the oil level. The oil should be 1/2 up in the sight glass.

If the evaporator temperature is above 32 F (0 C), it will be necessary to force defrost. To force defrost, use the relay board test.

If the box is empty, you can run the unit on the Heat cycle instead of the Defrost cycle.

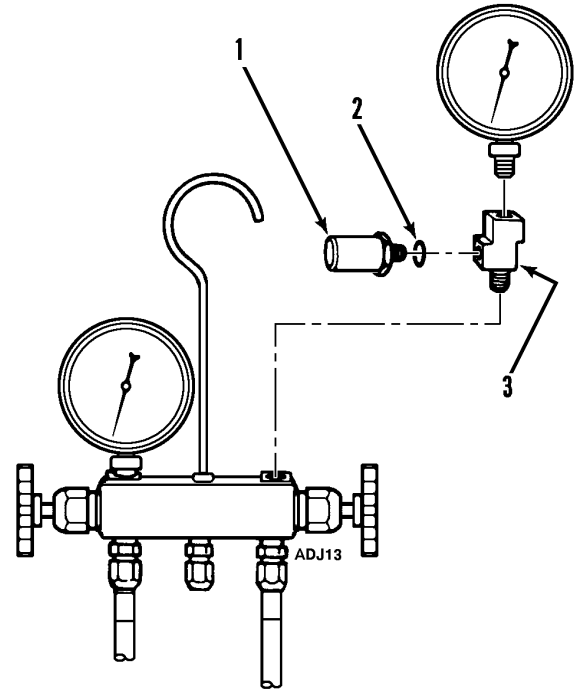
NOTE: Use refrigeration compressor oil ONLY. R-404A systems use a special Ester oil (see Tool Catalog). Required for Scroll compressors.

Oil can be added to the compressor through the Schrader valve on suction adapter while the unit is running. Take precautions to prevent contaminants from entering the system while adding oil.

High Pressure Cutout (HPCO)

The high pressure cutout is located on the discharge line. If the discharge pressure rises above 470 psig (3241 kPa), the switch opens the 8H circuit to stop the unit. To test the switch, rework a gauge manifold per illustration.

1. Connect the gauge manifold to the discharge service port with a heavy duty, black jacketed thick wall #HCA 144 hose with a 900 psig (6204 kPa) working pressure rating.



1.	Relief Valve
2.	O-ring
3.	Adapter Tee Weather Head

Figure 142: High Pressure Cutout Manifold

2. Set the thermostat well below the box temperature so that the unit will be in High Speed Cool.

3. Raise the discharge pressure of the compressor by blocking the condenser coil air flow by covering the roadside condenser grille with a piece of cardboard.

   NOTE: The discharge pressure should never be allowed to exceed a pressure of 470 psig (3241 kPa) on R-404A systems.

4. Failure of the HPCO system to stop compressor operation should be investigated first by checking the control circuit operation and secondly by HPCO switch replacement.

Low Side Pump Down

CAUTION: Do not pull scroll compressor into a deep vacuum to perform routine maintenance procedures.

NOTE: Operate the unit in COOL for 2 to 5 minutes before performing the low side pump down.

1. Unplug the hot gas bypass solenoid.
2. Install a gauge manifold to the suction service valve and the discharge service port.
3. Operate the unit in low speed cool.
4. Close the receiver tank outlet valve and allow the low side to pump down to 0 to 5 in. Hg vacuum (0 to -17 kPa).

CAUTION: Do not run scroll compressor in a vacuum for more than a few seconds.

5. Turn the unit Off.
6. Prepare to perform service on the low side by equalizing the high side and low side pressures through the gauge manifold.
7. Equalize low side pressure to 1 to 2 psig (7 to 14 kPa).

   NOTE: Repeat the pump down procedure if the pressures equalize above 20 psig (138 kPa). If acceptable low pressures cannot be achieved after the third pump down, the refrigerant must be recovered to perform service on the low side.

   NOTE: Valve stem MUST be back seated during normal unit operation.

8. Plug in the hot gas bypass solenoid.
9. Open the receiver tank return outlet valve, remove the gauges and return the unit to normal operation.

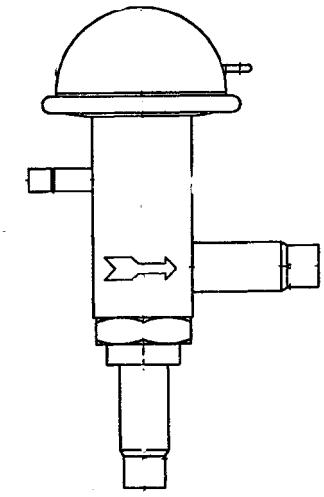


Figure 143: Discharge Pressure Regulator

Discharge Pressure Regulator Valve

This unit is equipped with a discharge pressure regulator valve, which is located in the hot gas line between the hot gas valve and the discharge line. The discharge pressure regulator valve maintains the compressor discharge pressure at 340 to 400 psig (2344 to 2758 kPa) during heat and defrost operation. These higher discharge pressures create higher discharge temperatures, resulting in enhanced heating capabilities.

The compressor discharge pressure is regulated by a spring and bellows. This valve is pre-set at the factory to maintain the compressor discharge pressure at 340 to 400 psig (2344 to 2758 kPa) during heat and defrost operation. This valve should not require any adjustment.

The discharge pressure regulator valve is not repairable and must be replaced as an assembly.

NOTE: It is generally good practice to replace the filter drier whenever the high side is opened or when the low side is opened for an extended period of time.

Accumulator

Removal

1. Remove refrigerant using approved methods.
2. Unsolder the inlet and outlet refrigerant suction lines from the accumulator tank.
3. Unbolt and remove the accumulator from the unit.

Installation

1. Place the accumulator in the unit and tighten the mounting bolts.
2. Solder the inlet and outlet suction lines to the accumulator tank.
3. Pressurize the low side and test for refrigerant leaks. If no leaks are found, *evacuate unit*.
4. Charge the system with refrigerant. Check refrigerant charge and compressor oil and add as required.

Compressor

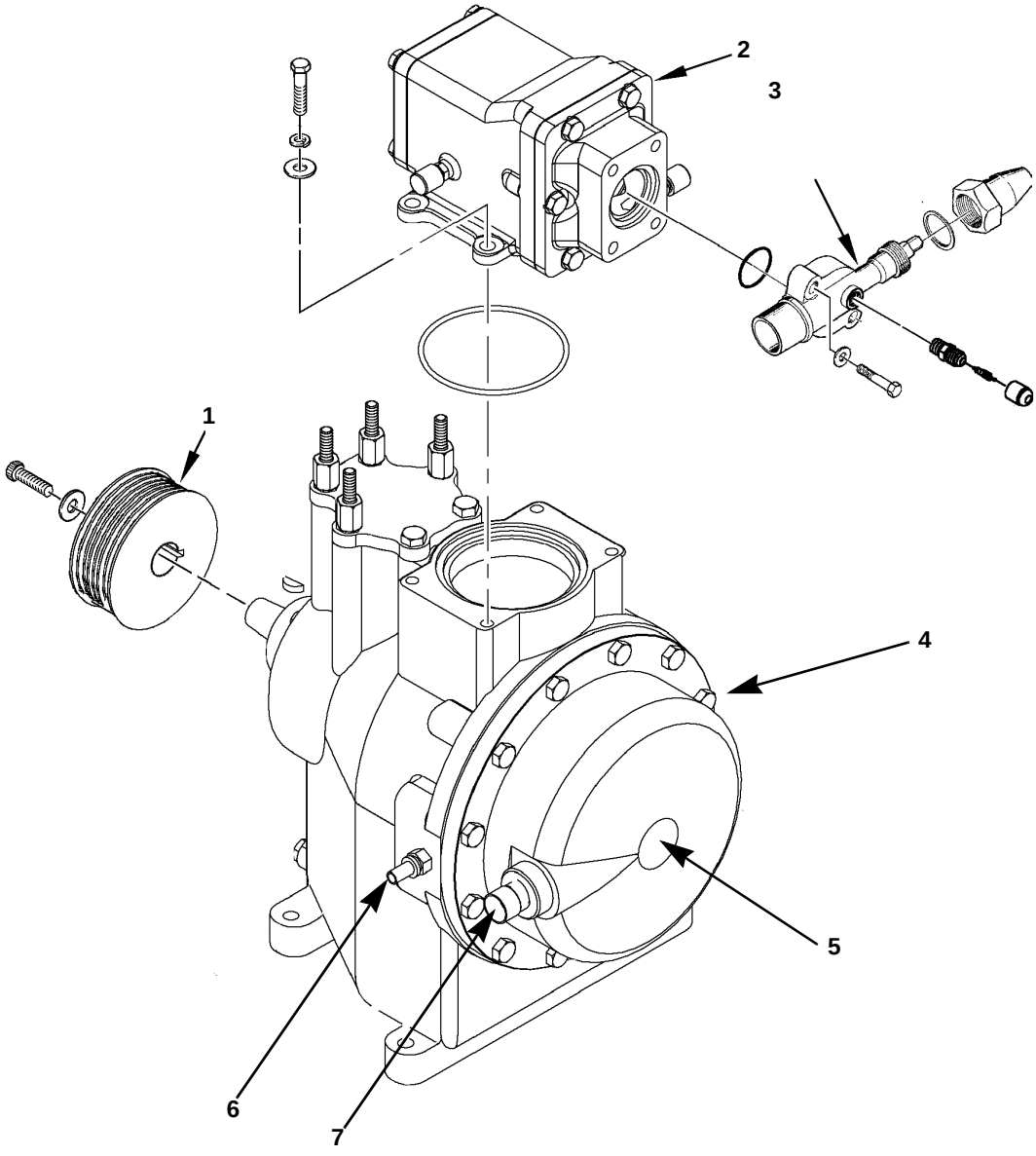
Removal

1. Remove the refrigerant from the unit using approved methods.
2. Loosen and remove the compressor/electric motor belt from the compressor pulley.
3. Unscrew the discharge line or fitting. Unsolder the liquid injection line, and unbolt the suction valve from the compressor.
4. Disconnect the thermister, unsolder liquid injection line and the discharge line.
5. Remove the compressor stabilization bracket and the compressor mounting bolts.
6. Lift the compressor out of the unit. Keep the compressor ports covered to prevent dust, dirt, etc., from falling into the compressor.
7. Unsolder the discharge line.

   NOTE: When the compressor is removed from the unit, the oil level should be noted, or the oil removed from the compressor should be measured so that the same amount of oil can be added before placing the replacement compressor in the unit.

Installation

1. Solder in the discharge line.
2. Lift the compressor into the unit and install the mounting bolts and the stabilization bracket.
3. Install the service valve using new gaskets soaked in refrigeration oil.
4. Reconnect the thermister, the discharge line, and liquid injection line.
5. Pressurize the compressor and test for refrigerant leaks.
6. If no leaks are found, *evacuate the system*. Replace the compressor/electric motor belt and adjust the tension.
7. Charge the system with refrigerant.
8. Operate the unit at least 30 minutes and then inspect the oil level in the compressor. Add or remove oil if necessary.
9. Check the refrigerant charge and add refrigerant if needed.



1.	Compressor Pulley	5.	Thermister
2.	Throttle Valve	6.	Liquid Injection Port
3.	Suction Valve	7.	Discharge Port
4.	Scroll Compressor		

Figure 144: Compressor Components

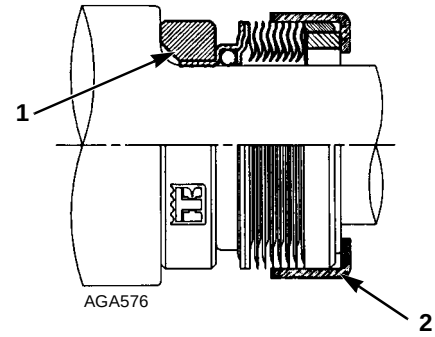
Shaft Seal Change Procedure

Thermo King recommends changing the compressor shaft seal when there is a major system interruption, such as component replacement or total loss of refrigerant charge. When the shaft seal is changed, Thermo King also recommends changing the oil and oil filter.

The steps for changing the shaft seal are as follows:

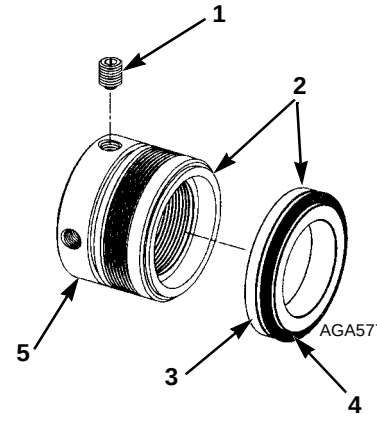
1. Recover refrigerant. Equalize pressure to slightly positive.
2. Remove compressor.
3. Remove drive pulley and Woodruff key from the shaft.
4. Clean shaft seal cover of excess dirt.
5. Remove four Torx head screws from shaft seal cover.
6. Carefully pry the shaft seal cover out of compressor body using flats at top and bottom of shaft seal cover.
7. Remove the old hard ring, lip seal, and o-rings from the seal cover.
8. Loosen the set screws that secure the bellows to the shaft. These set screws typically use an 1/8 inch Allen wrench which is provided with the new seal.
9. Remove the old bellows from the shaft. Use a small prybar or screwdriver on each side of the bellows, but do not scratch the shaft when removing the bellows. Be careful not to loose the spacer that is on the shaft.
10. Ensure the spacer is properly located on the shaft flat.
11. Back out the set screws from the new bellows and apply a small amount of removable thread locking compound (Loctite™ see Tool Catalog) to the set screw threads.

CAUTION: Keep the orange protective cap in position until final assembly.



1.	Clamp Ring
2.	Orange Protective Cap

Figure 145: Cross Section of Set Screw Type Bellows



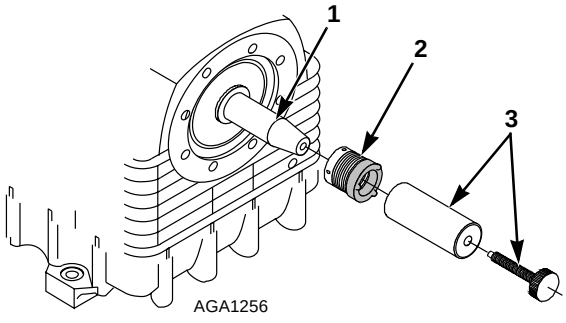
1.	Set Screw
2.	Seal Faces
3.	Hard Ring
4.	O-ring
5.	Bellows

Figure 146: Set Screw Type Bellows Seal

12. Apply clean compressor oil to the o-ring inside the bellows and place the bellows on the shaft. Leave the orange protective cap on the bellows.

13. Use seal installation tool (see Tool Catalog) to install the bellows squarely on the shaft. Clean the seal installation tool and place it on the shaft. Turn the knob until the tool bottoms out.

    NOTE: The following illustration shows the seal installation tool being used on a reciprocating compressor. The same procedure applies to the scroll compressor.



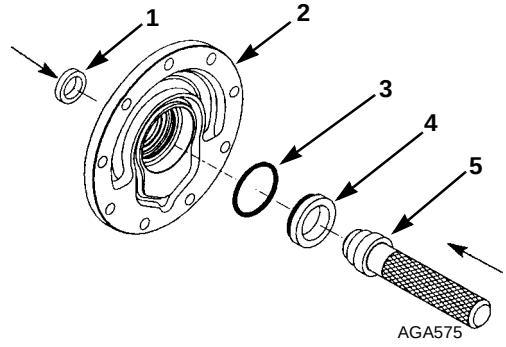
1.	Crankshaft
2.	Bellows
3.	Seal Installation Tool

Figure 147: Bellows Installation with Tool

14. Tighten the set screws to approximately 45 in.-lb (5.0 N•m) with the Allen wrench provided.
15. Remove the seal installation tool.
16. Install the new lip seal in the seal cover with the lip side facing out and the flat side facing toward the compressor.
17. Apply clean compressor oil to the new o-ring and install it in the seal cover. Apply clean compressor oil to the new hard ring. Ensure that the hard ring installation tool (see Tool Catalog) is clean. Use the hard ring installation tool to push the hard ring (with the polished surface toward the installation tool) fully into the seal cover. Do not pinch the o-ring.

    If the installation tool is not available, use the pad in the new seal packaging to protect the polished surface of the hard ring during assembly. A substitute installation tool should have a diameter approximately the same size as the O.D. of the polished surface.

    NOTE: The following illustration shows the seal installation tool being used on a reciprocating compressor seal cover. The same procedure applies to the scroll compressor seal cover.



1.	Lip Seal
2.	Seal Cover
3.	O-ring
4.	Hard Ring—Install with Polished Surface Toward Compressor
5.	Hard Ring Installation Tool

Figure 148: Lip Seal and Hard Ring Installation

CAUTION: Do NOT touch or damage the polished seal face surfaces.

18. Remove the orange protective cap. Clean the hard ring and the primary ring (bronze ring) with the alcohol wipes found in package labeled “1”. Then clean the polished mating surfaces of both rings with the lint free dry wipes from package number “2”. Apply clean compressor oil to polished surfaces of the seal and to the lip seal from package number “3” before assembling.

CAUTION: Oil applied to the seal faces must be absolutely clean.

19. Lubricate the new seal cover o-ring with compressor oil (see Tool Catalog) and install on the seal cover.
20. Install the seal cover on the body and torque screws to 100 to 110 in-lb (11.2 to 12.4 N•m). Do not bump the hard ring into the end of the shaft during assembly.
21. Install the Woodruff key and drive pulley. Torque the pulley bolt to 30 to 35 ft.-lb (41 to 47 N•m).

Parts List (Required)	
Seal Cover O-ring	See Tool Catalog
Use Seal Kit	See Tool Catalog

Parts List (As Needed)	
Torx Screws	See Tool Catalog

Compressor Oil Filter Replacement

Thermo King recommends changing the compressor oil filter when there is a major system interruption, such as component replacement or total loss of refrigerant charge. When the oil filter is changed, Thermo King also recommends changing the oil.

1. Recover refrigerant. Equalize pressure to slightly positive.
2. Clean oil filter cover plate area of excess dirt.
3. Remove cover plate and spring, noting the location of hex studs for proper installation.
4. Scrape gasket off compressor body and cover plate.
5. Remove oil filter and o-ring.
6. Clean oil filter cavity of any noticeable debris.
7. Lubricate new o-ring with compressor oil.
8. Press oil filter and o-ring over stem in compressor body until seated.
9. Lubricate new gasket with compressor oil.
10. Install spring, new gasket, and cover plate, using hex studs and torque head screws, torquing to 290 to 310 in-lb (34 to 36 N•m). Be certain to install hex studs in their original location.

Parts List (Required)	
Oil Filter and O-ring	See Tool Catalog
Gasket	See Tool Catalog

Parts List (As Needed)	
Cover Plate	See Tool Catalog
Spring	See Tool Catalog
Hex Studs	See Tool Catalog
Torx Screws	See Tool Catalog

Scroll Compressor Oil Change

1. Recover refrigerant. Equalize pressure to slightly positive.
2. Clean oil drain cap area (bottom and bottom rear of compressor) of excess dirt.
3. Remove oil drain plug from bottom rear of compressor to drain oil. Measure amount of oil drained from compressor.
4. Remove two screws and oil drain cap from compressor.
5. Scrape gasket from oil drain cap and body.
6. Remove spring, screen and screen cover from body.
7. Clean screen and cover.
8. Replace screen cover, ensuring notch in cover is aligned with notch in body.
9. Lubricate new gasket with compressor oil.
10. Replace screen, spring, gasket, cover plate, and screws.
11. Torque screws to 290 to 310 in-lb (34 to 36 N•m).
12. Lubricate o-ring on SAE plug with compressor oil.
13. Replace SAE plug in rear bottom of body, torquing to 100 to 110 in-lb (11.2 to 12.4 N•m).

14. Measure oil removed and add an equal amount or add 40 oz (1.2l) of compressor oil (see Tool Catalog), by pouring oil into the oil filter cavity.

NOTE: The gasket must be replaced (see Tool Catalog).

Other Parts Which May Be Used (As Needed) Are:	
SAE Plug	See Tool Catalog
Torx Head Screws	See Tool Catalog
Cover Plate	See Tool Catalog
Spring	See Tool Catalog
Screen	See Tool Catalog
Screen Cover	See Tool Catalog

Temperature Thermister Change Procedure

NOTE: Thermo King recommends changing the temperature thermister whenever the insulation on the leads has been broken or there is other reason to suspect a defective thermister.

The steps for changing the high temperature cutout thermister are as follows:

1. Cut through silicone sealant surrounding plastic cap.
2. Pry plastic cap out of top cap.
3. Remove thermister by pulling it out of top cap well.
4. Clean all debris out of top cap well and off of top cap surface.
5. Apply 0.25 to 0.50 cubic centimeters of thermally conductive silicone grease (p/n CHEMPLEX 1381 Heatsink Silicone into thermal well.
6. Apply RTV to underside of plastic cap and insert thermister back into well.

Parts List (As Needed)	
Thermister Assembly	See Tool Catalog
Silicone Sealant	N/A
RTV	See Tool Catalog

Liquid Injection Fitting Change Procedure

The steps for changing the liquid injection fitting are as follows:

1. Recover refrigerant. Equalize pressure to slightly positive.
2. Clean compressor body in area of liquid injection fitting.
3. Sweat tubing out of liquid injection fitting.
4. Visually inspect screen in liquid injection fitting.
5. If plugged, carefully remove liquid injection fitting from compressor body.
6. Install new o-ring on new liquid injection fitting.
7. Lubricate new o-ring with Mobil™ oil (see Tool Catalog).
8. Carefully thread new liquid injection fitting through compressor body into steel block on the inside. Make sure the fitting is not cross-threaded in the steel block.
9. Torque liquid injection fitting to 100 to 120 in-lb (11.2 to 13.6 N•m).
10. Re-attach tubing to liquid injection fitting.
11. Pressurize the unit and check for leaks.
12. Evacuate the unit and recharge system.

Parts List (As Needed)	
O-ring	See Tool Catalog
Liquid Injection Fitting	See Tool Catalog

Condenser/Radiator Coil

Removal

1. Remove the refrigerant charge by approved methods.
2. Remove the grille assembly.
3. Drain engine coolant from the expansion tank and disconnect the coolant hoses from the condenser/radiator coil.
4. Unsolder the hot gas inlet tube and liquid refrigerant line connections.

5. Unbolt and remove the condenser/radiator cap.

Installation

1. Clean the tubes for soldering.
2. Place the coil in the unit and install the mounting hardware.
3. Solder the inlet line and liquid line refrigerant connections.
4. Pressurize the refrigeration system and test for leaks. If no leaks are found, *evacuate the system*.
5. Connect the coolant hoses to the radiator and refill the expansion tank with 50/50 ethylene glycol/water solution.
6. Recharge the unit with refrigerant and check the compressor oil.
7. Reinstall the front grille.

Liquid Injection Valve

Removal

1. Pump down the unit and recover charge.
2. Unsolder the inlet/outlet lines from the liquid injection valve.
3. Remove liquid injection valve mounting bolts and remove the liquid injection valve from the unit.

Installation

1. Install and bolt the liquid injection valve assembly in the unit.
2. Solder (95-5 Solder) the inlet liquid line and the outlet line to the injection valve.
3. Pressurize the unit and test for leaks. If no leaks are found, *evacuate the unit and recharge*.
4. Open the refrigeration valves and place the unit in operation.
5. Test the unit to see that the valve is properly installed.

Dehydrator (Filter-Drier)

Removal

1. Pump down the refrigeration system and equalize the pressure to slightly positive.
2. Disconnect the nuts at the end of the drier.
3. Loosen the mounting hardware and remove the drier.

Installation

1. Install the new drier and tighten the mounting screws and nuts. Install new o-rings.
2. Install and tighten the inlet nut to the receiver tank outlet valve line (inlet end of drier is labeled “IN”). Hold the drier with a back-up wrench on the hex behind the flare fitting.
3. Release a small amount of refrigerant to purge the air through the drier. Then tighten outlet nut on the dehydrator to the evaporator line.
4. Pressurize the system and inspect for leaks. If no leaks are found, open the refrigeration valves and place the unit in operation.

High Pressure Cutout Switch

Removal

1. Install gauge manifold set.
2. Start the unit and pump down the low side.
3. Stop the unit.
4. Bleed high side to low side using gauge set.
5. Disconnect the wires and remove the high pressure cutout switch from the discharge tube.

Installation

1. Apply a refrigerant Loctite™ to the threads of the high pressure cutout switch.
2. Install and tighten high pressure cutout switch and reconnect the wires.
3. Pressurize the refrigeration system and test for leaks. If no leaks are found, evacuate the system.

High Pressure Relief Valve

Removal

1. Remove the refrigerant charge.
2. Unscrew and remove the high pressure relief valve.

Installation

1. Apply a refrigerant Loctite™ to the threads of the high pressure relief valve.
2. Install and tighten the high pressure relief valve.
3. Pressurize the refrigeration system and test for leaks. If no leaks are found, evacuate the system.
4. Recharge the unit with refrigerant and check the compressor oil.

Receiver Tank

Removal

1. Remove the refrigerant charge.
2. Unsolder the inlet tube from the receiver tank.
3. Unsolder the filter drier line from the receiver tank outlet tube.
4. Unbolt the mounting brackets and remove the receiver tank from the unit.

Installation

1. Place the receiver tank in the unit and install the mounting bolts and nuts loosely. Position the receiver tank so the sight glass is clearly visible and the outlet tube lines up.
2. Solder the condenser inlet tube.
3. Solder the filter drier line to the receiver tank outlet valve.
4. Tighten the receiver tank mounting hardware securely.
5. Pressurize the refrigeration system and check for leaks. If no leaks are found, evacuate the system.
6. Recharge the unit with refrigerant.

R-404A

The refrigeration industry has introduced a new refrigerant called R-404A. This refrigeration is classified as a Hydro-fluorocarbon (HFC) because it contains hydrogen fluorine and carbon. It does not contain chlorine.

The capacities of these new refrigerants are similar for box temperatures above 0 F (-18 C). At temperatures below 0 F (-18 C), HFC refrigerant capacities are slightly less than CFC refrigerants.

Unit Identification

Units charged with R-404A are identified by the following methods:

1. HFC-404A will be stamped on the unit's serial plate.
2. "HFC" may be incorporated in the model designation on the sides of the unit.
3. Decals will be applied to unit as shown below:

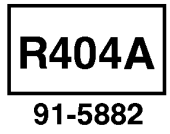


Figure 149: R404A Decal

Availability

Refrigerant 404A is available from wholesalers. The price will depend upon the quantity purchased. Thirty (30), 50 and 125 containers are available.

Leak Detection

Leaks can be detected by a Halogen leak detector such as the G.E. H10G or portable leak detector (see Tool Catalog). See Truck and Trailer Service Bulletin T&T 048 for additional details.

Compressor Oil

As of January 1, 1993, Thermo King Corporation has chosen to use a compressor oil called Polyol Ester (POE)—also called ester based oil. POE oil is compatible with R-404A and can be used in low temperature applications. This oil is available from service parts (see Tool Catalog). *Required for Scroll compressors.*

Compressors Shipped with POE Oil

Thermo King Scroll compressors are charged with Polyol Ester oil (POE). All gauge fittings are 1/4 inch fittings.

CAUTION: POLYOL ESTER (POE) IS THE ONLY OIL FOR USE WITH THERMO KING UNITS USING R-404A. IT SHOULD NOT BE ADDED TO STANDARD THERMO KING UNITS, NOR SHOULD THE STANDARD OR SYNTHETIC OIL BE ADDED TO SYSTEMS CONTAINING R-404A. COMBINING THE TWO OILS COULD RESULT IN DAMAGE TO THE SYSTEM.

Because Polyol Ester has an affinity for moisture, it must be kept in capped containers. In addition, it should be added as the last step in system repair. Rubber gloves are recommended when handling Polyol Ester because it may cause skin irritation.

Equipment Recommendations For Use With R-404A

Dedicated Equipment

CAUTION: Equipment that has been used with other refrigerants MUST NOT be used with R-404A refrigerants. Mixing R-404A with other refrigerants will cause contamination of the refrigerant. Using contaminated refrigerant will cause system failure.

Vacuum Pumps

When evacuating, a two stage three or five CFM pump is recommended. It is also recommended that dry nitrogen be used first. Ideally, a new vacuum pump should be used and dedicated for use with R-404A systems because residual refrigerants may remain in used vacuum pumps.

Pumps used with other Thermo King refrigerants may be used but extreme care should be taken to prevent contamination of R-404A systems with other refrigerants.

The Thermo King Evacuation Station is recommended. This station is available from service parts (see Tool Catalog). See Truck and Trailer Service Bulletin T&T 061 for additional details.

Use only recommended vacuum pump oils and change oil after every major evacuation. Vacuum pump oils are highly refined and the use of contaminated oils will prevent the desired vacuum from being obtained. Failure to follow these recommendations may result in conditions that will destroy the vacuum pump.

Gauge Manifold Sets

Gauge manifold sets that show the correct pressure-temperature relationship should be used. Gauge manifolds and manifold hoses used with other Thermo King refrigerants maybe used but extreme care should be taken to prevent contamination of the R-404A systems with other refrigerants. Purge manifold and hoses with dry nitrogen before using. *Never use equipment that may be contaminated with automotive type Polyalkylene Glycol (PAG) oils.*

System Clean-up

Existing clean up devices such as suction line filters and compressor oil filters may be used if they are thoroughly cleaned and new filter elements are installed. All standard compressor oils must be removed from clean-up devices to prevent contamination of R-404A systems. Dangerous contamination will result if other refrigerants or standard oils are introduced to R-404A systems.

NOTE: For additional information on parts and supplies, consult your local Thermo King dealer and the Thermo King Tool Catalog.

Refrigerant Recovery

Present systems can be adapted to the recovery of R-404A but should be dedicated to the recovery of these refrigerants. Consult the manufacturer of your recovery equipment for details.

Throttling Valve

Removal

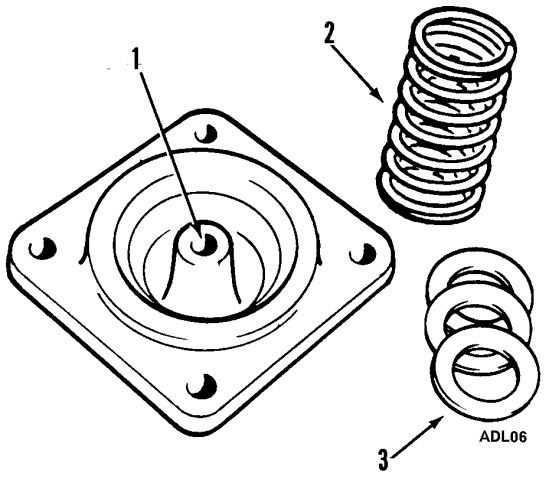
1. Pump down the unit using the refrigerant recovery system.
2. Front seat the suction service valve. Release remaining pressure.
3. Remove the suction valve and line.
4. Unbolt and remove the throttling valve from the unit.

Disassembly

1. Remove the piston end cap.
2. Remove the cotter pin from the castle nut and remove the nut.
3. Remove the spring and piston.
4. Loosen all the bolts on bellows end cap.

CAUTION: This end cap is under slight spring pressure.

5. Break the gasket free and remove the end cap.
6. Note the number of shims next to the cap. These can be reused.
7. Remove bellows (discard).

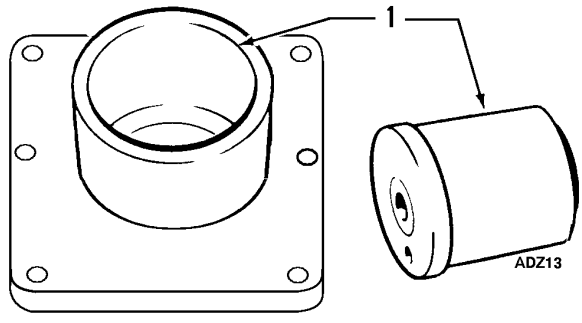


1.	Inspect Cap
2.	Inspect Spring
3.	Shims

Figure 150: Throttle Valve, Cap and Spring

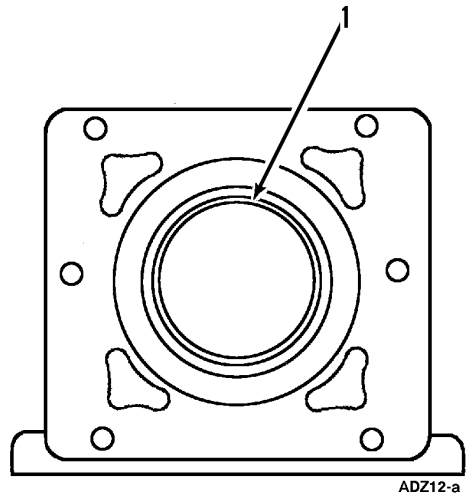
8. Inspect all the parts (replace if excess wear is found).
   a. Piston and cap for wear (scuff marks)
   b. Body for stripped threads
   c. Bellows end cap for damage in pilot hole

   NOTE: Bellows is normally replaced.



1.	Inspect for Wear

Figure 151: Throttle Valve Piston



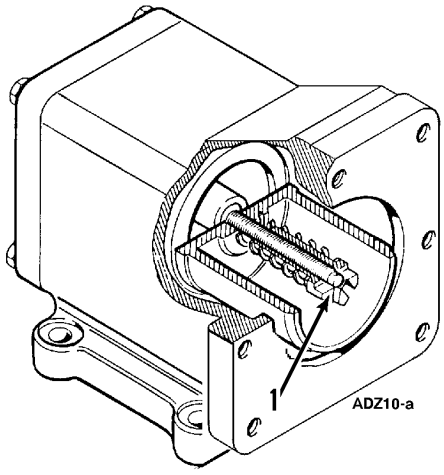
1.	Inspect for Damage

Figure 152: Throttle Valve Housing

9. Clean the parts to be reused.

Reassembly

1. Install new bellows with O-ring into the housing.
2. Center the spring on bellows shoulder.
3. Oil the gasket (same type of oil that is used in the system), install on the body, and place shims in end cap (use same number as removed). Tighten end cap in place with vent hole closest to outlet opening of the valve body.
4. Install the piston, spring and tighten the castle nut until firmly seated against the bottom of the piston.
5. Back off the castle nut, one full turn only.
6. Insert the cotter pin.



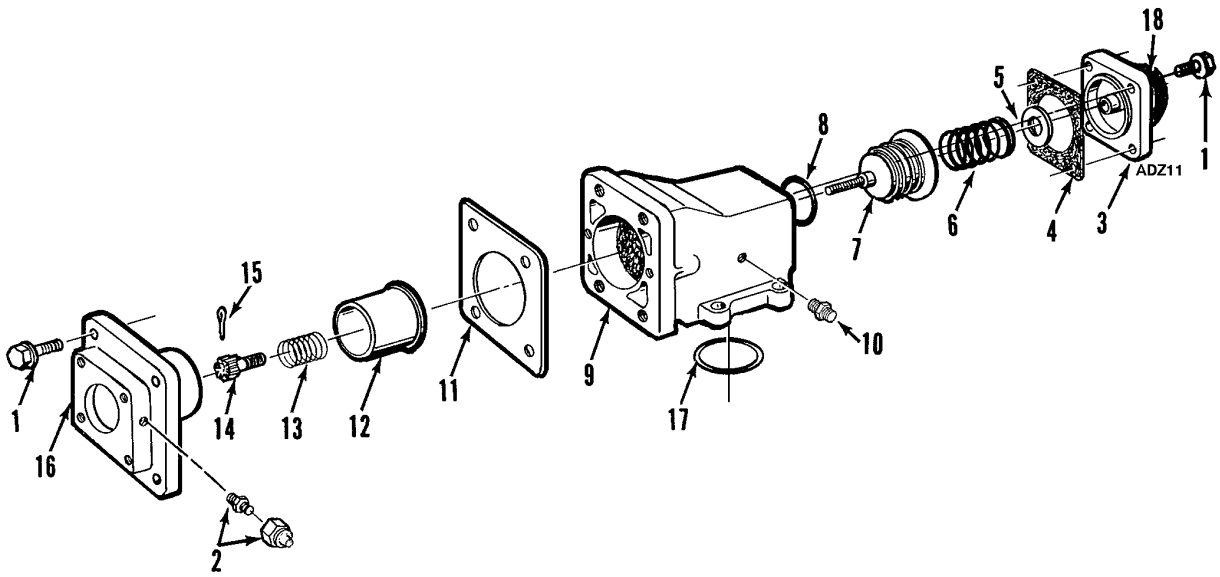
1.	Tighten Castle Nut to Bottom—Then Back Off 1 Turn Only. Insert Cotter Pin.

Figure 153: Throttle Valve Piston Assembly

7. Oil the gasket and install the end cap.
8. Throttling valve will have to be recalibrated on operating unit. (Refer to “Specifications” chapter for setting.)
9. Adjust by adding or removing shims under the spring.

Installation

1. Install the throttling valve using new o-ring soaked in compressor oil (same type of oil that is used in the system). Bolt the throttling valve to the compressor.
2. Connect the suction hose from the throttling valve to the accumulator tank. Install line from the compound gauge.
3. Pressurize the system and check for leaks. If no leaks are found, evacuate the system.
4. Open the refrigeration valves and place the unit in operation.



1.	Screw—plate and flatwasher	10.	Test Port—Schrader Valve
2.	Schrader Valve and Cap (location may vary)	11.	Gasket—piston housing
3.	Plate—bellows end	12.	Piston
4.	Gasket—end plate	13.	Spring—piston
5.	Washer—adjusting	14.	Nut—adjusting
6.	Spring—bellows	15.	Pin—cotter
7.	Bellows and Shaft—assembly	16.	Housing—piston
8.	O-Ring	17.	O-Ring—valve to compressor
9.	Housing	18.	Throttling Valve Cover

Figure 154: Throttling Valve

Large Truck Unit Centrifugal Clutch Change

The centrifugal clutch has three belt grooves and its engagement speed is 600 ± 100 RPM.

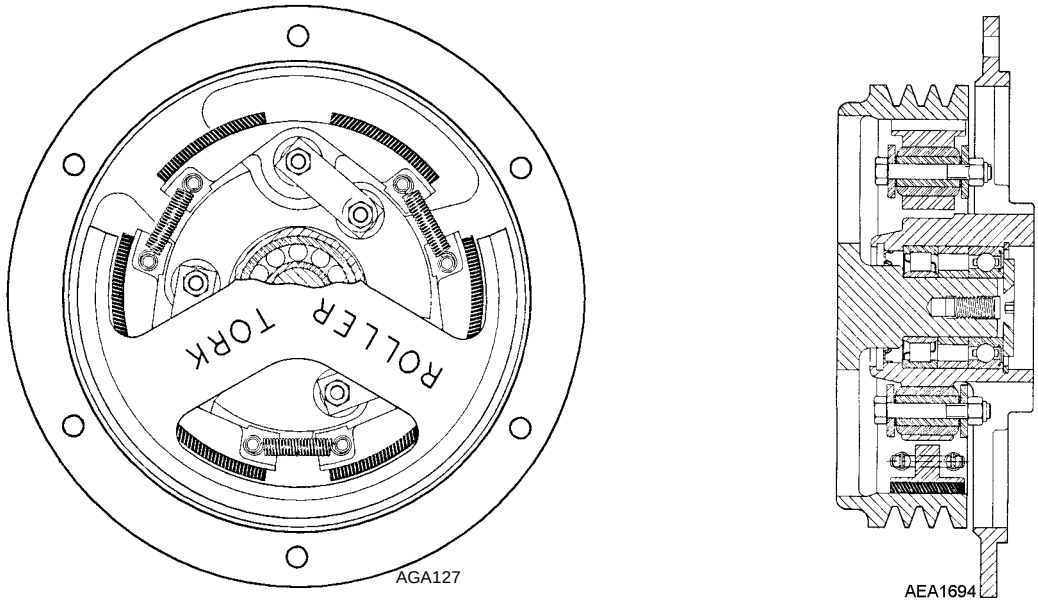
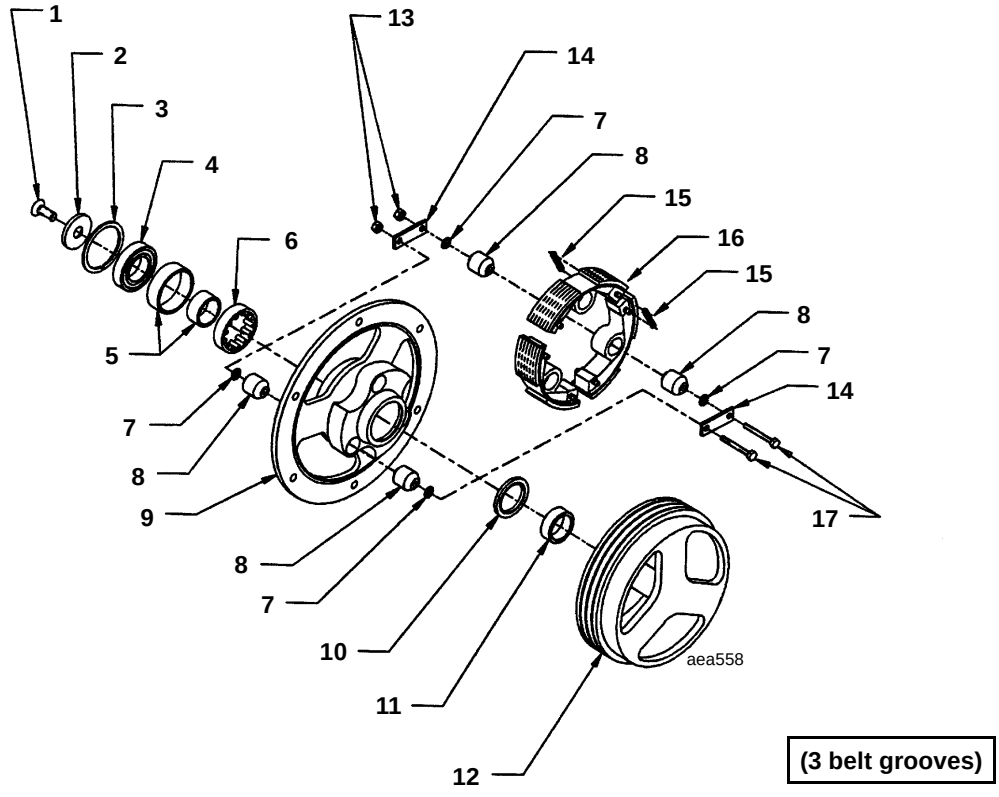


Figure 155: Front View and Cross Section



1.	Screw	10.	Grease Seal
2.	Washer	11.	Roller Bearing Inner Race
3.	Snap-Ring	12.	Pulley Housing
4.	Ball Bearing	13.	Elastic Stop Nuts (6)
5.	Large & Small Spacers	14.	Connector Link (6)
6.	Rolling Bearing	15.	Spring (6)
7.	Lockwasher (12)	16.	Shoe Assembly (3)
8.	Bushing (6)	17.	Screws (6)
9.	Hub		

Figure 156: Hilliard Centrifugal Clutch

Clutch Maintenance

Using an inspection mirror, inspect the clutch every 1000 hours of operation or yearly, whichever occurs first. If shoe wear is uneven on different shoes, remove the clutch, clean the shoes and drum, regrease bearings or replace if they are worn. Inspect anchor bushings, shoe lining and springs for wear and replace if necessary.

Tools Required

- Internal Retaining Ring Pliers
- 7/16 in. Wrench
- 7/32 in. Allen Wrench or 7/32 x 1/2 in. Socket Drive
- 1/2 in. Impact Tool
- Rubber or Plastic Hammer
- 7/16 in. Socket or Nut Driver
- Arbor Press with Various Sized Arbors
- Bearing Puller
- Ratchet (Optional)
- Torque Wrench

Grease

Mobil™ (Synthetic) (see Tool Catalog).

Disassembly Procedure

1. Remove retaining ring.
2. Remove the 3/8-16 flat head cap screw and washer.

   NOTE: This screw was installed using Loctite™ (see Tool Catalog) and will require the use of an impact tool for removal.

   NOTE: A small amount of heat (propane or acetylene torch with small heating tip) applied to the cap screw head may be required to help loosen the screw.

3. Remove housing from hub by supporting hub (in a minimum of three places) in spoke area, and pressing on the housing shaft. The inner race of the roller bearing will remain on the housing shaft.

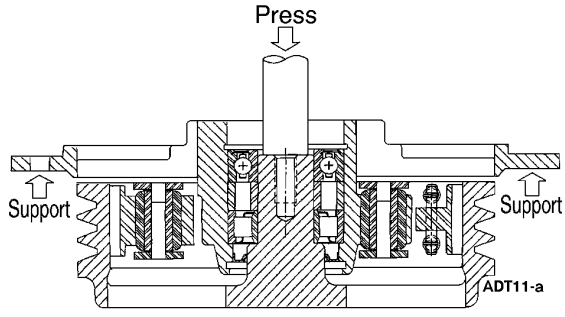


Figure 157: Housing Removal

4. Remove the nuts from six 1/4-28 link screws and remove screws, links, and lockwashers.
5. Remove the springs and shoes.
6. Pull oil seal and press bearings out of hub.

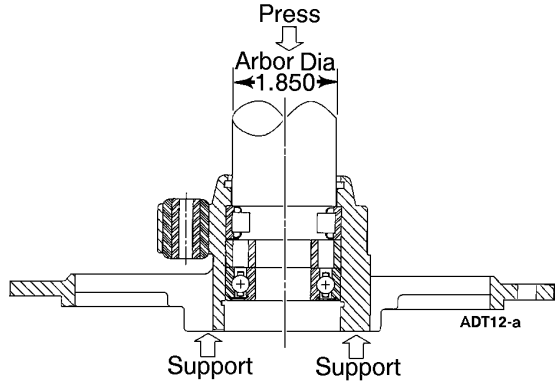


Figure 158: Bearing Removal

NOTE: Press tool should be slightly smaller than hub bore.

NOTE: Make sure the center of the hub is supported and not the outer rim of the hub, when pressing bearing out.

7. Press bushings out of hub.

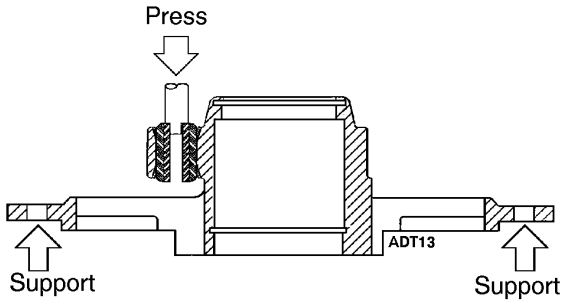


Figure 159: Bushing Removal

8. Remove inner race of roller bearing from the housing shaft.

   NOTE: This race had Loctite™ applied and was pressed in place. A puller will be required to remove it.

   NOTE: Make sure the center of the housing is supported and not the outer drum of the housing.

Assembly Procedure (Using New Bearings and Seal)

1. Press bushings into hub side opposite flange.

   NOTE: It is important to press bushings in straight.

   The bushings should also be centered in the hub socket leaving relatively equal amounts of bushing sticking out of the hub on each side.

   A suggested simple tool for pressing in bushing to hub is a 1/4 in. screw x 3 in. or 4 in. long and 1/4 in. nut. Thread nut onto screw approximately 3/4 to 1 in.

   Insert threaded end of screw into bushing. Lubricate bushing by dipping in clean water only. Then press into place.

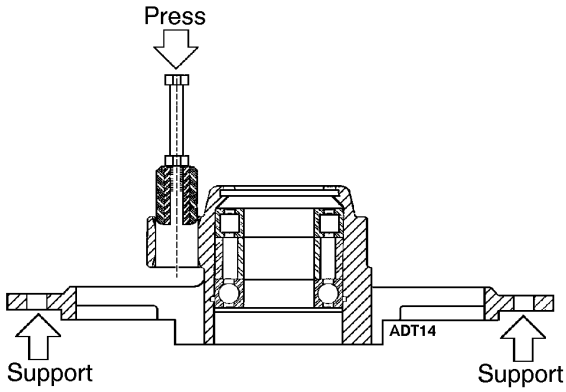


Figure 160: Bushing Insertion

   ****DO NOT USE SOAP OR OIL TO LUBRICATE BUSHING PRIOR TO ASSEMBLY.***

2. Remove the inner race from the roller bearing, apply a small amount of Loctite™ (see Tool Catalog) to race I.D. and press onto the housing shaft, seating against the step.

   CAUTION: During all bearing assembly, care must be taken to prevent Loctite™ from entering bearing.

3. Apply Loctite™ (see Tool Catalog) to O.D. of oil seal, then press seal in end of hub opposite the flange to a depth of approximately 1/16 in. below the surface.

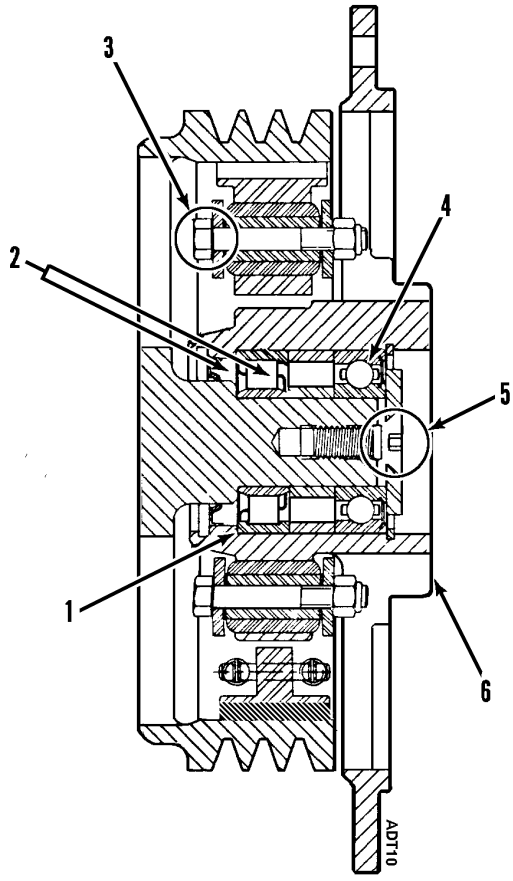
4. Apply a *small* amount of Loctite™ (see Tool Catalog) to O.D. of roller bearing and press into hub bore from the flange end until seated against the step in bore.

5. Slip large and *small* spacer into hub I.D. seating against the roller bearing.

6. Apply Mobil™ (see Tool Catalog) grease to roller bearing and fill cavity between large and small spacers. A small amount of grease should also be applied to the seal lip and space between the seal and roller bearing.
7. Pack ball bearing with Mobil™ (see Tool Catalog) grease.
8. Apply a *small* amount of Loctite™ (see Tool Catalog) to O.D. of ball bearing and press into hub until seated against spacer. Wipe excess Loctite™ from hub.
9. Install retaining ring.
10. Position shoes in a circle on flat surface and install springs on shoes.
11. Position shoes on the hub.
12. Install 1/4-28 x 1-3/4 in. screws through links, then external tooth 1/4 in. lockwasher. Then slide through bushings in shoes and hub.
13. Install remaining lockwashers then links and 1/4-28 in. locknuts, torquing them to 110 ± 5 in.-lbs (12.5 ± 6 N•m).

    NOTE: Shoes MUST be held tightly against hub while nuts are tightened.

14. Place the hub and shoe assembly into the housing and place flatwasher over the bearing.
15. Apply Loctite™ (see Tool Catalog) to 3/8-16 x 1 in. screw and install through washer into housing shaft. The housing and hub will be drawn together to the proper relative position as the screw is tightened. Tighten the screw to 30 to 35 ft.-lbs (41 to 48 N•m).



1.	Roller Bearing, Pack with Mobil™ (see Tool Catalog) grease
2.	Pack These Areas with Mobil™ (see Tool Catalog) grease at Assembly
3.	HEX HD Cap Screw (6X), 1-4/28 UNF X 1.75 Long. Torque to 110 ± 5 in-lbs (12.5 ±.6 N•m) ***NOTE: Shoes must be disengaged while tightening 6 bolts and MUST be held tightly against hub while nuts are tightened.***
4.	Bearing, Fill with Mobil™ (see Tool Catalog) grease Approximately 0.32 oz (70 to 80% full)
5.	3/8-16 UNC x 1.00 Long, Flat Head Socket Cap Screw with Nylox Insert / Apply Loctite™ (see Tool Catalog) and Torque to 30 to 35 ft.-lb (41 to 48 N•m)
6.	Serial Nameplate

Figure 161: Clutch

Unit And Engine Mounting Bolts

Periodically check and tighten all unit and engine mounting bolts. Torque the unit mounting bolts to 60 ft-lb (81.3 N•m). Torque the engine mounting bolts to 50 ft-lb (68 N•m).

Figure 162: Mounting Bolts

Unit Inspection

Inspect the unit during unit pretrip inspection and scheduled maintenance inspections for loose or broken wires or hardware, compressor oil leaks, or other physical damage which might affect unit performance and require repair or replacement of parts.

Condenser and Radiator Coils

Clean the coils during scheduled maintenance inspections. Remove any debris (e.g., leaves or plastic wrap) that reduces the air flow. Clean dirty coils with compressed air or a pressure washer. Be careful not to bend the fins when cleaning a coil. If possible, blow the air or water through the coil in the direction opposite the normal air flow. Repair bent fins and any other noticeable damage.

CAUTION: Air pressure should not be high enough to damage coil fins.

Fan Location

When mounting the fan and hub assembly on the fanshaft, position the assembly in the orifice with 30 to 35 percent of the blade width to the air discharge side for proper fan performance.

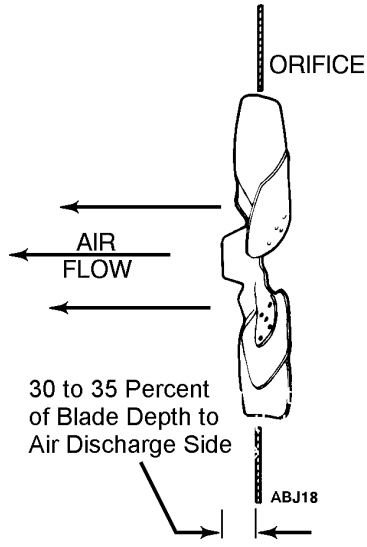


Figure 163: Fan Blade Position in Orifice

Mechanical Diagnosis

Condition	Possible Cause	Remedy
Unit switch On—nothing happens	Dead battery	Recharge or replace battery
	Remote switch Off (optional)	Turn On
	Fuse open	Replace
	Corroded battery connections	Clean and tighten
	Main harness fuse blown	Check for shorted main harness and replace fuse
Unit switch On—indicator lights come on but engine does not crank	Battery low	Replace or recharge battery
	Fuse blown	Replace
	Starter solenoid defective	Repair or replace
	Starter relay defective	Replace relay
	Corroded battery connections	Clean and tighten
	Starter clutch defective	Replace
	Starter defective	Repair or replace
Engine cranks but fails to start	Misadjusted fuel solenoid linkage	Adjust
	Fuel solenoid defective	Replace solenoid
	No fuel or wrong fuel in tank	Fill fuel tank. After filling a completely empty tank, first bleed fuel system.
	Engine too cold	Use winter preheat procedure
	Glow plugs defective	Replace glow plugs
	Air in fuel system	Bleed fuel system. During this operation, it can also be determined if the fuel lines are tight and filters clean.
	Speed/run relay malfunction	Check relay or unit thermostat
	Insufficient compression	Measure compression pressure. If necessary, grind valves or replace piston
	Electric fuel pump not operating	Check pump for running and 8 to 10 psig (55 to 69 kPa). Repair or replace fuel pump
	Injection pump incorrectly timed	Adjust timing
	Faulty injection nozzle(s)	Repair injection nozzle or replace it
	Faulty injection pump	Have pump repaired

Condition	Possible Cause	Remedy
Engine stops after starting	Air in injection pump	Bleed fuel system
	Fuel filter obstructed	Replace filter element
	High water temperature coolant	Add coolant. Check for leaks
	Low oil pressure	Add oil. Check for leaks
	Vent of fuel tank obstructed	Remove obstruction
	Electric fuel pump not operating	Check pump for running and 8 to 10 psig (55 to 69 kPa). Repair or replace fuel pump
	Dry air cleaner plugged	Change filter element
	Fuel solenoid not energized	Check run circuit
	High refrigerant pressure	Locate and correct cause
Engine does not reach full power	Air or dirt in fuel system	Adjust
	Fuel line leaks	Tighten connections of fuel lines. If necessary, replace damaged lines
	Speed adjustment wrong	Adjust speed
	Electric fuel pump does not run	Check voltage. Repair or replace pump
	Fuel filter blocked	Install new filter
	Electric fuel pump filter dirty	Clean and replace diesel filter
	Delivery of fuel pump insufficient	Repair or replace pump
	Cylinder head gasket leaking	Replace gasket
	Piston rings worn, stuck or broken	Replace rings
	Cylinder worn	Replace or bore
	Leaking injection nozzle or irregular injection caused by fouling	Clean and repair nozzle
	Insufficient compression pressure due to faulty piston or valves	Check cylinder with compression tester. If necessary, grind valves or replace piston
	Air filter clogged	Clean air filter
	Fuel tank vent clogged	Unclog vent
	Injection rate too low	Adjust pump discharge rate
	Insufficient injection pressure	Readjust or replace nozzle
	Pump injects too early or too late	Adjust injection pump timing
	Air in fuel system	Bleed fuel system
	Air is drawn into fuel pump	Check all fuel lines and fittings
	Loose governor assembly	Check and repair governor assembly
	Restricted exhaust system	Clean or replace restricted parts

Condition	Possible Cause	Remedy
Engine is sooting heavily, emits thick black clouds of smoke (excessive fuel to air ratio)	Wrong fuel	Drain and refill with correct fuel
	Clogged air intake system	Clean air cleaner
	Restricted exhaust system	Clean or replace
	Opening pressure of nozzle is too low or needle sticks	Repair nozzle. Replace if necessary
	Injection amount too great	Have pump repaired
	Oil being drawn in	Check oil level in oil bath air filter
	Injection pump timing	Check timing of injection pump
	Excessive load	Check drive system and engine oil pressure
Engine knocks	Insufficient air	Clean air filter
	Air in fuel system	Bleed fuel system
	Engine is cold	Warm up
	Fuel return line plugged	Remove restriction
	Injection pump not timed	Retime injection pump
	Injection nozzle fouled or opening pressure too low	Clean, repair or replace injection nozzle
	Dirty radiator	Clean radiator
	Worn engine parts	Overhaul engine
Engine runs hot	Engine coolant is low	Add coolant slowly while engine is in operation
	Dirty or plugged radiator	Clean radiator
	Cooling system heavily scaled	Clean cooling system
	Water pump leaks	Repair or replace water pump
	Worn or loose belt	Replace belt or adjust
	Cylinder head gasket leaks (bubbles appear in radiator if cylinder gasket is leaking)	Replace cylinder head gasket. Correct gasket
	Faulty thermostat	Check or replace the thermostat
	Faulty temperature gauge	Replace gauge
Oil pressure too low or drops suddenly	Insufficient oil in pan	Refill oil base after correcting cause of loss
	Leak in oil line	Tighten oil line fittings
	Oil relief valve sticking	Disassemble and clean oil pressure regulator valve
	Faulty oil pressure switch	Replace if necessary
	Worn oil pump, camshaft, main or connecting rod bearings, loose oil gallery plug, oil in water through crack	Repair engine
High oil consumption	Oil leakage	Check and eliminate possible causes

Condition	Possible Cause	Remedy
	Clogged air cleaner	Clean air cleaner
	Damaged valve seals	Replace seals on valve stem
	Worn valve stem or valve guides	Replace valves and valve guides
	Broken piston rings or cylinder bore worn or scored	Have engine repaired. Replace broken piston rings
	Crankcase breather clogged	Clean crankcase breather
Blue Smoke (oil consumption)	Excessive oil consumption	See “High oil consumption”. Repair as necessary
White Smoke (fuel is not burning)	Cold engine	Allow engine to warm up
	Low compression	Check and eliminate possible causes. Repair as necessary
	Timing	Readjust timing
	Air or water in fuel	Bleed system. Replace filters, clean fuel system, drain and clean tank and check supply tank for water. Use known good fuel
	Insufficient preheat	Check glow plugs
Battery is not recharging	Loose alternator belt	Tighten belt
	Loose connections in electrical system	Check all electrical connections and charging system
	Worn brushes in alternator	Repair
	Voltage regulator faulty	Replace
	Battery defective	Replace
	Alternator defective	Repair or replace

Electric Standby (Optional) Diagnosis

Condition	Possible Cause	Remedy
Unit switch On—Microprocessor display does not come on	Battery discharged	Charge or replace battery
	Electric motor reset switch tripping	Check for short circuit in unit wiring (high voltage)
	Fuse blown	Replace fuse
	Dirty battery terminals	Clean and retighten terminals
Unit switch On—Microprocessor display comes on but electric motor does not run	No standby power	Provide power to unit; check power at: 1. Power source 2. Power plug 3. Motor contactor hot side 4. Motor contactor load side (contactor closed) 5. Overload relay 6. Motor terminals
	Defective motor contactor	Repair or replace motor contactor
	Overload relay tripping	Check for shorted motor windings or wires
	Control circuit fuse open	Replace fuse and reset alarm codes
	Defective motor	Replace motor
	Batteries discharged	Charge or replace batteries
Electric motor hums but does not run	Locked rotor (overload relay will open after a period of time)	Remove interference
	Locked compressor	Repair compressor
	Defective clutch on engine (locked up)	Repair or replace clutch
	Low line voltage or no voltage on one leg	Bring voltage up to within 10% of motor rating

Condition	Possible Cause	Remedy
Contact chatter	Low battery voltage	Check voltage condition. Check momentary voltage dip during starting—low voltage prevents magnet sealing
	Defective or incorrect coil	Replace coil
	Poor contact in control circuit	Check auxiliary switch contacts and overload relay contacts. Check for loose connections in control circuits
Contact welding or freezing	Abnormal in-rush of current	Check or grounds, shorts or excessive motor load current
	Low voltage	Correct voltage condition. Check momentary voltage dip during starting
	Foreign matter prevents contacts from closing	Clean contacts
	Rapid cycling	Check for cause of short cycling (such as thermostat)
	Short circuit	Correct fault
Electric heaters do not heat—(optional) indicator lights come on	Defective heater contactor	Replace contactor
	HC wire open	Locate open and repair
Battery is not recharging	Loose connections in electrical system	Check all electrical connections and charging system
	Worn brushes in alternator	Replace brushes
	Voltage regulator faulty	Repair or replace regulator
	Battery defective	Replace battery
	Alternator defective	Repair or replace alternator
	Loose belt	Tighten belt
	Dirty battery terminals	Clean and retighten
	Alternator relay defective	Replace relay
	Fuse F309 open	Replace fuse

Refrigeration Diagnosis

Rapid cycling between Cool and Heat	Unit cools in Heat and Defrost cycle	Unit heats in Refrigeration cycle	High head pressure	Low head pressure	No head pressure	High suction pressure	Low suction pressure	No suction pressure	Unit operating in a vacuum	Receiver sight glass empty	Suction line frosting back	Unable to pump down system	Unable to pull vacuum in low side	Unable to hold vacuum in low side	Noisy compressor	Unit not refrigerating	Unit not heating or defrosting	**Symptom** / **Possible Causes**
			•			•									•	•		Overcharge of refrigerant
				•			•		•	•						•	•	Shortage of refrigerant
				•				•	•							•	•	No refrigerant
			•															Air through condenser too hot (ambient)
			•															Air flow through condenser restricted
				•			•			•								Air through condenser too cold (ambient)
			•												•	•		Air in refrigerant system
			•															Condenser fan blades bent or broken
•																		Air short cycling around evaporator coil
							•											Air through evaporator restricted
							•		•		•				•			Evaporator needs defrosting
													•					Compressor discharge valves leaking
						•						•						Scroll compressor seals leaking
																•		Too much compressor oil in system
															•			Faulty oil pump in compressor
															•			Loose compressor pulley
															•			Compressor bearing loose or burned out
				•								•	•	•	•			Broken discharge check valve in compressor
							•									•		Expansion valve power element lost its charge

Rapid cycling between Cool and Heat	Unit cools in Heat and Defrost cycle	Unit heats in Refrigeration cycle	High head pressure	Low head pressure	No head pressure	High suction pressure	Low suction pressure	No suction pressure	Unit operating in a vacuum	Receiver sight glass empty	Suction line frosting back	Unable to pump down system	Unable to pull vacuum in low side	Unable to hold vacuum in low side	Noisy compressor	Unit not refrigerating	Unit not heating or defrosting	**Symptom** / **Possible Causes**
						•					•					•		Expansion valve feeler bulb making poor contact
						•					•							Expansion valve open too much
							•									•		Expansion valve closed too much
						•					•							Expansion valve needle eroded or leaking
							•		•							•		Expansion valve partially closed by ice, dirt or wax
						•					•				•			Liquid refrigerant entering compressor
							•		•									Restricted line on the low side
			•				•		•							•		Restricted line on the high side
			•				•		•							•		Restricted drier
																	•	Evaporator shutter open
							•		•							•		Evaporator shutter stuck closed
								•										Suction service valve back seated
	•	•		•		•						•		•			•	Faulty CIS
	•	•										•				•	•	Faulty Hot Gas Solenoid
	•																•	Loose or broken electrical connections
•						•	•		•							•		Thermostat or thermometer out of calibration
						•	•	•	•									Suction pressure gauge out of calibration
												•						Leaky receiver tank outlet valve
			•														•	DPR Valve Faulty

Remote Evaporator Specifications

Refrigeration System

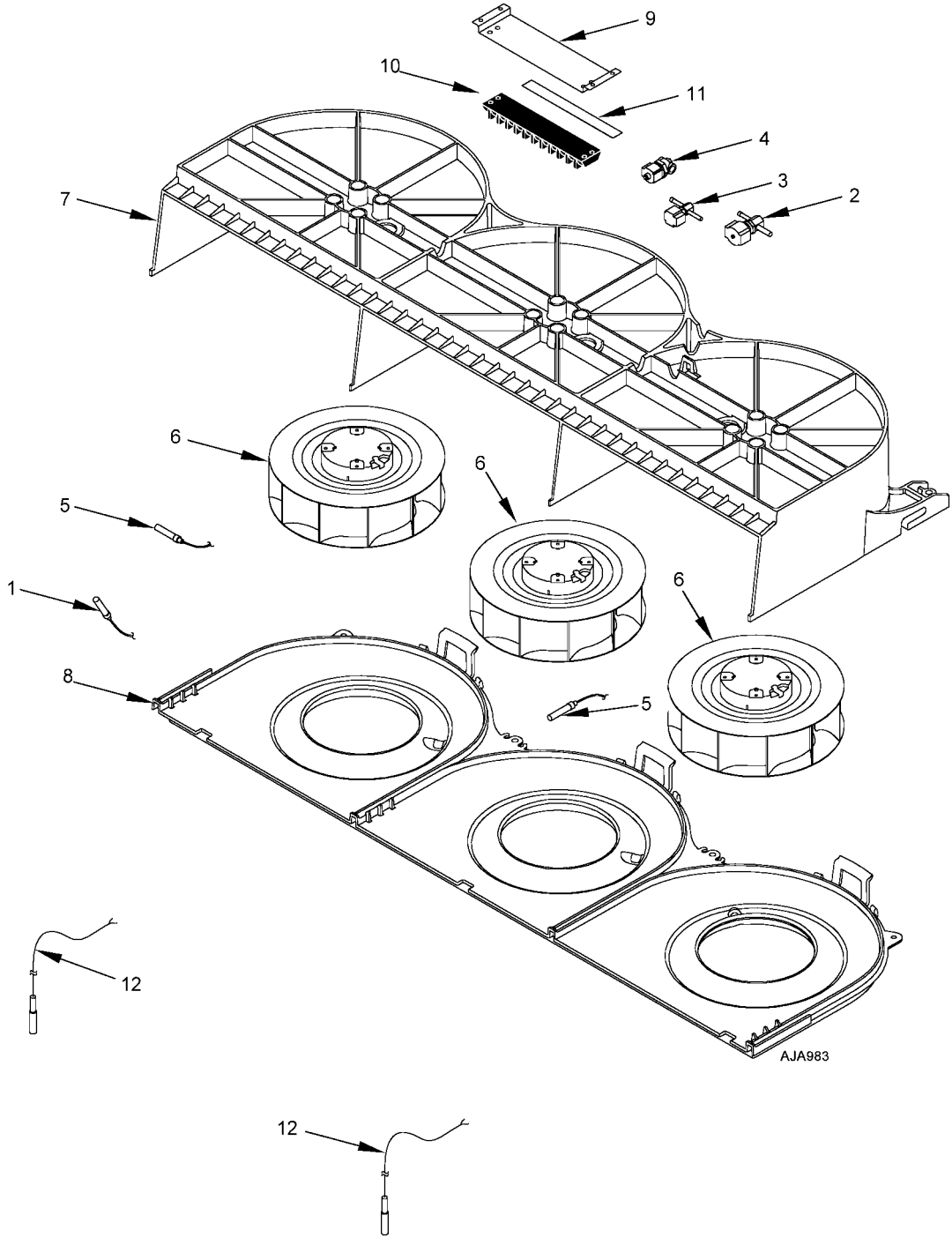
Evaporator Coil Type	Direct Expansion
Refrigerant Type	R404a
Heat/Defrost Method	Hot Gas

Electrical

Control System Voltage	12.5 Vdc
SPECTRUM™ TS Evaporator Fan Motor: Horsepower	0.13 hp
Fan Voltage	8 to 16 Vdc
rpm	1900
Full Load Amps	8.7 amps per motor
Fuse F1-1, F1-2, F2-1, F2-2	30 amp
Remote Liquid Line Solenoid (15w): Current Draw	1.2 amps
Resistance	10.4 ohms
Remote Hot Gas Solenoid (18w): Current Draw	1.4 amps
Resistance	8.7 ohms
Remote Suction Line Solenoid (18w): Current Draw	1.4 amps
Resistance	8.7 ohms

Remote Evaporator Maintenance Inspection Schedule

Pre-Trip	Every 1,500 Hours	Annual / 4,500 Hours	Inspect/Service These Items
			Electrical
	•	•	Inspect wire harness for damaged wires or connections.
	•	•	Inspect/replace fan motor brushes.
			Structural
•	•	•	Visually inspect unit for fluid leaks.
•	•	•	Visually inspect unit for damaged, loose or broken parts.
	•	•	Clean entire unit including evaporator coils and defrost drains.
		•	Check all unit mounting bolts, brackets, lines, hoses, etc.



1.	Coil Temperature Sensor, Ungraded)	5.	Discharge & Return Air Sensor (Graded)	9.	Terminal Board Bracket
2.	Hot Gas Solenoid	6.	Variable Blower (12 V)	10.	Terminal Board
3.	Liquid Line Solenoid	7.	Blower Housing	11.	Terminal Board Markstrip
4.	Hot Gas Solenoid	8.	Blower Cover	12.	Resistance Wire (3000 mm) Resistance Wire (4000 mm)

Figure 164: SPECTRUM™ Evaporator

Figure 165: SPECTRUM™ TS Evaporator-Front View

Figure 166: SPECTRUM™ TS Evaporator-Back View

The SPECTRUM™ multi-temperature refrigeration system provides heavy duty temperature control for multiple compartment trucks. The system provides direct expansion cooling in all cargo compartments.

Heat and defrost is provided in all compartments by circulating hot refrigerant gas through the evaporators.

The remote evaporator are ceiling mounted units.

Controls for the remote evaporator(s) are located in the SPECTRUM™ TS HMI.

Unit Operation

The remote evaporator cycles between cool, null and heat to maintain the cargo's compartment(s) at the setpoint. The operating modes include Cool, Null, Heat and Defrost.

Power to run the direct current fan motor is supplied by the alternator in the condensing unit.

When cooling is required, the SPECTRUM™ TS microprocessor energizes the remote liquid line solenoid valve. Refrigerant flows through the evaporator coil to provide cooling.

When the compartment temperature is near setpoint, the SPECTRUM™ TS microprocessor de-energizes the remote liquid line solenoid valve and switches the remote evaporator to null.

The SPECTRUM™ TS microprocessor energizes the remote hot gas solenoid when the remote compartment requires heat or defrost.

Defrost

The Defrost mode can be initiated any time the evaporator coil temperature is below 45 F (7 C). Defrost is initiated automatically by the controller or manually by selecting the manual defrost.

The evaporator fan stops during defrost. The Defrost mode will continue until the evaporator coil temperature rises to 52 F (11 C), causing the controller to terminate defrost. After defrost, the evaporator may shift back to cool, null or heat.

Operating Modes

Remote evaporator operating modes are:

- Cool
- Null
- Heat
- Defrost

NOTE: The controller locks out heat at setpoints below 15 F (-9.5 C).

Unit Features

- Direct Expansion Evaporator Coil
- SPECTRUM™ TS Microprocessor
- 12 Vdc Fan Motor
- Aluminum Housing
- Liquid Line Solenoid
- Hot Gas Solenoid
- Suction Line Solenoid
- Liquid Return Check Valve

Unit Protection Devices

- Fuses in Host Unit (located on interface board)

Serial Number Location

Unit: Nameplate on the right end of the unit frame.

1.	Nameplate on Right End of Unit Frame

Figure 167: Serial Number Location

Remote Evaporator Electrical Maintenance

SPECTRUM™ Microprocessor Controlled Components

Refer to the appropriate SPECTRUM™ Microprocessor Controller Operation & Diagnosis Manual for information about maintenance of the microprocessor controlled components.

Unit Wiring

Inspect the unit wiring and wire harnesses during scheduled maintenance inspections for loose, chaffed or broken wires to protect against unit malfunction due to opens or shorts.

Remote Evaporator Refrigeration Service Operations

NOTE: It is generally good practice to replace the filter drier whenever the high side is opened or when the low side is opened for an extended period of time.

Expansion Valve Assembly

Removal

1. Pump down the low side and equalize the pressure to slightly positive. Remove the evaporator access panels.
2. Disconnect the liquid inlet line and distributor from the expansion valve.
3. Remove the feeler bulb from the clamp. Note the position of the feeler bulb on the suction line.
4. Disconnect the equalizer line.
5. Remove the mounting U-bolt.
6. Remove the expansion valve assembly from the unit.

Installation

1. Place the expansion valve in the unit and install the mounting U-bolt.
2. Connect the equalizer line to the expansion valve.
3. Connect the liquid inlet line and distributor to the expansion valve.
4. Clean the suction line to a bright polished condition. Install the feeler bulb clamps and feeler bulb on the side of the suction line in its former position. The feeler bulb must make good contact with the suction line or the operation will be faulty. Wrap it with insulating tape.
5. Pressurize the low side and test for leaks. If no leaks are found, evacuate the low side.
6. Install the access panels.
7. Open the refrigeration valves and place the unit in operation.
8. Test the unit to see that the expansion valve is properly installed.

Evaporator Coil

Removal

1. Remove refrigerant by approved methods.
2. Remove evaporator assembly.
3. Remove the access panels.
4. Disconnect the distributor from the expansion valve.
5. Remove the insulating tape and feeler bulb from the suction line. Note the position of the feeler bulb on the suction line. Disconnect the equalizer line from the suction line.
6. Heat and unsolder the suction line connection to the evaporator coil.
7. Remove the mounting bolts and slide the coil from the housing.

Installation

1. Place the evaporator coil in the evaporator housing and install the mounting bolts.
2. Clean and solder the suction line connections to the evaporator coil.
3. Connect the distributor to the expansion valve.
4. Clean the suction line to a bright polished condition. Install the feeler bulb clamps and the feeler bulb on the suction line. Locate the bulb on the side of the suction line in its former position. The feeler bulb must make good contact with the suction line or the operation will be faulty. Wrap it with insulating tape.
5. Connect the equalizer line to the suction line.
6. Pressurize the low side and test for leaks. If no leaks are found, evacuate the low side.
7. Install the access panels.
8. Install evaporator assembly. Leak test, evacuate and charge the unit.

Solenoid Valves

NOTE: Valves that have nylon seats must be disassembled before soldering.

Removal

1. Pump down the low side and equalize the pressure to slightly positive.
2. Remove the access panels.
3. Remove the coil and disassemble the valve.
4. Unsolder the refrigeration lines from the valve, and remove the valve from the unit.

CAUTION: Use a heat sink to prevent damaging the valve

Installation

1. Clean the tubes for soldering.
2. Remove the coil, disassemble the valve, and place the valve in position.
3. Solder the inlet and outlet connections. After the valve cools, assemble the vale and install the coil.

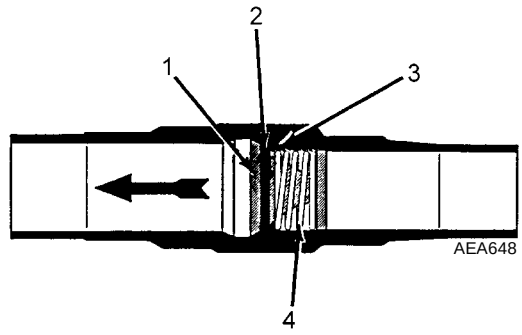
CAUTION: Use a heat sink to prevent damaging the valve.

4. Pressurize the refrigeration system and test for leaks.
5. If no leaks are found, evacuate the system.
6. Install the access panels.
7. Open the refrigeration valves and run the unit. Check the refrigerant charge and compressor oil. Add as required.

IMPORTANT: Truck Spectrum evaporators use Suction Line Solenoids with bleed port, where Trailer evaporators do not. Be careful not to intermix the two solenoids.

Liquid Return Check Valve

The unit uses an in-line check valve. The in-line check valve is not repairable and must be replaced if it fails. A heat sink must be used on the in-line check valve when it is being soldered in place to prevent damage to the neoprene seal.



1.	Valve
2.	Neoprene Seal
3.	Valve Seat
4.	Spring

Figure 168: Cross Section of In-line Check Valve

Removal

1. Pump down the low side and equalize the pressure to slightly positive.
2. Remove the access panels.
3. Place a heat sink on the check valve.
4. Unsolder lines and remove the check valve.

Installation

CAUTION: A heat sink must be used on the in-line check valve when it is being soldered in place to prevent damage to the neoprene seal.

1. Clean the tubes for soldering.
2. Place the check valve in position. The arrow on the valve body indicates the direction of refrigeration flow through valve.
3. Place a heat sink on the check valve.
4. Solder the inlet and outlet connections.
5. Pressurize the low side and test for leaks. If no leaks are found, evacuate the low side.
6. Install the access panels.
7. Open the refrigeration valves and place the unit in operation. Check the refrigerant charge and the compressor oil. Add as required.

Remote Evaporator Structural Maintenance

Unit Inspection

Inspect the unit during the unit pre-trip inspection and scheduled maintenance inspections for loose or broken wires or hardware, compressor oil leaks, or other physical damage which might affect unit performance and require repair or replacement of parts.

Defrost Drains

Clean the defrost drains during scheduled maintenance inspections to make sure the lines remain open.

Evaporator Coil

Clean the evaporator coil during scheduled maintenance inspections by blowing compressed air from the top side of the coil down toward the bottom (the direction opposite the normal air flow). Inspect the coil and fins for damage, and repair if necessary.

CAUTION: Air pressure should not be high enough to damage the coil fins.

Remote Evaporator System Diagnosis

Condition	Possible Cause	Remedy
Load temperature too high	Refrigerant shortage	Repair leak and recharge
	Setpoint too high	Adjust setpoint
	Expansion valve plugged	Clean or replace
	Partial obstruction in low side of refrigeration system	Locate obstruction and repair
	Iced or dirty evaporator coil	Defrost or clean evaporator coil
	Expansion valve open too much	Replace or adjust valve
	Poor fitting trailer door	Repair or replace doors
	Liquid line solenoid partially closed or defective	Repair or replace
	Evaporator fan not operating	Check and correct evaporator fan
Evaporator fan motor does not run	Fuse blown	Check for short circuit in unit wiring and replace fuse
	Open in FM circuit	Locate open and repair
	Defective fan relay	Replace fan relay
	Defective fan motor	Replace fan motor
	Bad ground	Tighten connection at ground stud

Index

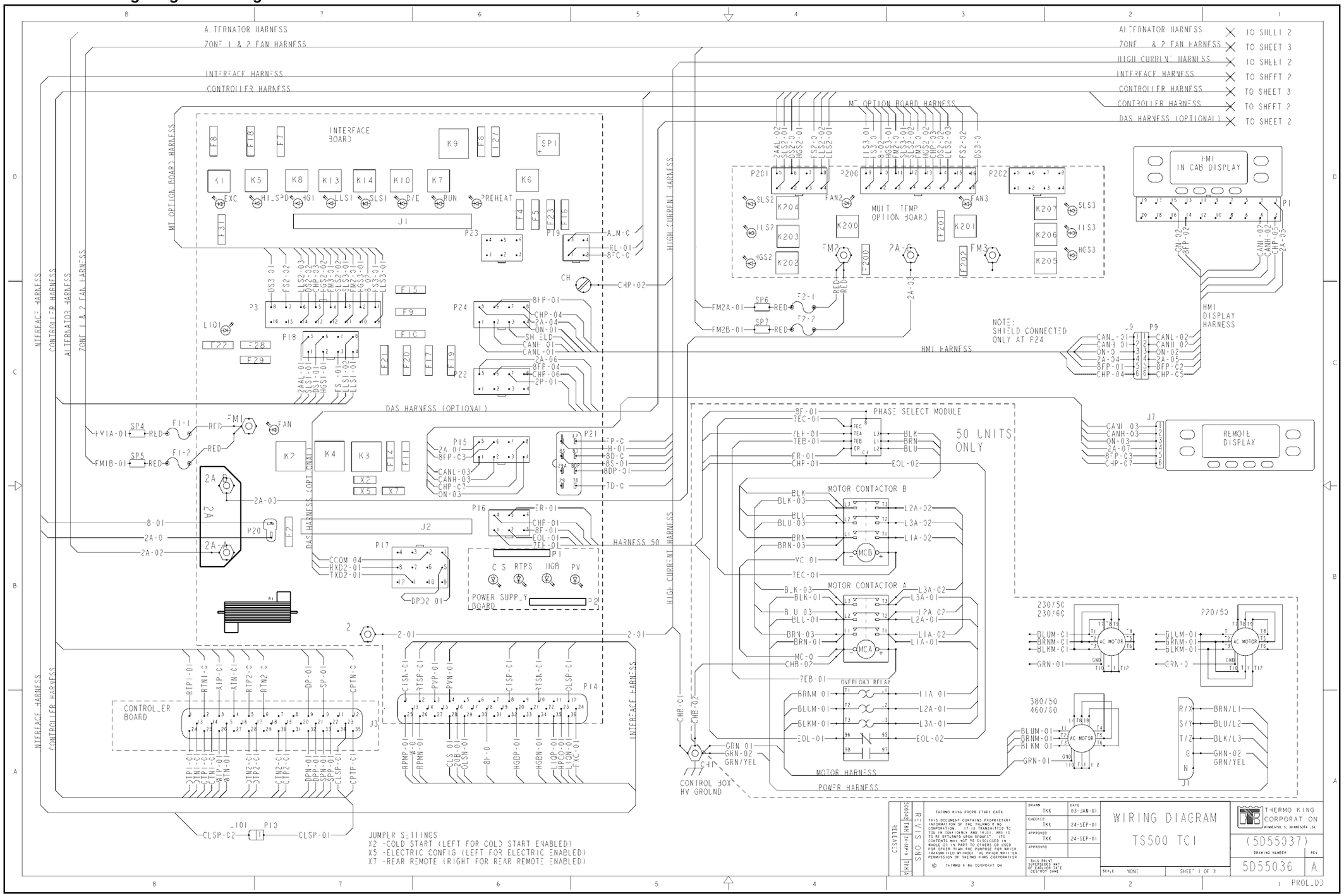
T

U

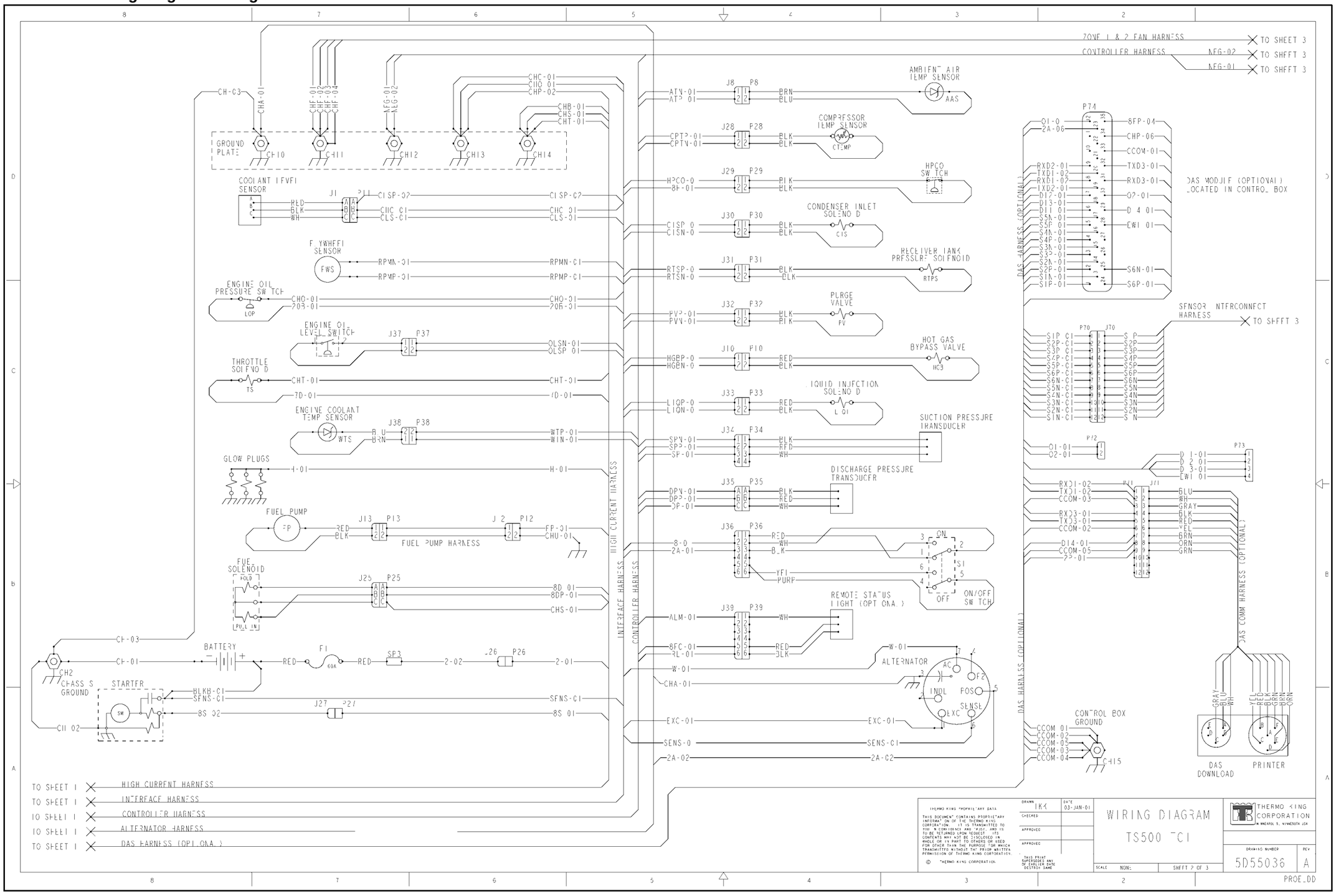
W

Wiring and Schematic Diagrams Index

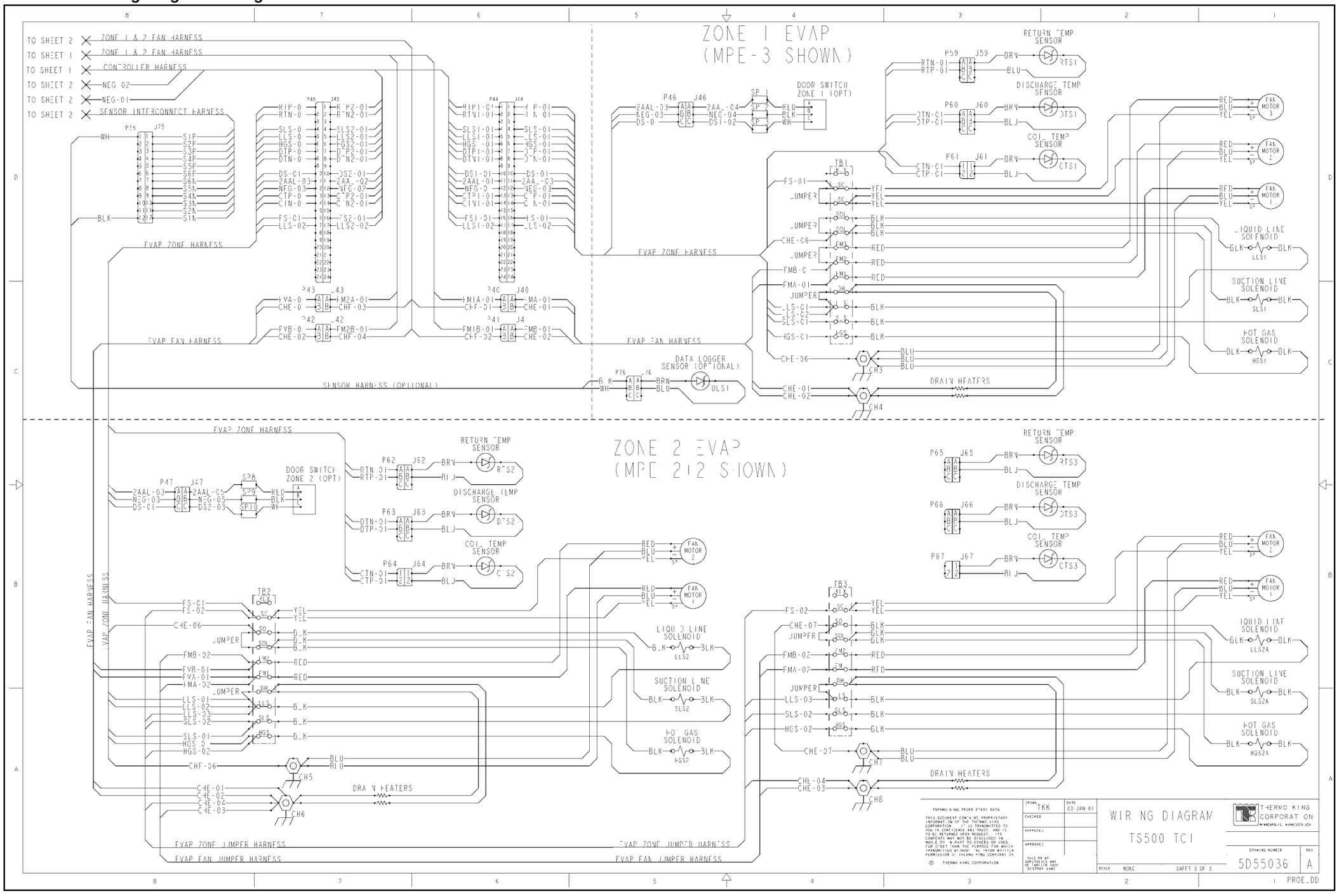
TS-500 TCI Wiring Diagram — Page 1 of 3



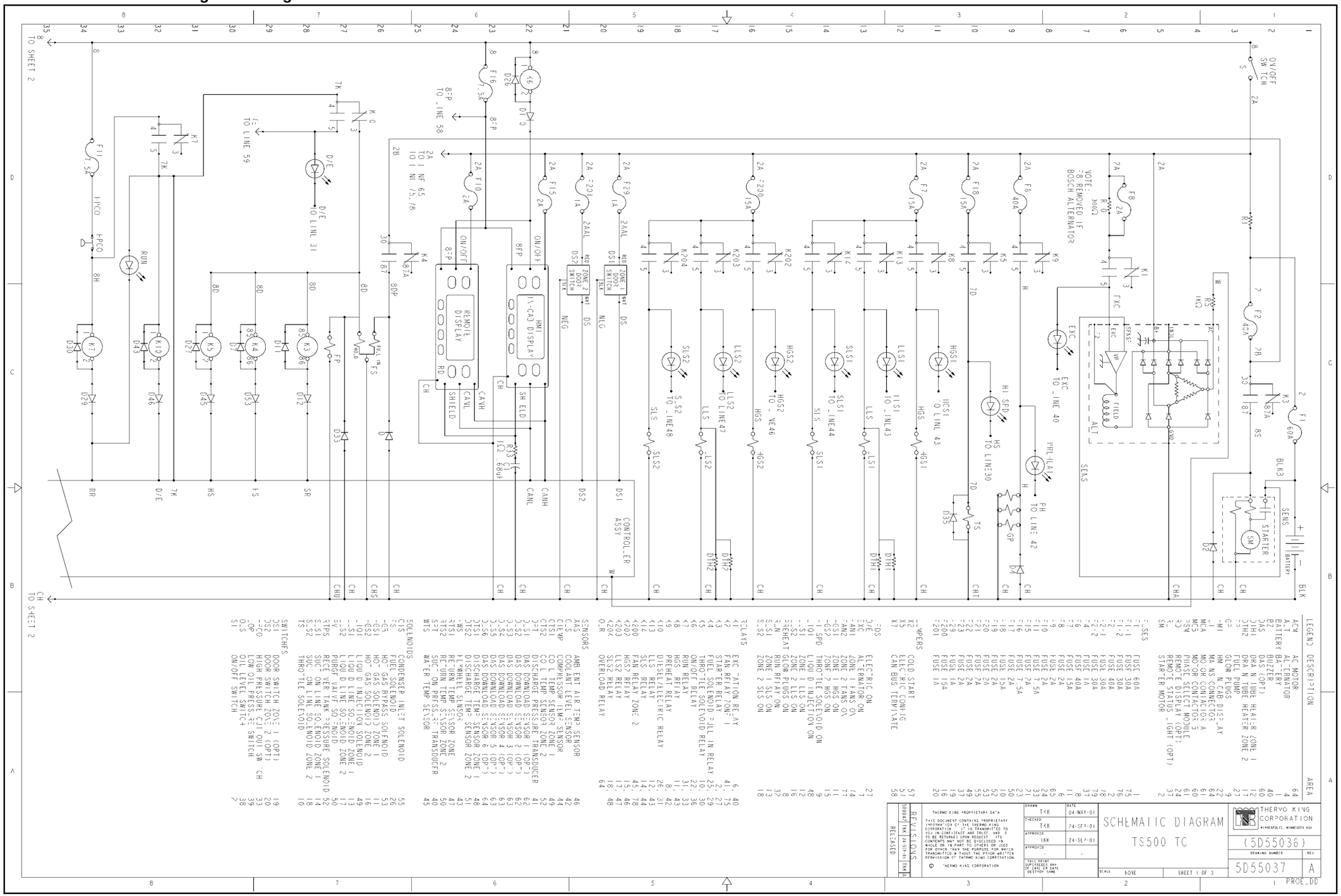
TS-500 TCI Wiring Diagram — Page 2 of 3



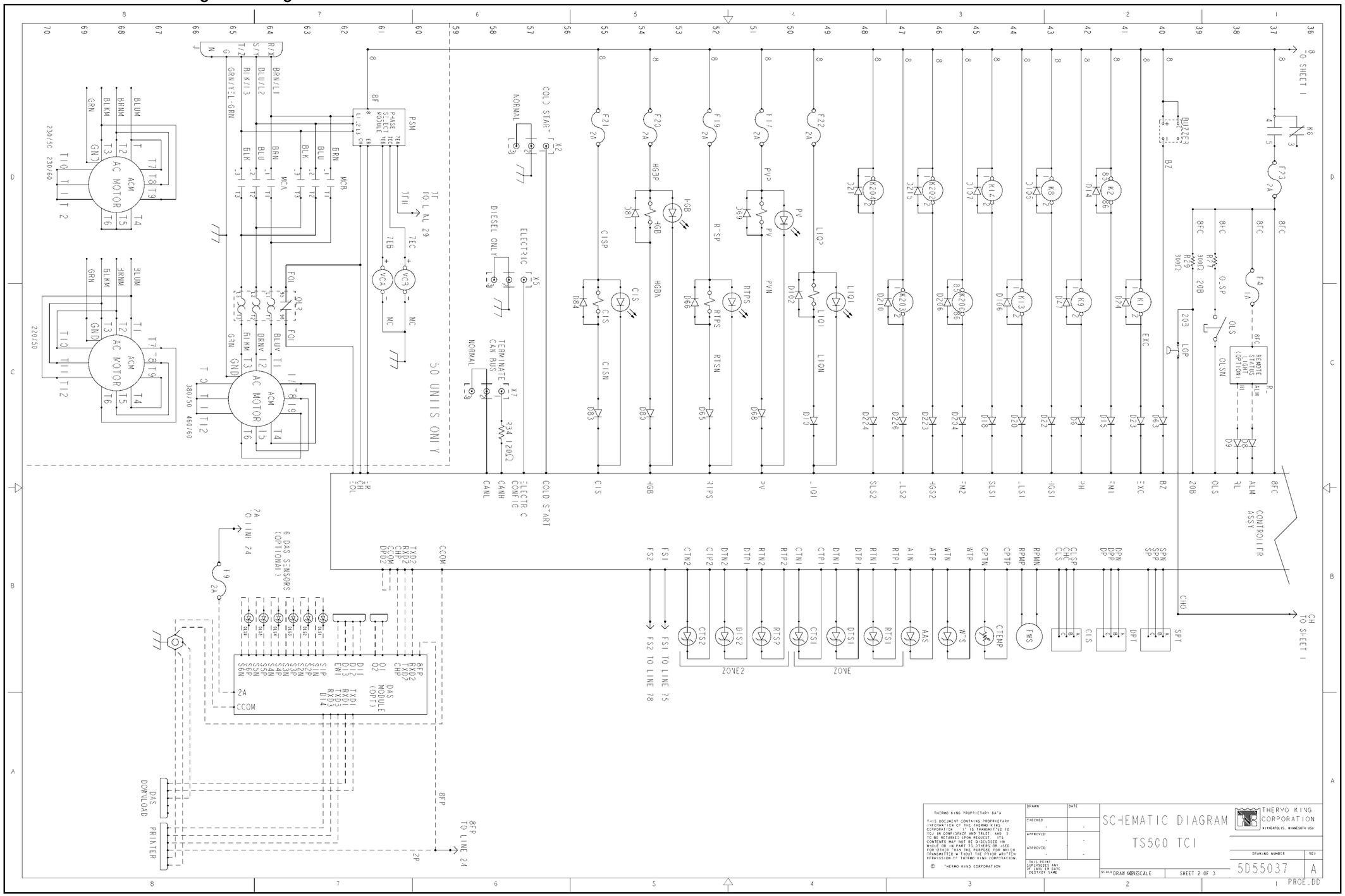
TS-500 TCI Wiring Diagram — Page 3 of 3



TS-500 TCI Schematic Diagram — Page 1 of 3



TS-500 TCI Schematic Diagram — Page 2 of 3



TS-500 TCI Schematic Diagram — Page 3 of 3