SB-200

TK 51014-2-MM (Rev. 3, 08/02)

(For units with or without EMI 3000)

The maintenance information in this manual covers unit models:

SB-200 30 (002001) System SB-200 30 (918590)

SB-200 50 (002002) System SB-200 50 (918591)

For further information, refer to:

SB-200 Operator's Manual	**TK 50901**
SB-200 Parts Manual	**TK 50988**
THERMOGUARD µP-VI Microprocessor Control System Diagnostic Manual	**TK 50566**
TK482 and TK486 Engine Overhaul Manual	**TK 50136**
X214, X418, X426 and X430 Compressor Overhaul Manual	**TK 6875**
Diagnosing TK Refrigeration System	**TK 5984**
Tool Catalog	**TK 5955**
Evacuation Station Operation and Field Application	**TK 40612**
ElectroStatic Discharge (ESD) 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."

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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.

Table of Contents

List of Figures

Safety Precautions

General Practices

1. *Always wear goggles or safety glasses.* Refrigerant liquid and battery acid can permanently damage the eyes. See First Aid under Refrigeration Oil.
2. Never operate the unit with the compressor discharge valve closed.
3. Keep your hands clear of the fans and belts when the unit is running. This should also be considered when opening and closing the compressor service valves.
4. Make sure the gauge manifold hoses are in good condition. Never let them come in contact with a belt, fan motor pulley, or any hot surface.
5. Never apply heat to a sealed refrigeration system or container.
6. Fluorocarbon refrigerants, in the presence of an open flame or electrical short, produce toxic gases that are severe respiratory irritants capable of causing death.
7. Make sure all mounting bolts are tight and are the correct length for their particular application.
8. Use extreme caution when drilling holes in the unit. The holes may weaken structural components. Holes drilled into electrical wiring can cause fire or explosion.
9. Use caution when working around exposed coil fins. The fins can cause painful lacerations.
10. Use caution when working with a refrigerant or refrigeration system in any enclosed or confined area with a limited air supply (for example, a bus or garage). Refrigerant tends to displace air and can cause oxygen depletion, resulting in suffocation.
11. EPA Section 608 Certification is needed to work on refrigeration systems.

Refrigerant

Although fluorocarbon refrigerants are classified as safe refrigerants, certain precautions must be observed when handling them or servicing a unit in which they are used. When exposed to the atmosphere in the liquid state, fluorocarbon refrigerants evaporate rapidly, freezing anything they contact.

First Aid: In the event of frost bite, 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 CPR or mouth-to-mouth ventilation, if necessary. Stay with victim until arrival of emergency medical personnel.

Refrigerant Oil

Avoid refrigeration oil contact with the eyes. Avoid prolonged or repeated contact of refrigeration oil with skin or clothing. Wash thoroughly after handling refrigeration oil to prevent irritation.

First Aid: In case of eye contact, immediately flush with plenty of water for at least 15 minutes. *Call a physician.* Wash skin with soap and water.

Electrical Hazards

High Voltage

When servicing or repairing a refrigeration unit, the possibility of serious or even fatal injury from electrical shock exists. Extreme care must be used when working with an operating refrigeration unit. Lethal voltage potentials can exist on connections in the high voltage tray of the control box.

Precautions

1. When working on high voltage circuits on the refrigeration 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.
2. Use tools with insulated handles that are in good condition. Never hold metal tools in your hand if exposed, energized conductors are within reach.
3. Treat all wires and connections as high voltage until a meter and wiring diagram show otherwise.
4. Never work alone on high voltage circuits on the refrigeration unit, another person should always be standing by in the event of an accident to shut off the refrigeration unit and to aid a victim.
5. 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 has to 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 power source, check immediately for the presence of a pulse and respiration. If a pulse is not present, start CPR (Cardio Pulmonary 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 refrigeration unit are low voltage (12 volts dc). This voltage potential is not considered dangerous, but the large amount of current available (over 30 amperes) can cause severe burns if shorted or ground.

Do not wear jewelry, a watch or rings. These items can short out electrical circuits and cause severe burns to the wearer.

Specifications

Engine

Model	TK 486
Number of Cylinders	4
Cylinder Arrangement	In-line vertical, number 1 on flywheel end
Firing Order	1-3-4-2
Direction of Rotation	Counterclockwise viewed from flywheel end
Fuel Type	No. 2 diesel fuel under normal conditions No. 1 diesel fuel is acceptable cold weather fuel
Oil Capacity: Crankcase	13 quarts (12.3 liters) crankcase Fill to full mark on dipstick
Oil Type	API Classification CG-4 or better (ACEA Rating E2-96 or better for Europe)
Oil Viscosity	5 to 122 F (-15 to 50 C): SAE 15W-40 -13 to 104 F (-25 to 40 C): SAE 10W-40 -13 to 86 F (-25 to 30 C): SAE 10W-30 -22 to 32 F (-30 to 0 C): SAE 5W-30
Engine rpm: Low Speed Operation	1450 ± 25 rpm
High Speed Operation	2200 ± 25 rpm
Engine Oil Pressure	18 psi (127 kPa) minimum in low speed 45 to 57 psi (310 to 390 kPa) in high speed
Intake Valve Clearance	0.006 to 0.010 in. (0.15 to 0.25 mm)
Exhaust Valve Clearance	0.006 to 0.010 in. (0.15 to 0.25 mm)
Valve Setting Temperature	70 F (21 C)
Fuel Injection Timing	10° BTDC (timed on No. 1 cylinder)
Low Oil Pressure Switch (Normally Closed)	17 ± 3 psi (117 ± 21 kPa)
Engine Coolant Thermostat	180 F (82 C)
Engine Coolant Type: Conventional	Conventional coolant (antifreeze) is green or blue-green. Units equipped with conventional coolant DO NOT have an ELC nameplate on the expansion tank. ***CAUTION: Do not mix conventional coolant and ELC.***
ELC (Extended Life Coolant)	ELC is red. Units equipped with ELC have an ELC nameplate on the expansion tank (see page 50). 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
Coolant System Capacity	7.5 quarts (7.1 liters)
Radiator Cap Pressure	7 psi (48 kPa)
Drive	Direct to compressor; belts to fans, alternator and water pump

Belt Tension

Model 30	Tension No. on TK Gauge P/N 204-427
Alternator Belt	35
Lower Fan Belt (Engine to Idler)	67
Upper Fan Belt (Fan to Idler)	74
Model 50	
Alternator Belt	29
Compressor Drive Belts	79
Fan Belt	74
Water Pump Belt	35

Refrigeration System

Compressor		Thermo King X430L
Refrigerant Charge—Type:		16 lb (7.25 kg) before fourth quarter of 2001 13 lb (5.90 kg) fourth quarter of 2001 and later See the serial number plate on the unit.
Compressor Oil Charge		4.3 qt (4.1 liters)*
Compressor Oil Type		Polyol Ester type P/N 203-413
Heat/Defrost Method:	Engine Operation	Hot gas
	Electric Operation	Hot gas and electric heater strips
High Pressure Cutout		470 ± 7 psi (3241 ± 48 kPa)
		Automatic reset @ 375 ± 38 psi (2586 ± 262 kPa)

**** 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.***

Electrical Control System

Voltage		12.5 Vdc
Battery		One, group C31, 12 volt battery
Fuse F3—Power to Defrost Relay/Damper		15 amp
Fuse F9—Main Control Power		40 amp
Fuse F18—Power to Throttle Solenoid		15 amp
Fuse F21—Power to On/Off Switch		25 amp
Other Fuses		2 or 5 amp
Battery Charging:	Model 30	12 volt, 37 amp, brush type alternator
	Model 50	12 volt, 105amp, brush type alternator
Voltage Regulator Setting		13.8 to 14.2 volts @ 77 F (25 C)

NOTE: Fuse F15 (Bypass Resistor for Prestolite Alternator) must be removed for the Bosch Alternator.

Electrical Components

NOTE: Disconnect components from unit circuit to check resistance.			
Component		**Current Draw (Amps) at 12.5 Vdc**	**Resistance—Cold (Ohms)**
Fuel Solenoid:	Pull-in Coil	35 to 45	0.2 to 0.3
	Hold-in Coil	0.5	24 to 29
Damper Solenoid		5.7	2.2
High Speed (Throttle) Solenoid		2.9	4.3
Air Heater		89	0.14
Pilot Solenoid		0.7	17.0
Electronic Throttling Valve:			
	Coil A (Red and Blue Wires)	—	20 to 35
	Coil B (Black and White Wires)	—	20 to 35
Hot Gas Bypass Valve		1.1	11.1
Starter Motor—Gear Reduction Type		250-375*	
**** On-the-engine cranking check. Bench test is approximately 80 amps on the gear reduction starter.***			

SMART REEFER µP-VI Microprocessor Temperature Controller

Temperature Controller:	Type	Electronic THERMOGUARD µP-VI Microprocessor with digital thermostat, thermometer and fault indicator monitor
	Setpoint Range	-20 to 80 F (-29 to 27 C) Programmable setpoint range -25 to 90 F (-32 to 32 C)
	Digital Temperature Display	-40 to 99.9 F (-40 to 40 C)
Internal Defrost Timer:	Temperature Pulldown	2, 4, 6, 8 or 12 hours (selectable, standard setting 4)
	Temperature In-range	4, 6, 8 or 12 hours (selectable, standard setting 6)
Defrost Initiation:	Coil Sensor	Coil temperature must be below 45 F (7 C)
Defrost Termination:	Coil Sensor	Terminates defrost at coil temperature above 57 F (14 C)
Interval Timer		Terminates defrost 30 to 45 minutes (programmable) after initiation if coil sensor has not terminated defrost

Electrical Standby (Model 50 Units Only)

Electric Motor and Overload Relay

Voltage/Phase/Frequency	Horsepower	Kilowatts	rpm	Full Load (amps)	Overload Relay Setting (amps)
230/3/60	14.0	10.4	1755	37.8	40
460/3/60	14.0	10.4	1755	18.9	20

Electric Heater Strips

Number	3
Watts	1000 watts (each)
Resistance	48 ohms (each)

Standby Power Cord Requirement

Supply Circuit Breaker	40 amps
Extension Cord Size	82 feet—AWG 8 (25 meters—2.5 mm^2)

Maintenance Inspection Schedule

Pretrip	Every 1,500 Hours	Every 3,000 Hours*	Annual/ 4,500 Hours	Inspect/Service These Items
				Microprocessor
•				Run Pretrip Test (refer to Pretrip Test in the Operating Manual).
				Engine
•				Check fuel supply.
•				Check engine oil level.
•	•	•	•	Inspect belts for condition and proper tension (belt tension tool No. 204-427).
•	•	•	•	Check engine oil pressure hot, on high speed (should display “OK”).
•	•	•	•	Listen for unusual noises, vibrations, etc.
•				Check air cleaner restriction indicator (change filter when indicator reaches 25 in.). Replace EMI 3000 air cleaner element (see “EMI 3000” on page 49) at 3,000 hours or two years (whichever occurs first) if indicator has not reached 25 in.
	•	•	•	Drain water from fuel tank and check vent.
	•	•	•	Inspect/clean fuel transfer pump inlet strainer (prefilter).
	•	•	•	Check and adjust engine speeds (high and low speed).
	•	•	•	Check condition of drive coupling bushings per Service Bulletin T&T 171.
			•	Check engine mounts for wear.
	•	•	•	Replace standard (silver) fuel filter/water separator.
		•		Replace EMI 3000 (black) fuel filter/water separator.
			—	Change green or blue-green engine coolant every two 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 (see page 50).
			—	Test fuel injection nozzles at least every 10,000 hours.
				ENGINE OIL CHANGE INTERVALS (see below)
				NOTE: The engine oil change interval is extended to 3,000 hours when equipped with the EMI 3000 oil filter and oil with API Rating CG-4 or better (ACEA Rating E2-96 for Europe). EMI 3000 filters are black with gold lettering.
				NOTE: Change engine oil and filter (hot).
	•	•	•	Standard blue (or silver) oil filter.
		•		EMI 3,000 (black) oil filter. Requires oil with API Rating CG-4 or better (ACEA Rating E2-96 for Europe).

**3,000 hours or two years, whichever occurs first.*

Pretrip	Every 1,500 Hours	Every 3,000 Hours*	Annual/ 4,500 Hours	Inspect/Service These Items
				Electrical
	•	•	•	Inspect battery terminals and electrolyte level.
	•	•	•	Inspect wire harness for damaged wires or connections.
•	•	•	•	Check operation of damper door (closes on defrost initiation and opens on defrost termination).
			•	Inspect alternator wire connections for tightness.
			•	Inspect electric motor, replace bearings yearly or every 6,000 hours.
				Refrigeration
•	•	•	•	Check refrigerant level.
	•	•	•	Check for proper suction pressure.
			•	Check compressor oil level and condition.
			•	Check compressor efficiency and pump down refrigeration system.
				Replace dehydrator and check discharge and suction pressure 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 tapered roller bearing fanshaft and idlers for leakage and bearing wear (noise).
	•	•	•	Clean entire unit including condenser and evaporator coils and defrost drains.
	•	•	•	Check all unit and fuel tank mounting bolts, brackets, lines, hoses, etc.
	•	•	•	Check evaporator damper door adjustment and operation.

**3,000 hours or two years, whichever occurs first.*

Unit Description

General Description

The unit is a one-piece, self-contained, diesel powered refrigeration-heating unit. The unit mounts on the front of the trailer with the evaporator portion extending into the trailer. There are two basic models.

Model 30: Cool, hot gas heat and defrost on engine operation.

Model 50: Cool, hot gas heat and defrost on engine operation and on electric standby operation. Electric evaporator heaters are also used to increase the heat and defrost capacities during electric operation.

During engine operation power is provided by the TK 486, a four-cylinder, water cooled, direct injection diesel engine. The TK 486 displaces 2.09 liters and is rated at 33.9 horsepower (25.3 kilowatts) at 2200 rpm.

The compressor is connected directly to the engine on the Model 30. A centrifugal clutch transfers power from the engine to the compressor on the Model 50. The centrifugal clutch engages when the engine reaches 400 ± 100 rpm. Belts are used to transfer power to the fans and the alternator.

During electric standby operation (Model 50 units only) the centrifugal clutch isolates the engine from the compressor. The electric motor drives the compressor, the fans, and the alternator through belts.

SMART REEFER µP-VI Microprocessor

The SMART REEFER µP-VI is a microprocessor control system designed for a transport refrigeration system. The µP-VI integrates the following functions: thermostat, digital thermometer, hourmeters, oil pressure condition, water temperature, ammeter, voltmeter, tachometer, mode indicator, refrigeration system controller, discharge and suction pressure sensors, and diagnostic system.

The CYCLE-SENTRY system, an integral defrost timer, data logging, and remote status lights are standard features. Remote controls are an optional feature.

The microprocessor mounts inside a weather tight control box. The LCD display is visible through a transparent cover. Opening the keypad door provides quick access to the microprocessor keypad. The keypad is used to control the operation of the microprocessor.

CYCLE-SENTRY Start-Stop Controls

A CYCLE-SENTRY Start-Stop fuel saving system provides optimum operating economy. Selecting Continuous or CYCLE-SENTRY operation (on units equipped with CYCLE-SENTRY) is accomplished using the microprocessor keypad.

WARNING: With the unit On/Off switch in the On position, the unit may start at anytime without prior warning.

NOTE: A buzzer sounds when the unit is automatically preheating.

NOTE: The microprocessor has an OptiSet™ feature that can lockout CYCLE-SENTRY operation and force Continuous Run within a programmable range of setpoints. If this feature is active and the setpoint is within the programmed lockout range, the CYCLE-SENTRY symbol will flash while the unit is automatically starting. After the unit starts, the CYCLE-SENTRY symbol will disappear and the unit will operate in Continuous Run as long as the setpoint is within the programmed lockout range. Refer to the appropriate THERMOGUARD Microprocessor Diagnostic Manual for specific information about the OptiSet™ feature.

The CYCLE-SENTRY system automatically starts the unit on microprocessor demand, and shuts down the unit when all demands are satisfied. As well as maintaining the box temperature, engine block temperature and battery charge levels are monitored and maintained. If the block temperature falls below 30 F (-1 C), the engine will start and run until the block temperature is above 90 F (32 C). If the battery voltage falls to the programmed limit selected by CYCLE-SENTRY Battery Voltage (typically 12.2 volts) and Diesel CYCLE-SENTRY mode is

selected, the engine will start and run until the charge rate falls below that programmed by CYCLE-SENTRY Amps (typically 5 amperes).

Features of the CYCLE-SENTRY system are:

- Offers either CYCLE-SENTRY or Continuous Run operation.
- Controller regulated all season temperature control.
- Maintains minimum engine temperature in low ambient conditions.
- Battery Sentry keeps batteries fully charged during unit operation.
- Variable preheat time.
- Preheat indicator buzzer.

Data Logging

The data logging system records operating events, alarm codes and compartment temperatures as they occur and at preset intervals. This trip data is retrieved through the DAS.

DAS

The DAS (Data Acquisition System) is an independent data logger that logs information from dedicated external DAS sensors and inputs. The DAS features up to six directly connected sensors. The DAS is also connected through a serial port to the unit microprocessor. This allows unit operating information to be logged as well. This trip data can be retrieved (but not erased) from the microprocessor memory using an IBM® PC compatible laptop or desktop computer. The data can be retrieved using an IBM® PC compatible laptop or desktop computer and Thermo King WinTrac 4.0 (or higher) software. The computer is connected to the Computer Port on the front of the control box. Detailed graph or table trip reports can then be created. A brief graphical or tabular report can be printed on a compatible printer (P/N 204-844 or P/N 204-1020). The printer is connected to the Printer Port on the front of the control box. Refer to the DAS Data Acquisition System Manual (TK 50565) for more information.

Thermo King X430L Compressor

The unit is equipped with a Thermo King X430L, four-cylinder compressor with 30 cu. in. (492 cm^3) displacement.

Electronic Throttling Valve (ETV)

The Electronic Throttling Valve (ETV) is a variable position valve operated by a stepper motor. The ETV is located in the suction line between the evaporator and the heat exchanger. Discharge and suction pressure transducers supply pressure information to the µP-VI microprocessor control system. The microprocessor controls the electronic throttling valve directly. The ETV replaces both the throttling valve and the modulation valve used in other units. The ETV system also uses a hot gas bypass valve like the one used with the modulation valve in other units.

The ETV system provides enhanced control of the refrigeration system as follows:

Suction Pressure Control: The suction pressure control algorithm is the primary control used to obtain maximum capacity. This allows the refrigeration system to fully utilize the power capabilities of the engine under varying conditions.

Discharge Pressure Protection: This protection algorithm provides an additional measure of protection against high discharge pressures and possible compressor damage. It will prevent shutdowns in high ambient temperatures by allowing continued operation of the unit at a temporarily reduced refrigeration capacity.

Engine Coolant Temperature Protection: This protection algorithm protects the engine from high coolant temperature shutdowns and possible engine damage. It will reduce the load on the engine by temporarily reducing refrigeration capacity. This lowers the engine temperature while still allowing continued unit operation.

Modulation Control: The ETV system replaces the modulation valve. The modulation control algorithm operates much the same as modulation on other units.

Sequence of Operation

When the On/Off switch is turned on, the LCD display (which normally shows the setpoint, the return air temperature, and the operating icons) is illuminated. If the CYCLE-SENTRY mode has been selected, the unit will start and stop automatically. If the Continuous mode has been selected, the unit will start and run automatically.

Operating Modes

The microprocessor uses a complex program to determine which operating mode the unit should be in. Therefore, it is difficult to predict which operating mode the unit should be in by comparing the setpoint to the box temperature.

In diesel operation the diesel engine operates at either low speed or high speed as determined by the microprocessor. The unit will cool or heat in either high or low speed. The unit will defrost in low speed only. Heat and defrost consists of hot gas delivered to the evaporator coil distributor.

In electric operation (Model 50 units only) the drive motor operates at a single speed. It does not run in null. Electric evaporator heaters are also used to increase the heat and defrost capacities during electric operation.

Diesel Operation

In diesel operation the microprocessor will select the operating mode from the list of possible modes below:

- High Speed Cool
- Low Speed Cool
- Low Speed Modulated Cool
- Null (CYCLE-SENTRY operation only)
- Low Speed Modulated Heat
- Low Speed Heat
- High Speed Heat
- Defrost

Electric Operation

In electric operation the microprocessor will select the operating mode from the list of possible modes below:

- Cool
- Modulated Cool
- Null (CYCLE-SENTRY operation only)
- Modulated Heat (Hot Gas only)
- Hot Gas Heat
- Full Heat (Hot Gas and Electric Heat)
- Defrost (Hot Gas and Electric Heat)

Defrost

Defrost is initiated manually through the defrost prompt screen using the microprocessor Mode key and Enter key. Defrost is initiated automatically on demand by the microprocessor or by a defrost timer.

The evaporator coil temperature must be below 45 F (7 C) to allow defrost. When the Defrost Icon appears, the damper door is closed by the damper solenoid.

A demand defrost cycle will occur if the differences between the return air temperature, discharge air temperature, and coil temperature are greater than predetermined values.

Two defrost timers are used. When the unit is In-Range (within a few degrees of setpoint), defrost intervals are controlled by the Defrost Interval In-Range timer (DEFI). This timer can be set for 4, 6, 8 or 12 hours. The standard setting is 6 hours. When the unit is not In-Range, defrost intervals are determined by the Defrost Interval Not In-Range timer (DEFN). This timer can be set for 2, 4, 6, 8 or 12 hours. The standard setting is 4 hours. This feature allows a shorter defrost interval to be used when the unit is out of range during a pull-down and more frequent defrost cycles may be beneficial.

Normally, longer defrost timer intervals are used for colder loads. The defrost interval may need to be changed if the unit will not hold the compartment temperature at setpoint.

- Use a longer defrost interval if defrost is not being initiated on demand.
- Use a shorter defrost interval if defrost is frequently being initiated on demand.

Data logger event codes starting with the letters DFF, DFI, and DFT are logged when defrost occurs on units equipped with data logging. DFF indicates defrost was forced. DFI indicates defrost was initiated manually. DFT indicates defrost was initiated by a timer.

If the unit is in CYCLE-SENTRY Null mode, the engine will start when defrost is initiated. The In-Range Icon will remain on if it was on when defrost was initiated.

The unit will stay in defrost until the evaporator coil temperature rises to 57 F (13 C). If the evaporator coil temperature does not rise above 57 F (13 C) within the Defrost Duration (DDUR) time limit, the microprocessor will terminate defrost. The Defrost Duration can be set for either 30 or 45 minutes.

Design Features	Unit Model SB-200 30 (002001)	Unit Model SB-200 50 (002002)
TK 486 Diesel Engine	•	•
X430L Compressor	•	•
230V, 60 Hz, 3 Phase Electric Standby Motor	—	•
Top Mount Muffler	•	•
Thermo King Radiator	•	•
Rust-Free Composite Lower Doors and Panels	•	•
Injection Molded Grilles	•	•
Fiberglass Top Cap	•	•
Stainless Steel Exterior Condenser Hardware	•	•
Stainless Steel Evaporator Hardware	•	•
Tapered Roller Bearing Fanshaft and Idler	•	•
Premium Drive Belts	•	•
Heavy Duty Dry Element Air Cleaner Inside Unit Frame	•	•
SMART REEFER µP-VI Microprocessor Controller	•	•
Fuel Filter with Water Separator	•	•
Spin-On Full Flow Bypass (Dual Element) Oil Filter	•	•
Dealer Installed Synthetic Engine Oil	Opt	Opt
Side Mount Coolant Expansion Tank	•	•
Defrost Timer	•	•
CYCLE-SENTRY System	•	•
37 Amp Alternator	•	—
105 Amp Alternator	—	•
Refrigerant R-404A	•	•
Electronic Throttling Valve	•	•
Silicone Coolant Hoses	•	•
12,000 Hour Service Interval Coolant	•	•
DAS (Data Acquisition System)	•	•
Remote Status Lights	•	•
Fuel Heater	Opt	Opt
460V, 60 Hz, 3 Phase Electric Standby Motor	—	Opt

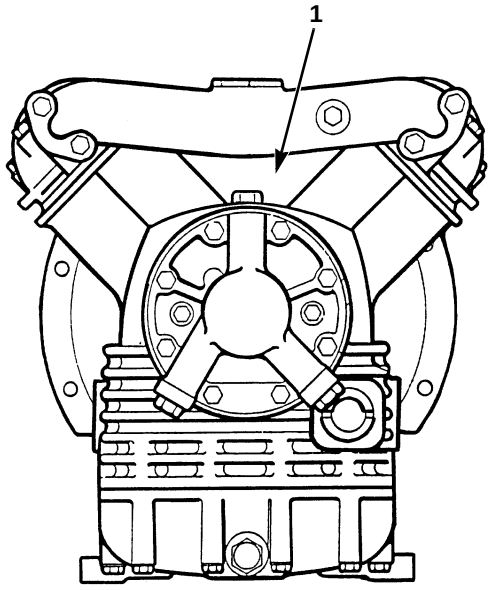
Protection Devices	Unit Model SB-200 30 (002001)	Unit Model SB-200 50 (002002)
Engine Coolant Temperature Sensor	•	•
Engine Low Oil Pressure Switch	•	•
Engine Low Oil Level Switch	•	•
Evaporator Coil Temperature Sensor	•	•
Refrigerant High Pressure Cutout Switch	•	•
Refrigerant High Pressure Relief Valve	•	•
12 Volt Fuse Link	•	•
Fuse in Main Power Circuit	•	•
Fuse in Control Circuit	•	•
Fuse in Microprocessor Power Circuit	•	•
Relay Fuses	•	•
Remote Status Light Fuse	•	•
Overload Relay Protection for Electric Motor	—	•

Serial Number Locations

Unit: Nameplate on the roadside of the unit on the evaporator liner and on the roadside of the unit frame below the control panel.

Engine: Nameplate on rocker arm cover.

Compressor: Stamped on the end above the oil pump.

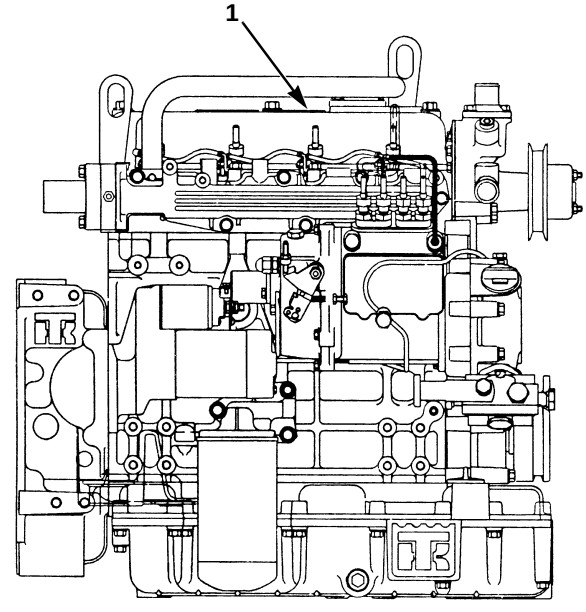


1.	Serial Number Location

Figure 1: Compressor Serial Number Location

1.	Serial Number Location

Figure 2: Unit Serial Number Locations



1.	Serial Number Location

Figure 3: Engine Serial Number Location

Unit Photos

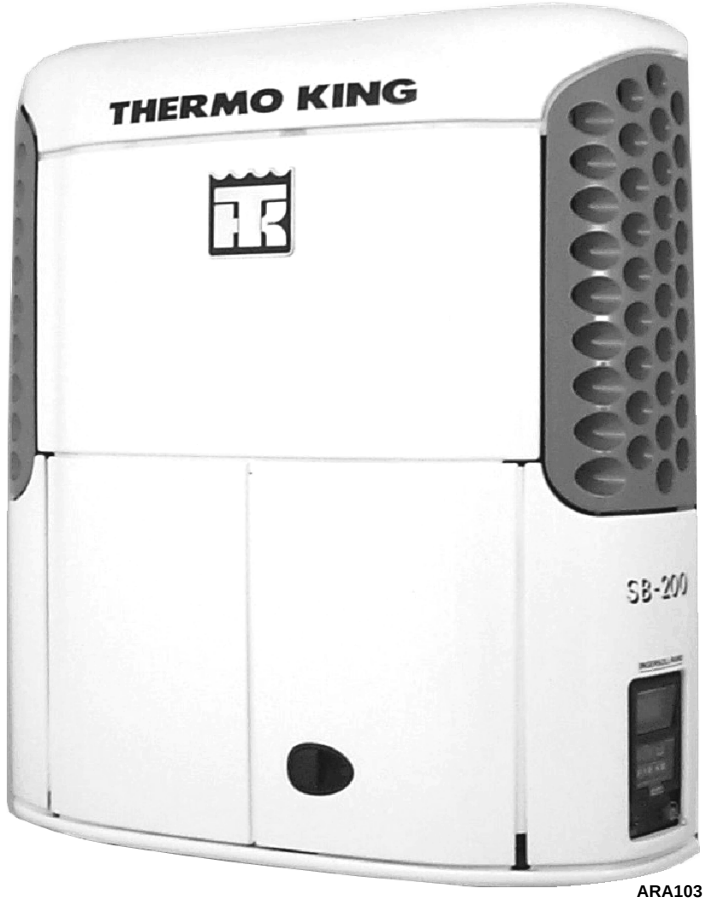
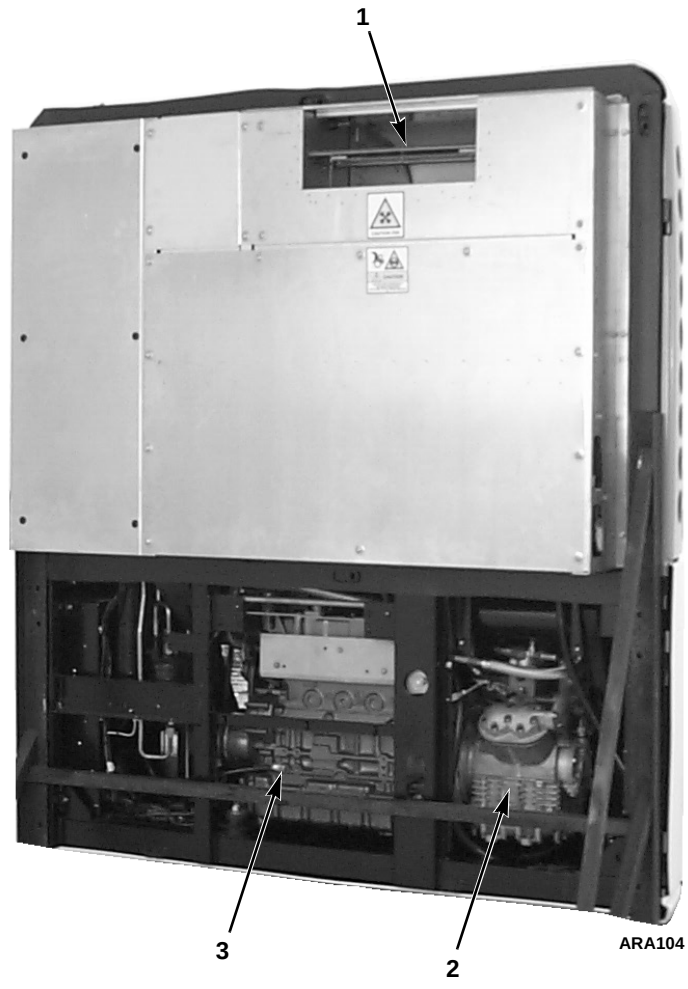
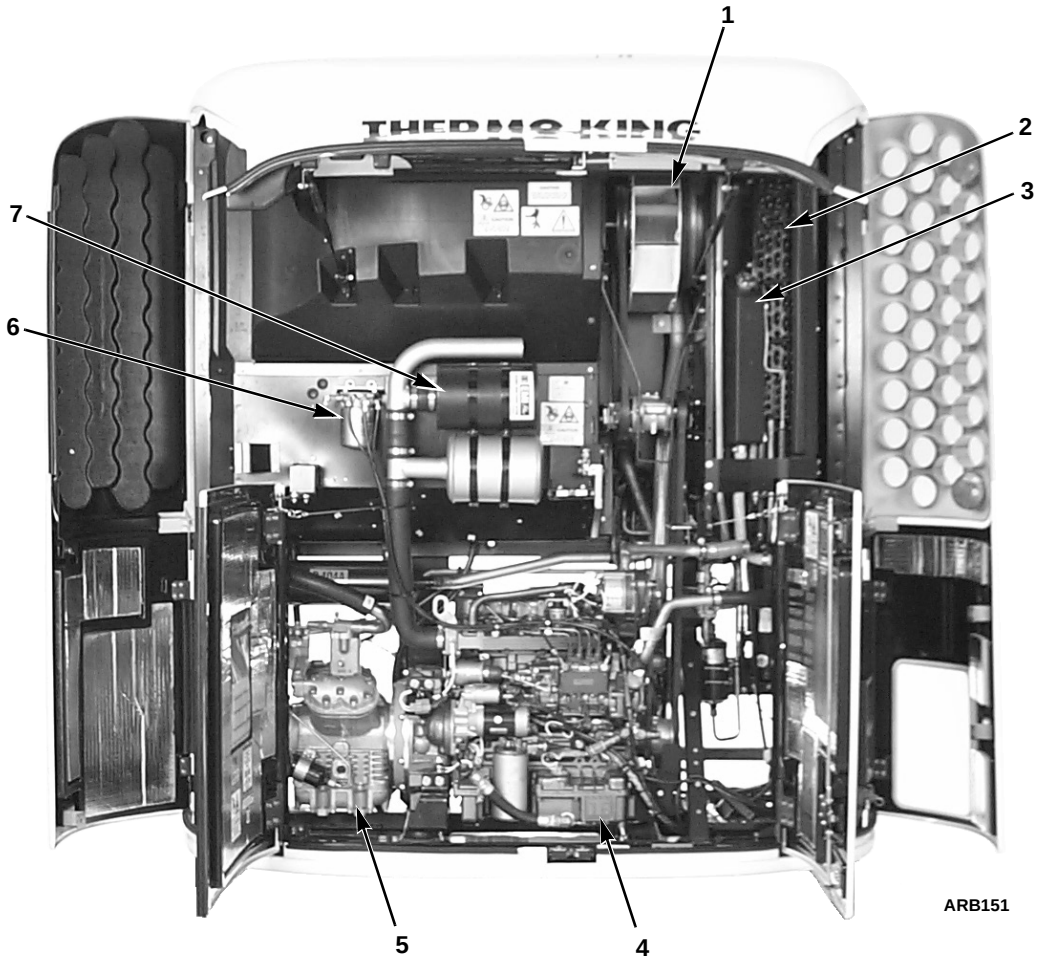


Figure 4: Front View



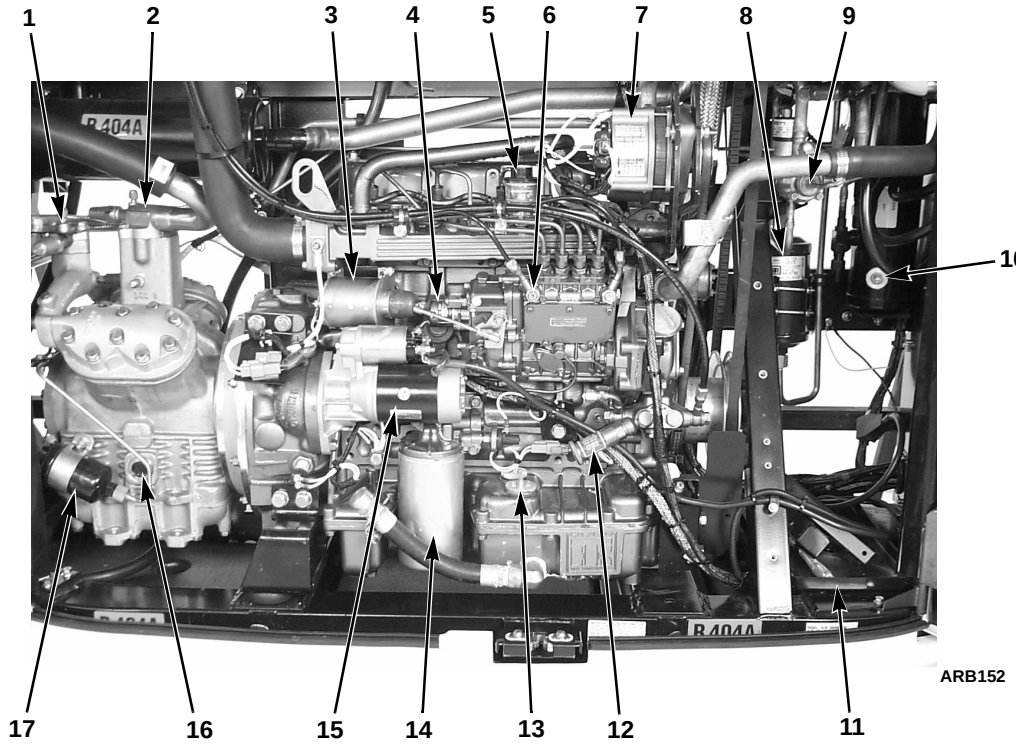
1.	Defrost Damper
2.	X430L Compressor
3.	TK 486 Engine

Figure 5: Back View



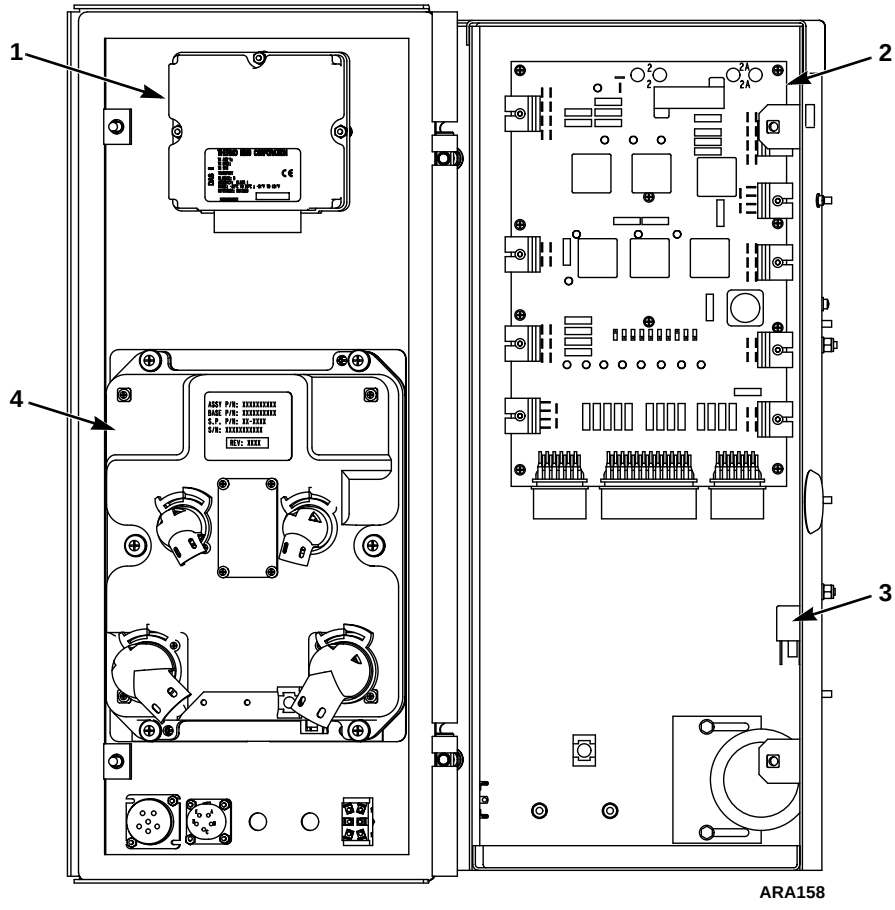
1.	Condenser Fan	5.	X430L Compressor
2.	Condenser Coil	6.	Fuel Filter/Water Separator
3.	Expansion Tank	7.	Air Cleaner
4.	TK 486 Engine		

Figure 6: Front View with Doors Open (Model 30)



1.	Discharge Service Valve	10.	Receiver Tank Sight Glass
2.	Suction Service Valve	11.	Battery Tray
3.	Throttle Solenoid	12.	Hand Primer Pump
4.	Fuel Solenoid	13.	Dipstick
5.	Air Restriction Indicator	14.	Oil Filter (Standard Blue Filter Shown)
6.	Fuel Bleed Screw	15.	Starter
7.	Alternator	16.	Compressor Sight Glass
8.	Filter Drier	17.	Compressor Oil Filter
9.	Three-way Valve		

Figure 7: Engine Compartment



1.	DAS
2.	Relay Board
3.	Air Intake Heater Relay
4.	Microprocessor

Figure 8: Control Box Components

Operating Instructions

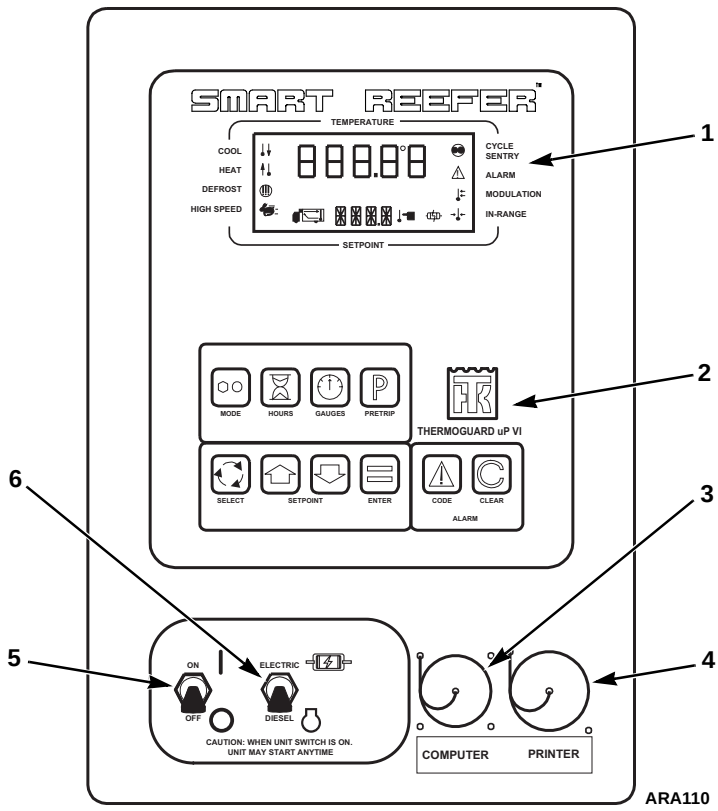
Control Panel

Most of the controls used to operate the unit are located on the control panel. Refer to the SB-200 Operator's Manual or the THERMOGUARD µP-VI Microprocessor Controller Diagnostic Manual TK 50566 for more complete operating information.

On/Off Switch

This switch turns the unit on and off. When the switch is in the Off position, the display will be off and the display backlight will be off. The switch should always be placed in the Off position before servicing the unit. When the switch is in the On position, the display backlight will turn on and the Standard Display will appear.

WARNING: The unit may start and run automatically any time the On/Off switch is in the On position.



1.	Display	4.	Printer Port
2.	Keypad	5.	On/Off Switch
3,	Computer Port	6.	Diesel/Electric Switch (Model 50 Only)

Figure 9: Control Panel

Optional On/Off/Sleep Switch

This switch turns the unit on and off and also places the unit directly into the Sleep Mode without an exit time. When the switch is in the Off position, the display will be off and the display backlight will be off. The switch should always be placed in the Off position before servicing the unit. When the switch is in the On position, the display backlight will turn on and the Standard Display will appear. When the switch is in the Sleep position, the unit will enter the Sleep mode (without an exit time), the display backlight will turn on, and the display will show [SLEEP] and [MODE].

WARNING: The unit may start and run automatically any time the On/Off/Sleep switch is in the On or Sleep position.

NOTE: The unit will not control the box temperature when the switch is in the Sleep position.

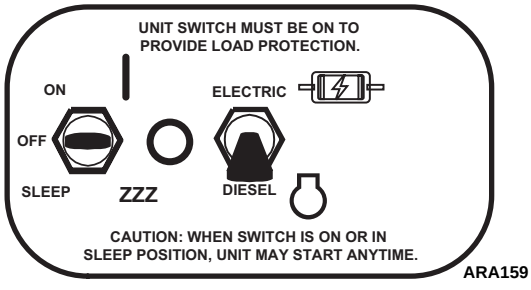


Figure 10: Model 50 On/Off/Sleep Switch

Diesel/Electric Switch (Model 50 Only)

This switch selects diesel or electric operation. To operate with the switch in the ELECTRIC position, the unit must be connected to an electric power source that has the correct voltage and frequency.

Display

The display normally shows the Standard Display of return or discharge air temperature and setpoint. Other operating and unit information can also be shown here. All possible segments and operating icons are shown in the illustration on page 31.

Icons

An icon will appear next to the appropriate description when the unit is operating in that mode or if an alarm condition exists.

Cool Icon: Appears when the unit is operating in cool mode.

Heat Icon: Appears when the unit is operating in heat mode.

Defrost Icon: Appears when the unit is operating in defrost mode.

High Speed Icon: Appears when the diesel engine is operating in high speed.

CYCLE-SENTRY Icon: Appears when the unit is operating in CYCLE-SENTRY mode.

Alarm Icon: Appears when the microprocessor detects an alarm condition.

Modulation Icon: Appears when the unit is operating in modulation mode.

In-Range Icon: Appears when the box temperature is within a few degrees of setpoint.

Discharge Air Icon: (Arrow pointing from unit) Discharge air temperature is being shown.

Return Air Icon: (Arrow pointing to unit) Return air temperature is being shown.

Setpoint Icon: Appears when the setpoint is being shown in the lower display.

Keypad

These touch sensitive keys are used to change the setpoint, view operating conditions and other unit information, and to control the unit.

MODE Key: Allows selection of a Manual Defrost Cycle, CYCLE-SENTRY or Continuous Mode, and Sleep Mode.

HOURMETER Key: Displays Total Hours, Engine Hours, Electric Hours and the 3 programmable hour meters.

GAUGES Key: Displays Water Temperature, Oil Pressure, Amps, Battery Volts, Engine RPM, Suction Pressure, Discharge Pressure, and ETV Position.

PRETRIP Key: Allows selection of Pre-trip Test, print, or start of trip marker.

THERMO KING LOGO KEY: Allows selection of Pretrip Test, Print and Start of Trip and displays software revision and clock/calendar settings.

CLEAR KEY: This key is pressed to clear alarm codes when they are shown on the display.

CODE KEY: Pressing this key displays any alarm codes that may be present. [00] means no codes are present.

ENTER KEY: Pressing this key will execute a prompt or load a new setpoint or other setting.

NOTE: An audible enter prompt is available. If enabled, this feature sounds a buzzer when the display flashes to remind you to press the ENTER key.

UP and DOWN ARROW KEYS: Pressing these keys will change a displayed prompt or increase/decrease the setpoint or other setting.

SELECT KEY: Pressing this key displays temperature sensor readings and Sleep Mode Wakeup Time (if programmed). See the following list:

[DIS.A]	Discharge Air Temp
[TPDF]	Temp Differential
[COIL]	Coil Temp
[AMB.T]	Ambient Temp
[SPR.1]	Spare Sensor 1 Temp
[SPR.2]	Spare Sensor 2 Temp
[DAS.1]	DAS Temp Sensor 1*
[DAS.2]	DAS Temp Sensor 2*
[DAS.3]	DAS Temp Sensor 3*
[DAS.4]	DAS Temp Sensor 4*
[DAS.5]	DAS Temp Sensor 5*
[DAS.6]	DAS Temp Sensor 6*
[SDAY]	Sleep Mode Wakeup Day**
[SHR]	Sleep Mode Wakeup Hour**
[SMN]	Sleep Mode Wakeup Minute**

** DAS Sensors are optional.*

*** Only if Sleep Mode Wakeup Time is Programmed*

Computer Port

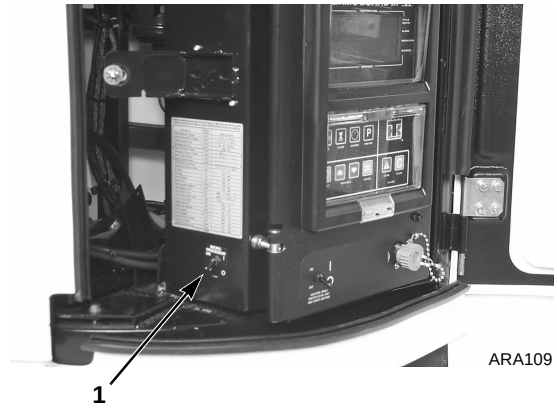
A serial cable from a computer is connected to the download port to access the Data Logging functions of the DAS.

Printer Port

A serial cable from a printer is connected to the printer port to obtain a printout of the data log.

Microprocessor Power Switch

Early model units are equipped with a Microprocessor Power Switch, which is located on the side of the control box in the engine compartment. Because this unit is equipped with a DAS, the Microprocessor Power Switch should always be placed in the down position. This switch was eliminated on late model units.



1.	Microprocessor Power Switch

Figure 11: Microprocessor Power Switch Location

Unit Indicators

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.

Compressor Oil Sight Glass: The compressor oil sight glass is used to check the relative level of compressor oil in the compressor sump.

Air Restriction Indicator: An air restriction indicator is attached to the intake manifold. Visually inspect the restriction indicator periodically to assure the air filter is not restricted. Service the air filter when the yellow diaphragm indicates 25 in. of water column. Press the button on the top of the restriction indicator after servicing the air filter. Replace the EMI 3000 air cleaner element (see "EMI 3000 Air Cleaner" on page 65) at 3,000 hours or two years (whichever occurs first) if air clean indicator has not reached 25 in.

Remote Status Light: The remote status light indicates the operating status of the unit. The green "T" indicates the unit is functioning properly. The amber "K" indicates the unit has a check alarm but is still functioning. The green "T" and amber "K" both flash to indicate the unit has a shutdown alarm and is not functioning.

Unit Protection Devices

Fuse Link (Current Limiter): The fuse link is located in the positive battery cable. The fuse link protects the electric system from a short in the 2 circuit.

Fuses: A number of fuses, located on the relay board, protect various circuits and components.

- Fuse F3 (15 amp) protects the circuit that provides power to defrost relay and the damper.
- Fuse F9 (40 amp) protects the main control power circuit.
- Fuse F18 (15 amp) protects the circuit that provides power to the throttle solenoid.
- Fuse F21 (25 amp) protects the circuit that provides power to the On/Off switch.
- A number of 2 or 5 amp fuses protect microprocessor circuits, control relay circuits, remote status light circuits and various components.

High Pressure Cutout: The high pressure cutout is a pressure sensitive switch, which is located in the compressor discharge service valve (Model 50 units have two). The switch opens to shut down the unit if the discharge pressure rises above 470 psi (3241 kPa).

High Pressure Relief Valve: The high pressure relief valve is designed to relieve excess pressure within the refrigeration system. The valve is a spring-loaded piston that lifts off its seat when refrigerant pressure exceeds 500 psi (3447 kPa). The valve will reseat when the pressure drops to 400 psi (2758 kPa). The valve could possibly leak refrigerant after it has relieved excess pressure. Tapping the valve lightly may help the valve reseat and SEAL PROPERLY. The valve is non-repairable and requires no adjustment. If the valve fails to reseat properly, remove the refrigerant charge and unscrew and replace the valve.

The high pressure relief valve is located on the receiver tank. Its location is such that when the pressure is expelled from the valve, it would be directed away from anyone servicing the unit.

Low Oil Level Switch: The low oil level switch closes if the oil drops below a certain level. If it stays closed for a specified time, the microprocessor will shut the unit down and record alarm code 66.

Preheat Buzzer: The preheat buzzer sounds when the CYCLE-SENTRY system energizes the air heater. This should warn anyone near the unit that the CYCLE-SENTRY system is about to start the diesel engine.

Setpoint/Mode Key Buzzer (Optional): This buzzer sounds when the setpoint is changed until the **ENTER** Key is pressed. It also sounds when a **MODE** Key selection is changed until the **ENTER** Key is pressed.

Overload Relay—Manual Reset (Model 50): An overload relay protects the standby electric motor. The overload relay opens the circuit to the electric motor if the motor overloads for any reason (e.g., low line voltage or improper power supply) while the unit is on electric standby operation.

Unit Operation

Manual Pretrip Inspection (Before Starting Unit)

The following Manual Pretrip Inspection should be completed before starting the unit and loading the trailer. While the Manual Pretrip Inspection is not a substitute for regularly scheduled maintenance inspections, it is an important part of the preventive maintenance program designed to head off operating problems and breakdowns before they happen.

1. FUEL. The diesel fuel supply must be adequate to guarantee engine operation to the next check point.
2. ENGINE OIL. The engine oil level should be at the FULL mark with the dipstick turned (threaded) into oil pan. Never overfill.
3. COOLANT. The engine coolant must have antifreeze protection to -30 F (-34 C). Code 37 indicates low coolant. Add coolant in the expansion tank.

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

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. See "ELC (Extended Life Coolant)" on page 50 for more information.

4. BATTERY. The terminals must be clean and tight.
5. BELTS. The belts must be in good condition and adjusted to the proper tensions.
6. ELECTRICAL. The electrical connections should be securely fastened. The wires and terminals should be free of corrosion, cracks or moisture.
7. STRUCTURAL. Visually inspect the unit for leaks, loose or broken parts and other damage. The condenser and evaporator coils should be clean and free of debris. Check the defrost drain hoses and fittings to make sure they are open. Make sure all the doors are latched securely.

Starting Unit With electronic full pretrip

This procedure is used for a complete checkout of the unit and unit control circuits. It should be used when first starting the unit for a trip before the cargo is loaded. A full Pretrip procedure may take up to 30 minutes and the unit will run unattended.

1. Perform a Manual Pretrip Inspection.
2. Adjust the setpoint to the desired load temperature (refer to the appropriate Operator's Manual or Diagnostic Manual for detailed information about adjusting the setpoint).
   a. Change the setpoint display with the **ARROW** keys.
   b. Enter the new setpoint by pressing the **ENTER** key within 5 seconds.
3. Initiate a Pretrip test (refer to the appropriate Operator's Manual or Diagnostic Manual for detailed information about the Pretrip). This procedure is automatic and can be performed on the way to the loading area or while waiting to load.
   a. Place the On/Off switch in the ON position.
   b. Clear any alarms.
   c. Press the **PRETRIP** key.
      - PRE TRIP will appear on the display.
   d. Press the **ENTER** key while PRE TRIP is displayed.
      - PRE LOAD will appear on the display and the PRE TRIP test will start.
      - PRE AMPS will appear on the display indicating that the amps check is running and the PRE TRIP has started.
      - The amps check will continue for several minutes, then the unit will start automatically and the operational tests will be performed.

4. When the PRE TRIP test is complete, PASS, CHECK, or FAIL will appear on the display until a function key (e.g., SELECT or ENTER) is pressed. Continue as follows:
   - PASS—The unit is running and no alarms have been recorded. The unit has passed the PRE TRIP. Go to step 6.
   - CHECK—The unit is running but Check Alarms have been recorded. Go to step 5.
   - FAIL—The unit has shut down, recorded Alarm Code 28, and possibly recorded other Shutdown Alarms. Go to step 5.
5. View the Alarms with the **CODE** key (refer to the appropriate Diagnostic Manual for detailed information about alarms).
   a. Correct the alarm conditions.
   b. Clear the alarms with the **CLEAR** key (refer to the appropriate Diagnostic Manual for detailed information about alarms).
   c. Repeat the PRE TRIP test until PASS appears (the unit passes the Pretrip).
6. Recheck the setpoint.
7. Complete the “After Start Inspection” on page 37.

Selection Of Operating Modes

The Thermo King CYCLE-SENTRY system is designed to save refrigeration fuel costs. The savings vary with the commodity, ambient temperatures and trailer insulation. However, not all temperature controlled products can be properly transported using CYCLE-SENTRY operation. Certain highly sensitive products normally require continuous air circulation.

- The microprocessor has a CYCLS screen, which is used to select CYCLE-SENTRY (CYCLS YES) or Continuous Run (CYCLS No) operation. Refer to the appropriate Operator’s Manual or Diagnostic Manual for detailed information about CYCLE-SENTRY selection.
- The microprocessor has an OptiSet™ feature that can lockout CYCLE-SENTRY operation and force Continuous Run operation within a programmable range of setpoints. This feature can be used to provide continuous air circulation (within the programmed setpoint range) during CYCLE-SENTRY operation. Refer to the appropriate Diagnostic Manual for specific information about the OptiSet™ feature.

Your selection of the operating mode for the proper protection of a particular commodity should use the following guidelines:

Examples of Products Normally Acceptable for CYCLE-SENTRY Operation

- Frozen foods (in adequately insulated trailers)
- Boxed or processed meats
- Poultry
- Fish
- Dairy products
- Candy
- Chemicals
- Film
- All non-edible products

Examples of Products Normally Requiring Continuous Run Operation for Air Flow

- Fresh fruits and vegetables, especially asparagus, bananas, broccoli, carrots, citrus, green peas, lettuce, peaches, spinach, strawberries, sweet corn, etc.
- Non-processed meat products (unless pre-cooled to recommended temperature)
- Fresh flowers and foliage

The above listings are not all inclusive. Consult your grower or shipper if you have any questions about the operating mode selection of your type of load.

Restarting Unit—Diesel Operation

This procedure is used when starting units that have been shut off for short periods of time. When a unit that has been shut off for a long period of time is first started, it should be started and put through a full pretrip.

1. Place the Diesel/Electric switch (if so equipped) in the Diesel position.
2. Place the On/Off switch in the On position.
3. After a 10 second delay, the unit should preheat and start automatically.

   NOTE: When the CYCLE-SENTRY Icon is active, the unit may not start if: the compartment temperature is near the setpoint, the engine is warm, and the battery is fully charged.

Restarting Unit—Electric Operation

This procedure is used when starting a unit that has been shut off for a short period of time. When a unit that has been shut off for a long period of time is first started, it should be started and put through a full pretrip.

1. Place the Diesel/Electric switch in the Electric position.
2. Connect the unit to an appropriate electric power supply.

   CAUTION: Always turn the electric power supply Off when handling, connecting, or disconnecting high voltage power cords.

3. Turn the high voltage power supply On.

   CAUTION: Do not start the electric drive motor unless the diesel engine is completely stopped.

4. Place the On/Off switch in the On position. If the microprocessor determines that the unit should cool or heat, the appropriate icon(s) will appear and the electric motor will start. It may not start if the return air sensor temperature is within a few degrees of setpoint.

After Start Inspection

After the unit is running, the following items can be quickly checked to confirm that the unit is running properly.

1. OIL PRESSURE. Check the engine oil pressure in high speed by pressing the **GAUGES** key. The oil pressure should read OK, not LOW.
2. AMMETER. Check the ammeter reading by pressing the **GAUGES** key. The ammeter should indicate normal battery charging current. It may be fairly high right after starting the unit, but should taper off as the battery is recharged.
3. COMPRESSOR OIL. The compressor oil level should be visible in the sight glass.
4. REFRIGERANT. Check the refrigerant charge. See Refrigerant Charge in the Refrigeration Maintenance chapter.
5. 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.

6. 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 **MODES** key until the dEF (defrost) prompt screen appears, then press the **ENTER** key.

   Refer to the appropriate Operator's Manual or Diagnostic 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 45 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 trailer. (Unit may be running when loading the trailer from a warehouse with door seals.)
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 transport refrigeration 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, manually initiate a defrost cycle. If the evaporator coil sensor temperature is below 45 F (7 C), the unit will defrost. The microprocessor will terminate defrost automatically when the evaporator coil temperature reaches 57 F (13 C) or the unit has been in the defrost mode for 30 or 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 (Australian Bosch) Model 30

Charging System Diagnostic Procedures

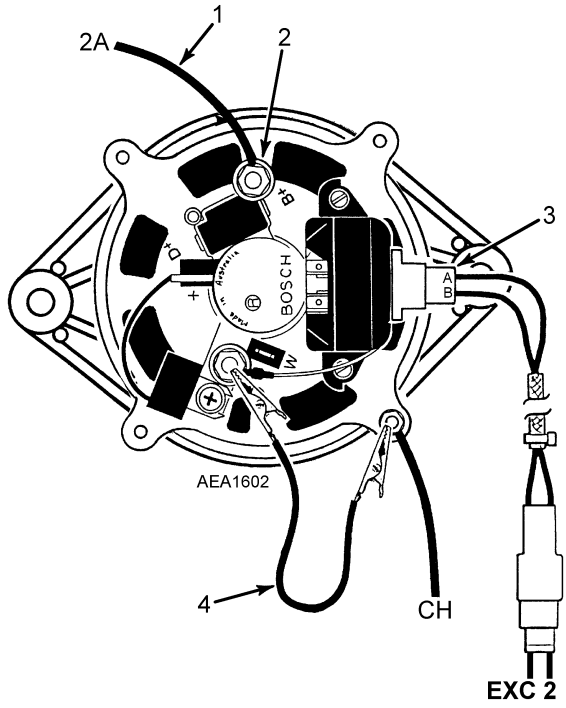
NOTE: Units manufactured with CYCLE-SENTRY and alternators with integral regulators MUST use replacement alternators with integral regulators.

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.

CAUTION: The F15 fuse must be removed from the relay board on units equipped with the Australian Bosch alternator. The voltage regulator will be damaged if the unit is turned On with the F15 fuse in place on the relay board.

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

- When testing alternators use accurate equipment such as a Thermo King P/N 204-615 (FLUKE 23) digital multimeter and a Thermo King P/N 204-613 amp clamp or an equivalent.



1.	Check Point for 2A Amperage	3.	Check Point for Sense Circuit and Excitation Circuit Voltages
2.	Check Point for B+ Voltage	4.	Position for Full Fielding Jumper

Figure 12: Check Points for Alternator Test

- 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. Check to make sure that the F15 fuse has been removed from the relay board. If not, it must be removed, however, the voltage regulator has probably already been damaged.
2. Set the unit for continuous run operation and place the On/Off switch in the Off position.
3. 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.
4. Check the voltage at the B+ terminal on the alternator. Battery voltage must be present. If not, check the 2A circuit.
5. Disconnect the alternator harness from the voltage regulator by carefully pushing on the spring clip to release the plug lock.
6. Place the On/Off switch in the On position and enter Service Test Mode (HSC) before the unit starts. Refer to the appropriate Diagnostic Manual for specific information about the Service Test Mode.
7. Check the voltage at the A pin and at the B pin in the two pin connector on the alternator harness.
   a. The A pin is the battery sense circuit and should be at battery voltage. If not, check the sense circuit (2 or equivalent) in the alternator harness and in the main wire harness.
   b. Energize the run relay in the relay board test. The B pin is the excitation circuit and should be at 10 volts or higher. If not, check the excitation circuit (7K or equivalent) in the alternator harness and in the main wire harness.
8. If battery voltage is present on the sense and excitation circuits, connect the alternator harness to the voltage regulator and check the voltage on the B pin in the two pin connector on alternator harness. The voltage should be 0.7 to 1 volt using the relay board test.
   a. No voltage or a voltage reading below 0.7 volts indicates that the rotor or the voltage regulator may be shorted. Perform the field current test to further isolate the problem.
   b. A voltage reading above 3 volts indicates that the field circuit may be open or have high resistance. The brushes or the rotor are probably defective.
9. Attach a clamp-on ammeter to the 2A wire connected to the B+ terminal on the alternator.
10. Connect a voltmeter between the B+ terminal and a chassis ground.
11. Start the unit and run it in high speed.
12. Connect a jumper wire between the F2 terminal and a chassis ground. This will full field the alternator.

    CAUTION: DO NOT full field the alternator for more than seven seconds while checking the meter readings, or the electrical system may be damaged.

13. Check the amperage in the 2A wire and record the reading. Check the voltage at the B+ terminal and continue to observe this voltage for a few seconds to see if it increases, decreases, or stays the same. Note the change in voltage and record the voltage reading.

    Amperage in the 2A wire =____amps.

    Voltage at the B+ terminals =____volts.

    The voltage at the B+ terminal should be 13 to 18 volts and the amperage in the 2A wire should be at least as high as the rated output of the alternator.

NOTE: An alternator can easily exceed its rated output. An alternator MUST at least reach its rated output when full fielded. An alternator that has a defective rectifier diode may reach 75% of its rated output with a full field.

14. Stop the unit.
15. Use the readings obtained previously to determine the problem by referring to the Diagnosis Chart.

    NOTE: This assumes that the alternator did not charge properly prior to the full field test.

Field Current Test (Checks the field windings, brushes and slip rings)

Perform this test with the On/Off switch in the Off position.

1. Attach a clamp-on ammeter to the 2A wire near the B+ terminal on the alternator.
2. Connect a jumper wire between the F2 terminal on the alternator and a chassis ground, and note the ammeter reading.
3. The ammeter reading indicates field current. The following chart shows the field current for each alternator with 12 volts applied to the field:

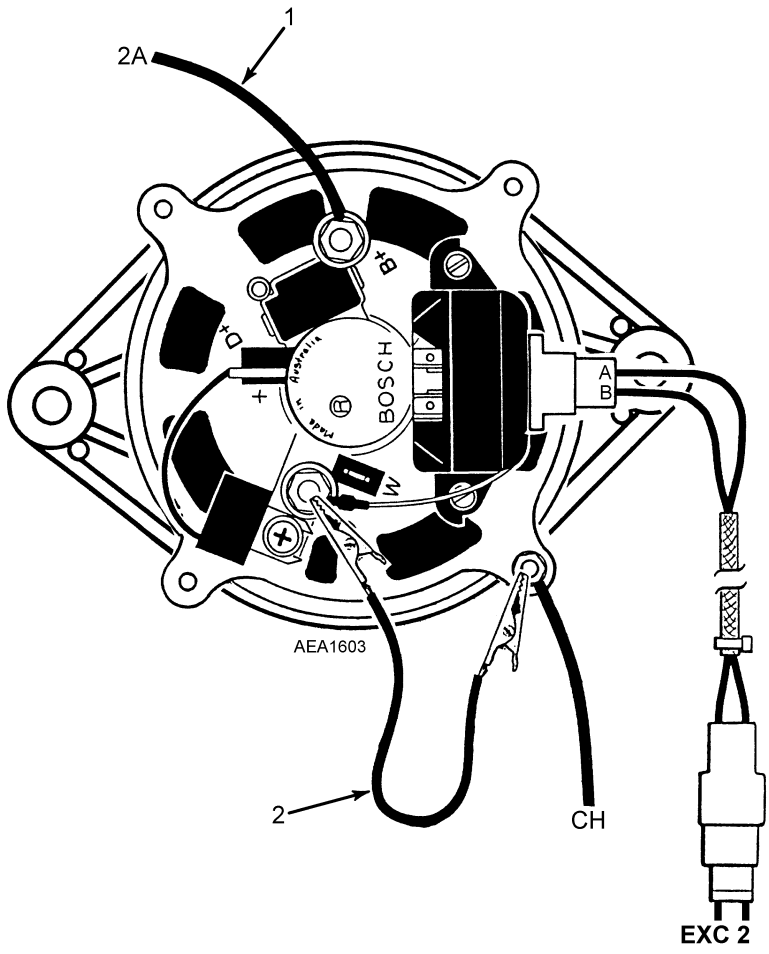
Alternator Rating	Field Current @ 12 Volts
23 Amp	1.0 to 3.0 Amps
37 Amp	3.5 to 4.5 Amps
65 Amp	4.0 to 5.0 Amps

   a. No field current or a low field current indicates an open circuit or excessive resistance in the field circuit. Replace the voltage regulator and brush assembly, inspect the slip rings and repeat the test. If the brushes are not the problem, replace the rotor or the alternator.

   b. High field current indicates a short in the field circuit. Repair or replace the alternator.

Diagnosis Chart

Amperage in 2A	Voltage at B+	Problem/Solution
At or above rated output	At or above battery voltage and increasing	Voltage regulator defective / Replace voltage regulator and brush assembly
Approximately 60% of rated output	Approximately equal to battery voltage and does not change, or rises slightly	Rectifier diode defective / Repair or replace alternator
Low or no output	Less than or equal to battery voltage and decreasing	Stator windings, field windings, brush or diode defective / Perform Field Current Test to check brushes and field coil, or replace alternator



1.	Check Point for 2A Amperage
2.	Position for Full Fielding Jumper

Figure 13: Full Field Test

Alternator (Prestolite) Model 50

Charging System Diagnostic Procedures

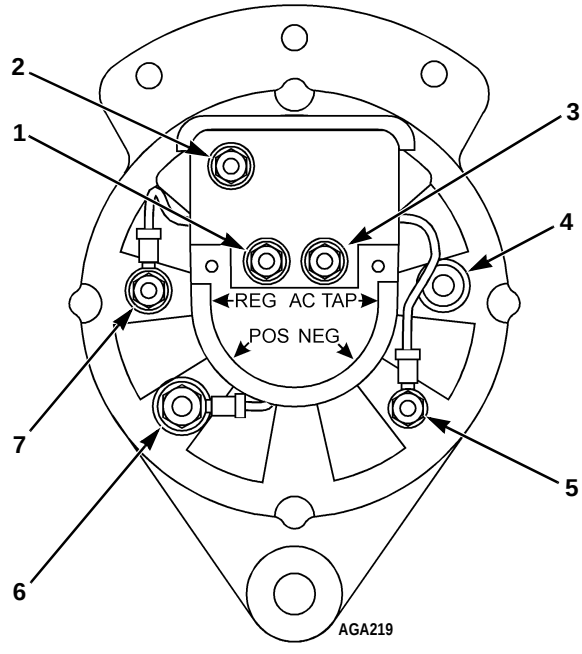
NOTE: Units manufactured with CYCLE-SENTRY and alternators with integral regulators MUST use replacement alternators with integral regulators.

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.

NOTE: The F7 fuse must be installed in the relay board on units equipped with the Prestolite alternator. If the F7 fuse is not in place, the alternator will not charge properly.

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

- When testing alternators use accurate equipment such as a Thermo King P/N 204-615 (FLUKE 23) digital multimeter and a Thermo King P/N 204-613 amp clamp or an equivalent.



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 14: Prestolite Terminal Locations

- 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. Check to make sure that the F7 fuse is in place on the relay board. If not, it must be installed in order for the alternator to charge properly.
2. Set the unit for continuous run operation and place the On/Off switch in the Off position.
3. 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.
4. Check the voltage at the B+ terminal on the alternator. Battery voltage must be present. If not, check the 2A circuit.
5. Check the voltage at the VOLT SENSE terminal on the alternator. Battery voltage must be present. If not, check the 2 circuit.
6. Set the unit for continuous run operation and place the main On/Off switch in the On position.
7. Check the voltage at the EXC terminal on the alternator. Battery voltage must be present. If not, check the EXC circuit.
8. Attach a clamp-on ammeter to the 2A wire connected to the B+ terminal on the alternator.
9. Connect a voltmeter between the B+ terminal and a chassis ground.
10. Start the unit and run it in high speed.
11. 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.

Battery

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, chaffed or broken wires to protect against unit malfunctions due to open or short circuits.

Fuses

A number of fuses, located on the relay board, protect various circuits and components. The relay board is located inside the control box. Refer to the appropriate THERMOGUARD Microprocessor Controller Diagnostic Manual for a complete list of the size and function of the fuses.

- Fuse F3 (15 amp) protects the circuit that provides power to defrost relay and the damper.
- Fuse F9 (40 amp) protects the main control power circuit.
- Fuse F18 (15 amp) protects the circuit that provides power to the throttle solenoid.
- Fuse 21 (25 amp) protects the circuit that provides power to the On/Off switch.
- A number of 2, 3, or 5 amp fuses protect microprocessor circuits, control relay circuits, remote status light circuits and various components.

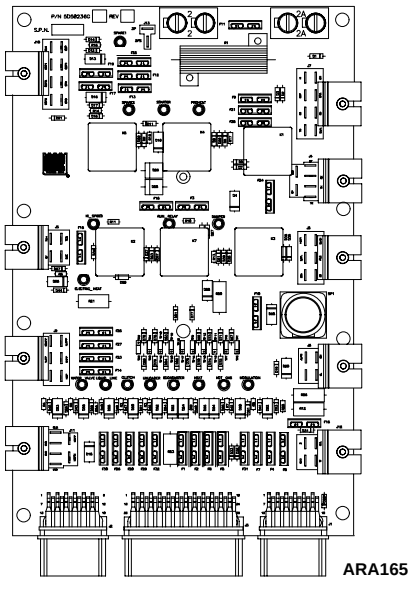


Figure 15: Relay Board

Fuse Link

The fuse link is located in the positive battery cable. The fuse link protects the electrical system from a short in the 2 circuit. If the fuse link burns out, check for a grounded 2 wire before replacing the fuse link. Replace this fuse link by replacing the positive battery cable.

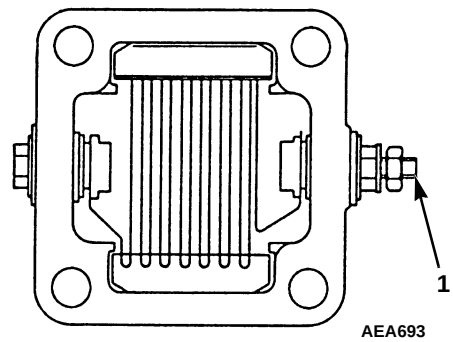
Air Heater

The air heater is mounted on the open end of the intake manifold. It heats the intake air to help the engine start in cold weather. The air heater is energized by the microprocessor during preheat, just before the engine is started.

The heater is probably defective if the resistance is more than 0.2 ohms and the current draw is less than 60 amps, or if the current draw is more than 100 amps.

Check the resistance of the air intake heater with an ohmmeter between the M6 terminal on the front of the heater and the screw on the back of the heater (or the heater case). The resistance should be 0.1 to 0.2 ohms.

Check the current draw of the heater with a clamp-on ammeter at the H1 wire near the M6 terminal on the front of the heater. During preheat the current draw should be approximately 89 amps at 12.5 volts and approximately 77 amps at 11 volts.



1.	M6 Terminal

Figure 16: Air Heater

Thermoguard µP-VI Microprocessor Controller

Refer to the appropriate THERMOGUARD Microprocessor Diagnostic Manual for complete service information about the Microprocessor Controller and the related components.

AC Components

CAUTION: Model 50 units use high voltage ac for electric standby operation. Lethal voltage potentials can exist on connections in the high voltage box. Take appropriate precautions and use extreme care when testing the unit.

Electrical Contactors

Periodically inspect all contactor points for pitting or corrosion and repair or replace as necessary. Test the contactor points by checking the voltage drop across each set of points when the contactor is energized and the system is operating. If the voltage drop across a set of points is more than 15 Vac, replace the contact points as a set.

Test the contactor coil by checking the voltage across the coil. The contactor coil should be energized by a minimum of 10 Vdc.

Auto Phase System

The Auto Phase system automatically adjusts the phase sequence of the power supply to correspond with the wiring of the electric motor. The main components of the system are the phase selection module (PSM), its two relays, and the two motor contactors (MC1 and MC2). Contactor MC1 is wired to retain the phase sequence. Contactor MC2 is wired to change the phase sequence. The PSM senses the phase sequence at the heater contactor and energizes the appropriate motor contactor by energizing one of the relays.

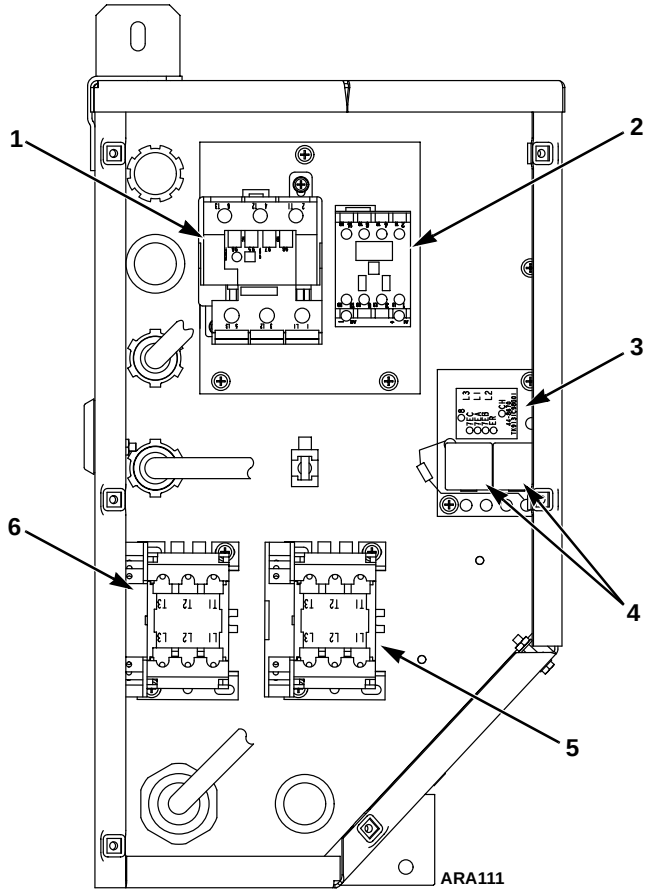
Troubleshooting the Auto Phase System

If the electric motor runs backwards (unit airflow incorrect):

1. Turn the electric power supply Off and check the unit wiring. Refer to the appropriate wiring diagrams, schematics, and Figure 17 “High Voltage Tray” on page 47.
   a. The three wires from the PSM should be connected to the heater contactor terminals as follows: Brown wire to terminal L1, Blue wire to terminal L2, and Black wire to terminal L3.
   b. Wires L1, L2, and L3 should be connected respectively to terminals L1, L2, and L3 on the heater contactor and both motor contactors.
   c. Wires L1A, L2A, and L3A should be connected respectively to terminals T1, T2, and T3 on MC1.
   d. Wires L1A, L2A, and L3A should be connected respectively to terminals T3, T2, and T1 on MC2.
   e. Wires L1A, L2A, and L3A should be connected respectively to terminals L1, L2, and L3 on the overload relay.
   f. Wires 1, 2, and 3 should be connected respectively to terminals T1, T2, and T3 on the overload relay.
   g. Wires Brown, Blue, and Black should be connected respectively to terminals R1, S2, and T3 in the power receptacle.
   h. Wires Brown, Blue, and Black should be connected respectively to terminals T1, T2, and T3 on MC1.
   i. Wires 7EH, 7EC, 7EB, and CH should be connected to the corresponding terminals on the PSM.
   j. The electric motor must be wired correctly.
2. Check the relays on the PSM to make sure that one of them is not faulty (contacts stuck closed).
3. Check MC1 and MC2 to make sure that one of them is not faulty (contacts stuck closed).
4. If all of the wiring is correct, and the relays and contactors are acceptable, but the electric motor still runs backwards, switch the Brown wire and the Black wire from the PSM at the heater contactor: Black to L1, Blue to L2, and Brown to L3. If the electric motor now runs correctly, it is probably wired incorrectly.

If the electric motor does not run at all:

1. Make sure that the unit is turned On, the Diesel/Electric switch is in the Electric position, and that the power supply is connected and turned On.
2. Check the CH terminal on the PSM for continuity to the CH circuit (chassis ground). If there is no continuity to the CH circuit, check the CH wire for continuity.
3. Check for battery voltage (12 volts) at the 7EH terminals on the PSM. Battery voltage should be present. If not, check the 7EH circuit, the overload relay, the 7EA circuit, the Electric HPCO, the 7E circuit, the F16 fuse, the 7ES circuit, the Diesel/Electric switch, the 7K circuit, the F4 fuse, the run (7K) relay, the 8F circuit, the On/Off switch, the 2AA circuit, the F21 fuse, he 2A circuit, the 2 circuit, the fuse link, and the battery. Also make sure that the microprocessor display is on and that the microprocessor is calling for heat or cool.



1.	Overload Relay	4.	PSM Relays
2.	HC—Heater Contactor	5.	MC2—Motor Contactor
3.	PSM—Phase Selection Module	6.	MC1—Motor Contactor

Figure 17: High Voltage Tray

4. Check for battery voltage at the 7EB and 7EC terminals on the PSM. Battery voltage should be present on one of these terminals when AC voltage is present on L1, L2, and L3. If not, replace the relays on the PSM with relays that function properly and recheck the voltage on the 7EB and 7EC terminals. If battery voltage is not present, the PSM is faulty.
5. Check for battery voltage at the 7EB terminal on MC1 and at the 7EC terminal on MC2. Battery voltage should be present at one of these terminals. If not, check the continuity of the 7EB and 7EC wires.
6. Check the continuity of the RED wires on the motor contactors. The RED wires must have continuity.
7. Check the CH circuit at MC1 and MC2 for continuity to a chassis ground. If the CH circuits do not have continuity to a chassis ground, check the CH wires.
8. Check the continuity of the BLK wires on the motor contactors. The BLK wires must have continuity.
9. If the CH circuits and BLK wires do have continuity to CH, the contactor that has battery voltage present at 7EB (MC1) or at 7EC (MC2) is faulty.

EMI 3000

EMI 3000 is an extended maintenance interval package. It was phased in as standard equipment on this unit in the first quarter of 2001. The EMI 3000 package consists of the following key components:

- New EMI 3000-Hour Cyclonic Air Cleaner Assembly and Air Cleaner Element
- New EMI 3000-Hour Fuel Filter (black with gold lettering)
- New EMI 3000-Hour Dual Element Oil Filter (black with gold lettering)
- API Rating CG-4 Mineral Oil (ACEA Rating E2-96 for Europe)
- Five Year or 12,000 Hour ELC (Extended Life Coolant).

The EMI package allows standard maintenance intervals to be extended to 3,000 hours, or 2 years, whichever occurs first.

NOTE: Units equipped with the EMI 3000 package do require regular inspection in accordance with Thermo King's maintenance recommendations.

NOTE: The new EMI 3000 oil filters and new EMI 3000 air cleaners are NOT interchangeable with the oil filters and air cleaners previously used in this unit. Refer to Service Bulletin T&T 274-1 for information about retrofitting EMI 3000 components.

Engine Lubrication System

The TK 486 engine has a pressure lubrication system. A trochoid type oil pump circulates the oil through the system to lubricate the engine compartments. The oil pump contains a pressure regulating valve that limits the oil pressure to approximately 45 to 57 psi (310 to 390 kPa). The oil pump is driven by the crankshaft gear, and is attached to the lower part of the timing gear housing.

The oil is picked up by a screened inlet near the bottom of the oil pan. The inlet is positioned far enough from the bottom of the pan to avoid picking up any of the residue that tends to settle on the bottom of the pan. The oil then passes through the intake pipe to the oil pump.

The oil pump forces the oil through an oil gallery to the dual element (full flow/bypass) oil filter. Dirt and other particles are trapped in the filter element as the oil passes through the oil filter. If the filter element becomes clogged, a bypass valve built into the oil filter allows the oil to bypass the filter element. This keeps the engine components from being starved for oil if the filter element is clogged.

After passing through the oil filter, the oil enters the main oil gallery. Oil passages connected to the main oil gallery supply oil to the idler gear shaft, the camshaft bearings, the main bearings, and the fuel injection pump.

Oil from the idler gear shaft lubricates the idler gear bushing, the idler gear, the other timing gears, and the fuel pump before returning to the oil pan.

Some of the oil supplied to the main bearings flows through passages in the crankshaft to the connecting rod bearings. This oil is thrown around the bottom end of the engine as it flows out of the bearings while the crankshaft rotates. Some of this oil lubricates the cylinder walls. Some of this oil lands in the holes on the top of the connecting rods and lubricates the wrist pins and the connecting rod bushings. The oil eventually returns to the oil pan.

Some of the oil supplied to the camshaft bearings flows through passages in the cylinder block, the cylinder head, and the rocker arm supports to the rocker arm shaft. The rocker arm shaft supplies oil to the rocker arm bushings and the rocker arms. Some oil squirts out of holes in the rocker arms to lubricate the valve stem caps and the valve stems. The oil that is pumped up to the rocker arm assembly flows back down through the push rod openings and lubricates the tappets and the cam lobes as it returns to the oil pan.

The oil that flows to the fuel injection pump returns to the oil pan after lubricating the injection pump components.

Oil pressure is affected by oil temperature, oil viscosity, and engine speed. Low oil pressure can usually be traced to the lack of oil, a faulty oil pressure regulating valve, loose connections in the lubrication system, or worn bearings. Low oil pressure is not normally caused by a faulty oil pump.

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, keep unit and trailer level so all the oil can flow from the oil pan. It is important to get as much of the oil out as possible because most of the dirt particles are contained in the last few quarts of oil that drain out of the pan. Refill the pan with 13 quarts (12.3 liters) and check the dipstick level. Run the unit, and then recheck the oil level. The engine oil level should be at the FULL mark with the dipstick turned (threaded) into the oil pan. Never overfill. See Specifications section for correct type of oil.

Oil Filter Change

The oil filter should be changed along with the engine oil. Use a genuine Thermo King extended maintenance oil filter.

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

Engine Cooling System

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, circulates it through the cylinder block and head and returns it to the radiator. A thermostat mounted in the coolant outlet line 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 50% permanent type antifreeze concentrate and 50% water mixture 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.

ELC (Extended Life Coolant)

ELC has been phased into all trailer units equipped with TK 486, engines. 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.

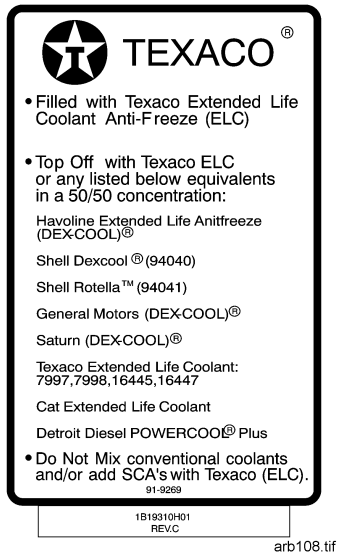


Figure 18: ELC Nameplate Located On Expansion Tank

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 (nitrite free) premixed 50/50% mixture.
- Havoline Dex-Cool #7994 (nitrite free) 100% concentrate, or #7997 (with nitrites) 100% concentrate.
- Havoline Dex-Cool #7995 (nitrite free) premixed 50/50% mixture, or #7998 (with nitrites) premixed 50/50% mixture.
- Shell Dexcool #94040.
- Shell Rotella #94041.
- Havoline XLC #30379 (Europe) 100% concentrate.
- Havoline XLC #33013 (Europe) premixed 50/50% mixture.
- 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 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 486 engine serial number L16553.

Units with engine serial numbers L16553 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 L16553 must have the water pump replaced to change over to ELC coolant. Refer to Service Bulletin T&T 274 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 50 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 (P/N 204-754) 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 its normal operating temperature. Stop the unit.
2. Open the engine block drain (located behind the starter) and completely drain the coolant. Observe the coolant color. If the coolant is dirty, proceed with a, b and c. Otherwise go to 3.

CAUTION: Avoid direct contact with hot coolant.

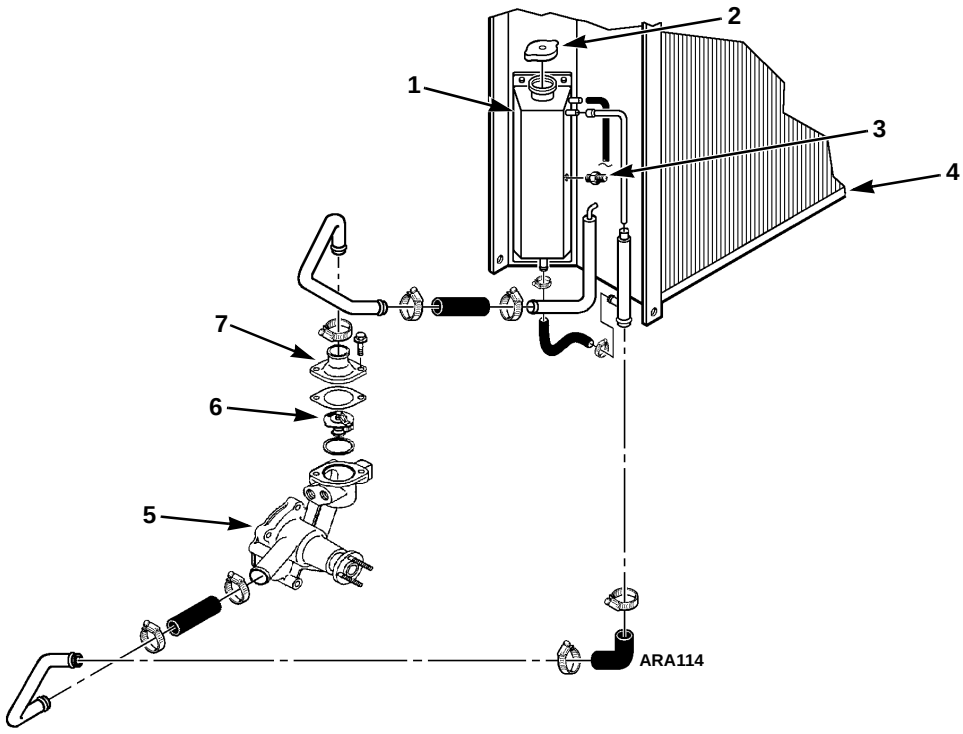
   a. Run clear water into the radiator and allow it to drain out of the block until it is clear.

   b. Close the block drain 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 engine block drain to drain the 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 block until it is clear.
4. Inspect all hoses for deterioration and 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. Determine which type of antifreeze to use. Conventional coolants are green or blue-green. ELC is red. Do not mix conventional coolants and ELC. See “ELC (Extended Life Coolant)” on page 50 to help determine which type of antifreeze to use.



1.	Expansion Tank	5.	Water Pump
2.	Radiator Cap	6.	Thermostat
3.	Coolant Level Sensor	7.	Thermostat Housing
4.	Radiator		

Figure 19: Engine Cooling System

8. Mix one gallon of the appropriate permanent 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.)
9. Refill the radiator with the 50/50 antifreeze mixture and make sure to bleed the air from the cooling system as needed.

Bleeding Air from the Cooling System

Jiggle pin thermostats are original equipment on units that have TK 482/486 engines. Jiggle pin thermostats make it unnecessary to bleed the air out of the engine block because they keep air from being trapped in the engine block. Normally, when the cooling system is drained, approximately 6 quarts (5.7 liters) of coolant drain out. If approximately 3 quarts (2.8 liters) of coolant seem to fill the cooling system after it has been drained, air has been trapped in the block. Bleed the air out of the block using the following procedure:

CAUTION: IF YOU SUSPECT THAT AIR IS TRAPPED IN THE BLOCK, DO NOT START THE ENGINE WITHOUT BLEEDING THE AIR OUT OF THE BLOCK.

NOTE: If an engine runs with air trapped in the block, the engine may be damaged. The high water temperature switch may not protect an engine that has air trapped in the block, because the high water temperature switch is designed to protect an engine from overheating due to failures in the cooling system.

1. Loosen the plug on the back of the water pump below the thermostat cover until coolant comes out of the plug fitting.
2. Tighten the plug.
3. Pour coolant into the system until it appears to be full.
4. Make sure that the amount of coolant that goes back into the system is approximately equal to the amount of coolant that came out of the system.
5. Start the unit on low speed heat, let it run for two minutes, and then shut it off.
6. Check the coolant level and add coolant if necessary.
7. Repeat steps 5 and 6 until the coolant level stabilizes.

Engine Thermostat

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

Engine Fuel System

The TK 486 engine is a direct injection diesel that uses an in-line injection pump.

The components of the fuel system are:

1. Fuel tank
2. Inlet strainer (prefilter)
3. Fuel filter/water separator
4. Priming pump
5. Fuel transfer pump
6. Injection pump
7. Injection nozzles

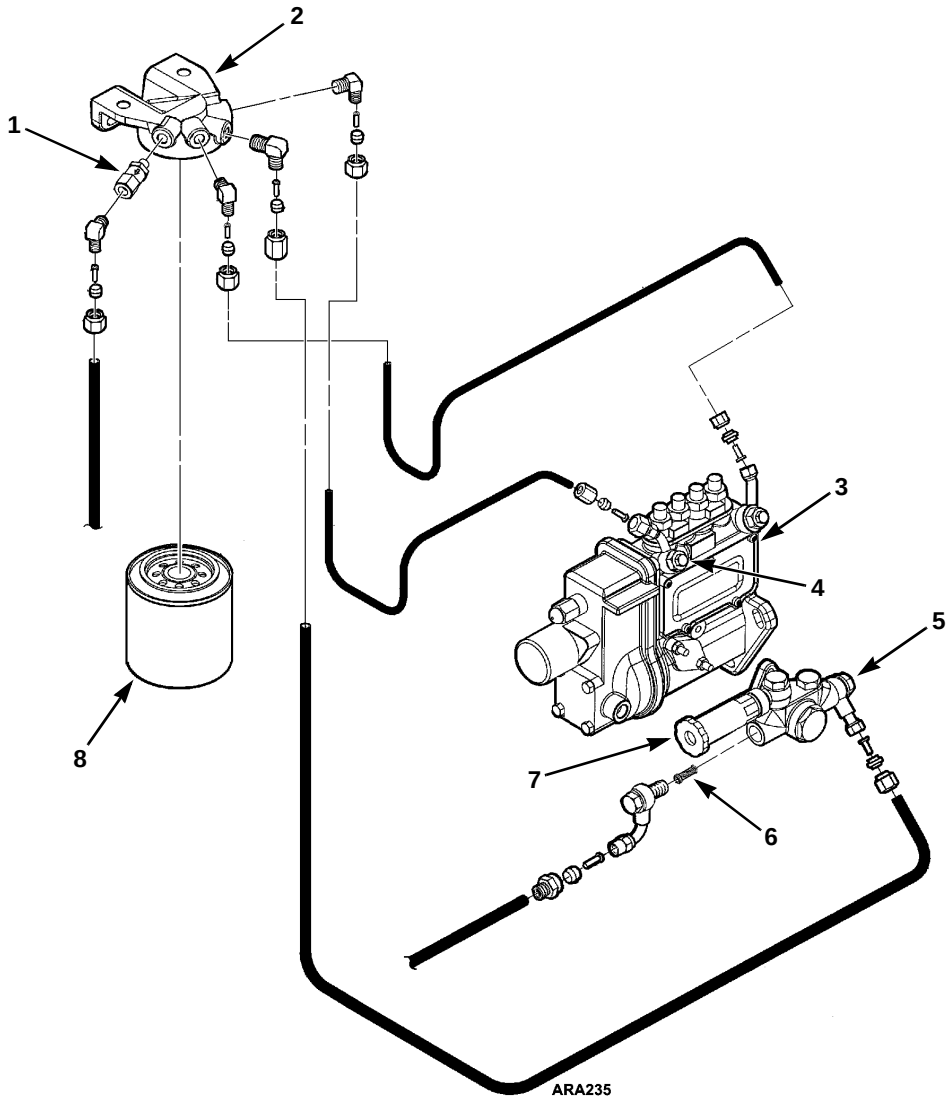
The priming pump is used to manually draw fuel from the tank up to the fuel pump if the unit should run out of fuel.

Operation

Fuel is drawn from the fuel tank and through the prefilter by the fuel transfer pump. The fuel transfer pump delivers fuel to the fuel filter/water separator. Two orifices in the filter head control the pressure in the fuel system by allowing a certain amount of fuel to return to the tank. One orifice is located in the center of the filter head. It bleeds off water. The other orifice is located off-center on the filter head. It bleeds off air. Filtered fuel passes through a line from the outlet fitting on the filter base to the injection pump.

The injection pump plungers are activated by a gear driven injection pump camshaft. The governor sleeve and weight assembly is mounted on the end of the pump camshaft. The governor's speed requirements are relayed to the injection

pump through a linkage arrangement located in the rear 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. Injection pump leakage, injection nozzle overflow and excess fuel from the fuel filter orifice are then all sent back to the fuel tank in the return line.



1.	Check Valve	5.	Fuel Transfer Pump
2.	Filter Head	6.	Inlet Strainer (Prefilter)
3.	Injection Pump	7.	Priming Pump
4.	Bleed Screw	8.	Fuel Filter/Water Separator

Figure 20: Engine Fuel System

Maintenance

The injection pump and fuel transfer pump are relatively trouble-free and if properly maintained will usually not require major service repairs between engine overhauls.

Contamination is the most common cause of fuel system problems. Therefore, to ensure best operating results, the fuel must be clean and fuel tanks must be free of contaminants. Change the fuel filter/water separator regularly and clean the prefilter on the inlet side of the fuel transfer pump.

NOTE: The injection nozzles should be tested (and repaired if necessary) at 10,000 hour intervals when used in normal conditions. Normal conditions are considered to be the use of clean high quality fuel, no used oil blending, and regular maintenance of the fuel system according to the Maintenance Inspection Schedule. Refer to the TK 482 and TK 486 Overhaul Manual TK 50136 for injection nozzle testing and repair procedures.

Whenever the fuel system is opened, take the following precautions to prevent dirt from entering the system:

1. Cap all fuel lines.
2. Work in a relatively clean area whenever possible.
3. Complete the work in the shortest possible time.

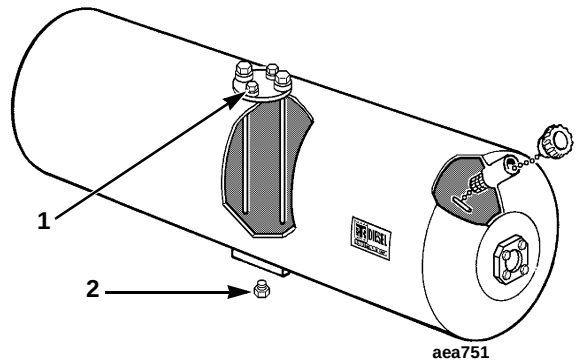
Any major injection pump or nozzle repairs should be done by a quality diesel injection service shop. The necessary service equipment and facilities are not found in most engine rebuild shops because of the large investment required.

The following procedures can be done under field conditions:

1. Bleeding air from the fuel system.
2. Fuel tank and filter system maintenance.
3. Priming pump (hand) replacement or repair.
4. Fuel pump replacement or repair.
5. Injection line replacement.
6. Injection pump and governor adjustments.
7. Injection pump timing.
8. Nozzle spray pattern testing and adjustment.
9. Minor rebuilding of nozzles.

Bleeding the Fuel System

If the engine runs out of fuel, repairs are made to the fuel system, or if air gets into the system for any other reason, the air must be bled out of the fuel system.



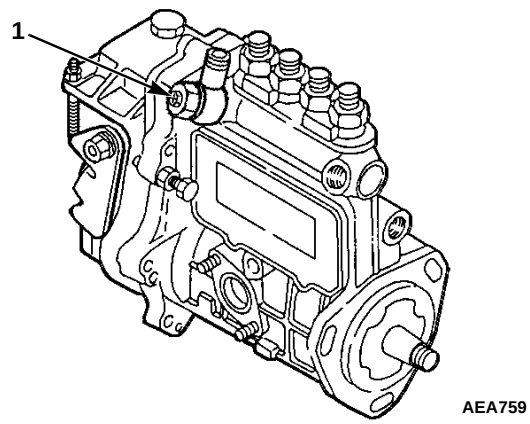
1.	Vent
2.	Drain Plug

Figure 21: Fuel Tank

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

To bleed air from the fuel system:

1. Loosen the bleed screw in the inlet fitting on the injection pump.



1.	Bleed Screw

Figure 22: Injection Pump

2. Unscrew the priming pump handle and manually prime the fuel system until air bubbles are no longer visible in the fuel coming out of the bleed screw.
3. Tighten the bleed screw and screw the priming pump handle back in.
4. Loosen the injection lines at the injection nozzles.
5. Crank the engine until fuel appears at the nozzles.
6. Tighten the injection lines.
7. Start the engine and observe the engine run for a few minutes. If the engine fails to start, or starts but stops in a few minutes, repeat the procedure.

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.

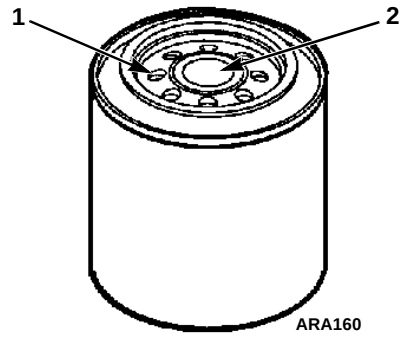
Fuel Filter/Water Separator

The fuel filter/water separator removes water from the fuel and returns it to the fuel tank.

Fuel Filter/Water Separator Replacement

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

1. Unscrew the fuel filter/water separator canister with a strap wrench. Drain, and dispose of properly.
2. Clean the filter head seal surface.
3. Lubricate the canister seal with clean fuel.
4. Through one of the small openings in the top of the canister, fill the new fuel filter/water separator canister with clean fuel. This will purge the air from the canister. Do not fill canister through the center hole.
5. Screw the new canister on hand-tight. Using a strap wrench, tighten another 1/4 turn.



1.	Fill Through Small Opening
2.	Do Not Fill Through Center Hole

Figure 23: Filling Fuel Filter/Water Separator

Engine Speed Adjustments

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

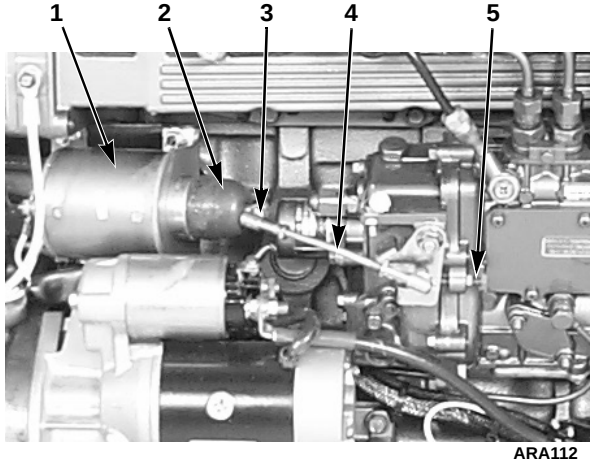
1. Check the fuel inlet screen. Check the speed.
2. Bleed the air out of the fuel system. Check the speed.
3. Bleed the air out of the nozzles. Check the speed.

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

High Speed

1. Use the Service Test Mode to run the unit in high speed and check the high speed rpm. It should be 2200 ± 25 rpm.
2. Shut the unit off.
3. Remove the ball joint from the eye bolt in the high speed solenoid.
4. Remove the boot from the high speed solenoid.
5. Pull the plunger out of the solenoid enough to loosen the jam nut. An Allen wrench placed in the hex opening in the face of the plunger will keep the plunger from turning. Turn the plunger eye bolt clockwise to increase the speed and counterclockwise to decrease the speed.
6. Replace the ball joint, start the unit and check the speed. When the speed is correct, tighten the jam nut and replace the solenoid boot.

NOTE: If the correct speed cannot be set close enough with half turns of the eye bolt, use the Allen wrench to turn the plunger in smaller increments.



1.	High Speed Solenoid
2.	Boot
3.	Ball Joint
4.	Speed Control Rod
5.	Low Speed Adjustment Screw

Figure 24: Engine Speed Adjustments

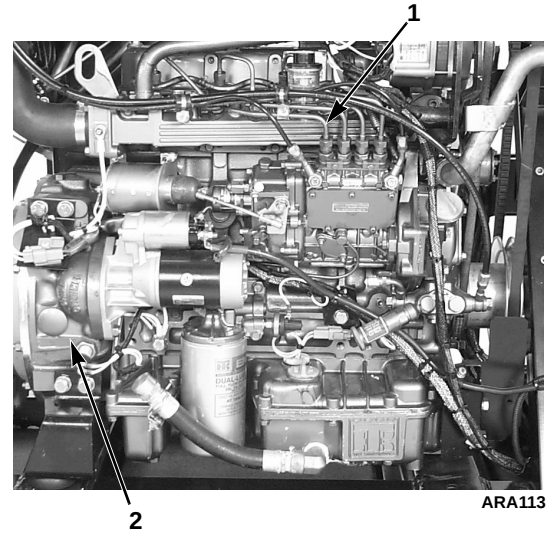
Low Speed

1. Loosen the jam nut on the low speed adjustment screw.
2. Use the Service Test Mode to run the unit in low speed. Adjust the screw to obtain the correct speed. It should be 1450 ± 25 rpm.
3. Tighten the jam nut and recheck the speed.

Injection Pump Timing

This timing procedure requires fuel pressure at the injection pump inlet. This can be accomplished by pumping the priming pump by hand, or by using an electric fuel pump to supply fuel to the fuel pump inlet.

1. Place the On/Off switch in the Off position.
2. Remove the round cover (plug) from the timing mark access hole on the front of the bell housing. The index marks on either side of this hole and the timing marks on the flywheel are used to check the injection pump timing.



1.	Number One Cylinder Injection Line
2.	Timing Mark Access Hole

Figure 25: Component Location

CAUTION: Loosen all of the injection lines at the injection nozzles to prevent the possibility of the engine firing while it is being rotated.

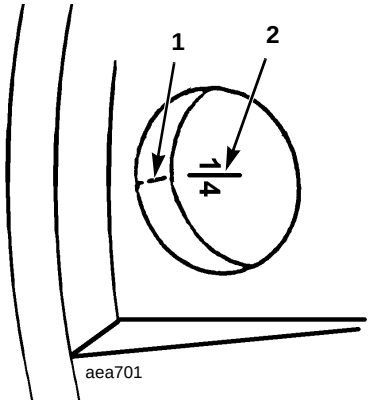
3. Remove the injection line for the number one cylinder from the delivery valve on the injection pump and from the injection nozzle.

   NOTE: The number one cylinder is the cylinder at the flywheel end of the engine.

4. Remove the rocker arm cover.

5. Place the engine at top dead center of the compression stroke for the number one cylinder. Refer to steps a. through d.

   a. Rotate the engine in the normal direction of rotation (clockwise viewed from the water pump end) until the 1-4 timing mark on the flywheel lines up with the index mark in the timing mark access hole.



1.	Index Mark
2.	Top Dead Center Mark for 1 and 4

Figure 26: Top Dead Center One and Four

   b. Check the rocker arms on the number one cylinder to see if they are loose.

   c. If the rocker arms are loose, the engine is at top dead center of the compression stroke for the number one cylinder.

   d. If the rocker arms are tight, the engine is at top dead center of the exhaust stroke for the number one cylinder. Rotate the engine 360° to place the engine at top dead center of the compression stroke for the number one cylinder.

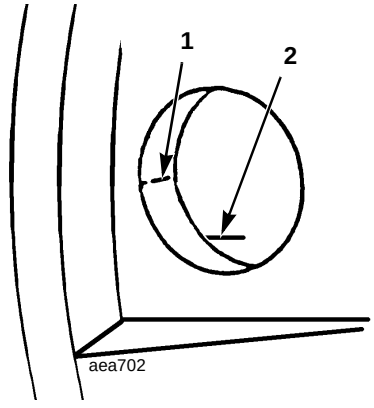
6. Disconnect the 8S wire from the starter solenoid to prevent the engine from cranking when the unit is turned On.

7. Place the On/Off switch in the On position.

8. Use the microprocessor keypad to enter the Relay Board Test Mode. Refer to the appropriate Microprocessor Diagnostic Manual for detailed information about the Service Test Mode.

9. Energize the fuel solenoid by energizing the run relay [RUNR] with the Relay Board Test Mode.

10. Rotate the engine backwards (counterclockwise viewed from the water pump end) until the injection timing mark is positioned in the bottom of the timing mark access hole. The injection timing mark is a horizontal line stamped on the flywheel approximately 1.2 in. (30 mm) before the top dead center mark.



1.	Index Mark
2.	Injection Mark

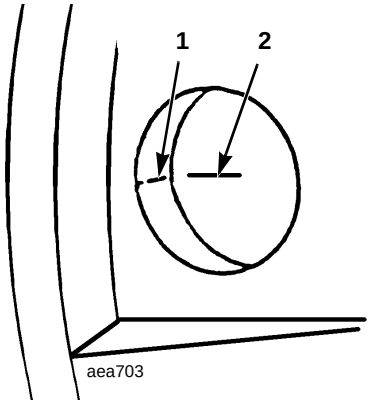
Figure 27: Timing Mark Alignment

11. Pump the priming pump by hand a few times, or energize the electric fuel pump if an electric fuel is being used.

12. Use a clean towel to remove the fuel from the top end of the delivery valve holder.

13. Slowly turn the engine in the normal direction of rotation until you see the fuel rise in the end of the delivery valve holder. Stop as soon as you see the fuel rise.

14. Check position of the timing marks. The injection timing mark on the flywheel should be aligned with the index mark on the side of the timing mark access hole. Repeat steps 10 through 14 to recheck the timing.



1.	Index Mark
2.	Injection Mark

Figure 28: Correct Injection Timing Mark Alignment

NOTE: Some engines have two injection timing marks approximately 0.2 in. (5 mm) apart. One at 10 degrees BTDC, and another at 12 degrees BTDC. In that case, the index mark should be aligned with the mark closer to the top dead center mark.

15. If the timing is off by more than 1 degree (0.1 in. [2.5 mm]), loosen the mounting nuts on the studs that fasten the injection pump to the engine and rotate the injection pump to change the timing.
    a. Pull the top of the injection pump away from the engine to advance the timing.
    b. Push the top of the injection pump toward the engine to retard the timing.
16. Tighten the injection pump mounting nuts and recheck the timing. Repeat steps 10 through 16 until the timing is correct.
17. Install the cover in the timing mark access hole, install the injection line for the number one cylinder, install the rocker arm cover, tighten the other injection lines and reconnect the 8S wire to the starter solenoid when finished with the procedure.

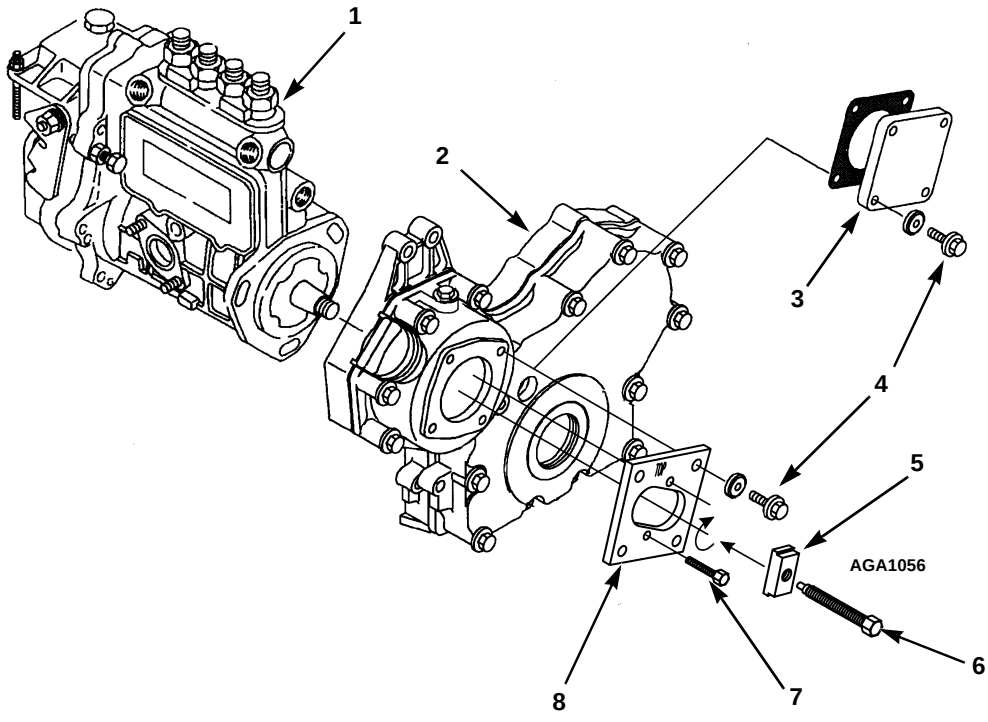
Injection Pump Removal

The injection pump drive gear will not fit through the gear housing when removing the pump, the gear must be separated from the pump. Using tool P/N 204-1011, it will not be necessary to remove the belts, fuel pump, crankshaft pulley, crankshaft seal or front plate. See Figure 29 “Injection Pump Gear Tool” on page 60.

1. Remove the starter for clearance, remove throttle linkage, fuel lines, harness and mounting hardware from injection pump.
2. Remove the cover plate from the gear case. Remove the nut and lock washer which secure the gear to the injection pump shaft. Use a shop rag to prevent the lock washer or nut from falling into the gear case.
3. Use the hardware from the cover plate to attach the tool plate (with the marked side pointing up and out) to the gear case.
4. Align the threaded holes in the injection pump gear with the two holes in the tool plate by rotating the engine crankshaft. Attach the gear to the tool plate with the screws provided with the tool plate.
5. Thread the long screw supplied with the tool plate into the small end of the adapter, also supplied with the tool plate. Insert the adapter into the tool plate and rotate to provide a solid position to force the injection pump shaft from the gear. Caution should be made to align the screw over the center of the injection pump shaft.
6. Remove the screw and adapter leaving the tool plate in place. This holds the gear in proper tooth alignment until the injection pump is re-installed.

Injection Pump Reinstallation

1. Position injection pump shaft into gear, rotating shaft to mate key with keyway in gear.
2. Secure injection pump to gear case with previously removed hardware.
3. Remove hardware holding gear to tool plate, then remove tool plate.
4. Secure gear to injection pump shaft with lock washer and nut, use a shop rag, as before, to prevent the lock washer or nut from falling into the gear case. Torque the nut to 84 to 90 ft-lb (113 to 122 N•m)
5. Fasten cover plate to gear case and reinstall all components removed previously to facilitate injection pump removal.



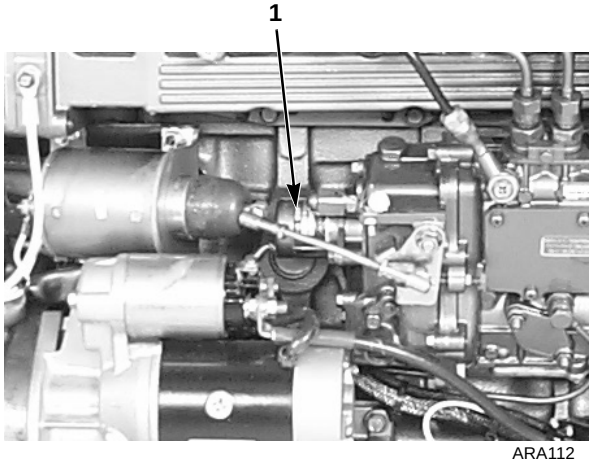
1.	Injection Pump	5.	Adapter
2.	Gear Case	6.	Tool Long Screw
3.	Cover Plate	7.	Tool Short Screw
4.	Cover Plate Bolt	8.	Tool Plate

Figure 29: Injection Pump Gear Tool

Fuel Solenoid

The fuel solenoid is located on the end of the injection pump. It contains two coils: the pull-in coil, and the hold-in coil. The pull-in coil draws approximately 35 to 45 amps at 12 volts. The hold-in coil draws approximately 1 amp at 12 volts.

The pull-in coil must be energized to move the injection pump governor linkage to the fuel on position. Once the injection pump governor linkage has been moved to the fuel on position, the hold-in coil will keep it in fuel on position until the 8D circuit is de-energized. The pull-in coil must be de-energized after a few seconds to keep it from being damaged. The pull-in coil is controlled by the microprocessor through the fuel solenoid relay (FSR).



1.	Fuel Solenoid

Figure 30: Fuel Solenoid Location

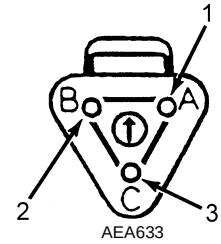
Testing the Fuel Solenoid

NOTE: The fuel solenoid pull-in coil will require 35 to 45 amps to turn on the fuel. The unit's battery must be in good condition. If the battery has enough power to crank the engine over, it has enough power to energize the fuel solenoid pull-in coil.

If you suspect that the engine does not run because the fuel solenoid is not operating correctly, use the following procedure:

1. Use the microprocessor keypad to enter the Relay Board Test Mode. Refer to the appropriate Microprocessor Diagnostic Manual for specific information about the Relay Test Mode.
2. Energize the run relay [RUNR] with the Relay Board Test Mode. The fuel solenoid relay is momentarily energized when the run relay is energized with the Relay Board Test Mode. This energizes the fuel solenoid, which makes a definite click when energized.
3. De-energize the run relay [RUNR] with the Relay Board Test Mode. This de-energizes the fuel solenoid, which makes a definite click when de-energized.
4. Repeat steps 2 and 3 a few times to check the operation of the fuel solenoid.

   NOTE: The fuel solenoid may be removed from the injection pump to visually check its operation. The fuel solenoid must be energized when it is re-installed in the injection pump. If it is not, the plunger and the linkage may not line up correctly and the fuel solenoid will not function properly.
5. If the fuel solenoid is not operating properly, check the run relay, the fuel solenoid relay, their fuses, and the associated circuits. If the relays, fuses and circuits are acceptable, use steps 6 through 9 to isolate and check the fuel solenoid.
6. Disconnect the fuel solenoid wire connector from the main wire harness.



1.	Red (8D)
2.	White (8DP)
3.	Black (CH)

Figure 31: Fuel Solenoid Connector Pin Identification

7. Place a jumper wire between the black wire (CH—pin C) in the fuel solenoid connector and a good chassis ground.
8. Test the pull-in coil by momentarily placing a jumper between the white wire (8DP—pin B) in the fuel solenoid connector and the positive battery terminal. The fuel solenoid should make a definite click when the pull-in coil is energized and should click again when the pull-in coil is de-energized.

   NOTE: The pull-in coil will draw 35 to 45 amps so do not leave the jumper connected to the white wire (8DP—pin B) for more than a few seconds.

   a. If the pull-in coil does not energize, check the resistance of the pull-in coil by placing an ohmmeter between the white wire (8DP—pin B) and the black wire (CH—pin C) in the fuel solenoid connector. The resistance of the pull-in coil should be 0.2 to 0.3 ohms. If the resistance of the pull-in coil is not in this range, replace the fuel solenoid.

   b. If the pull-in coil does energize, go to step 9.
9. Test the hold-in coil.

   a. Energize the hold-in coil by placing a jumper between the red wire (8D—pin A) in the fuel solenoid connector and the positive battery terminal.

   b. Momentarily energize the pull-in coil by placing a jumper between the white wire (8DP—pin B) in the fuel solenoid connector and the positive battery terminal. The fuel solenoid should make a definite click when the pull-in coil is energized, but should not click when the pull-in coil is de-energized.

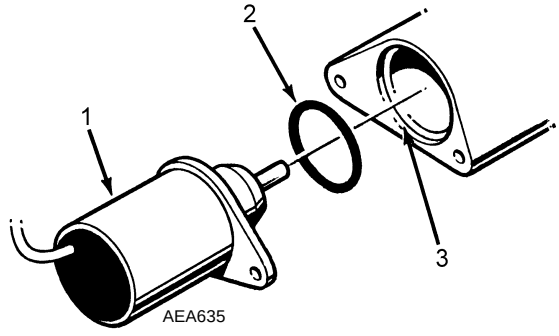
   c. De-energize the hold-in coil by removing the jumper from the red wire (8D—pin A) and the 2 terminal. The fuel solenoid should make a definite click when the hold-in coil is de-energized.

   d. If the hold-in coil does not function properly, check the resistance of the hold-in coil by placing an ohmmeter between the red wire (8D—pin A) and the black wire (CH—pin C) in the fuel solenoid connector. The resistance of the hold-in coil should be 24 to 29 ohms. If the resistance of the hold-in coil is not in this range, replace the fuel solenoid.

Fuel Solenoid Replacement

1. Disconnect the fuel solenoid wire connector from the main wire harness and remove the old fuel solenoid.
2. Connect the new fuel solenoid wire connector to the main wire harness.
3. Place the On/Off switch in the On position.
4. Use the microprocessor keypad to enter the Relay Board Test Mode. Refer to the appropriate Microprocessor Diagnostic Manual for specific information about the Relay Test Mode.
5. Energize the fuel solenoid by energizing the run relay [RUNR] with the Relay Board Test Mode.

   NOTE: The fuel solenoid must be energized when it is installed. If not, the plunger and the linkage may not line up correctly and the fuel solenoid will not function properly.
6. Place the O-ring in the groove in the end of the fuel injection pump. Make sure that the O-ring is positioned correctly during installation to avoid damage and leaks.



1.	Fuel Solenoid
2.	O-ring
3.	Groove in Fuel Injection Pump

Figure 32: Fuel Solenoid Components

7. Install the new fuel solenoid.

8. Place the On/Off switch in the Off position after installing the fuel solenoid.

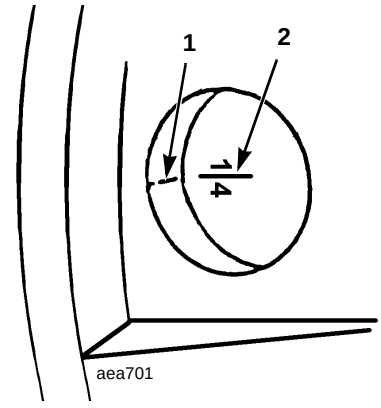
Engine Valve Clearance Adjustment

1. Remove the rocker arm cover.
2. Remove the round cover (plug) from the timing mark access hole on the front of the bell housing.

CAUTION: Loosen all of the injection lines at the injection nozzles to prevent the possibility of the engine firing while it is being rotated.

3. Place the engine at top dead center of the compression stroke for the number one cylinder. Refer to steps a. through d.

   a. Rotate the engine in the normal direction of rotation (clockwise viewed from the water pump end) until the 1-4 timing mark on the flywheel lines up with the index mark in the timing mark access hole.



1	Index Mark
2	Top Dead Center Mark for 1 and 4

Figure 33: Top Dead Center One and Four

   b. Check the rocker arms on the number one cylinder to see if they are loose.

   c. If the rocker arms are loose, the engine is at top dead center of the compression stroke for the number one cylinder.

   d. If the rocker arms are tight, the engine is at top dead center of the exhaust stroke for the number one cylinder. Rotate the engine 360° to place the engine at top dead center of the compression stroke for the number one cylinder.

Valve Adjustments and Cylinder Configurations								
	Front						Rear	
Cylinder No.	**1**		**2**		**3**		**4**	
Valve arrangement	E	I	E	I	E	I	E	I
Piston in No. 1 cylinder is at TDC on compression stroke	○	○		○	○			
Piston in No. 4 cylinder is at TDC on compression stroke			◎			◎	◎	◎

4. Use a feeler gauge to check the valve clearance on both valves for the number one cylinder, the intake valve for the number two cylinder, and the exhaust valve for the number three cylinder. The valve clearance for both the intake valve and the exhaust valve should be 0.006 to 0.010 in. (0.15 to 0.25 mm).

   NOTE: Check to make sure that the valve stem cap is in good condition and is positioned squarely on the top of the valve stem. Replace the valve stem cap if it shows significant wear.

5. Adjust the valves if necessary by loosening the locknut and turning the adjustment screw until the valve clearance is correct.

6. Hold the adjustment screw in place and tighten the locknut.

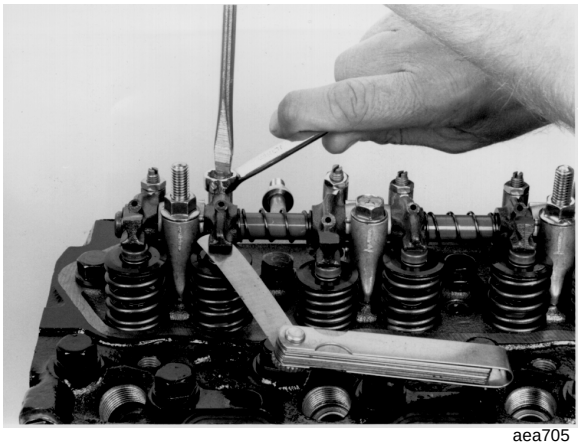


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Figure 34: Adjusting the Valve Clearance

7. Recheck the valve clearance.

8. Rotate the engine one full turn (360°) in the normal direction of rotation (clockwise viewed from the water pump end), and align the 1-4 timing mark on the flywheel with the index mark in the timing mark access hole. This is top dead center of the compression stroke for the number four cylinder.

9. Check and adjust the exhaust valve for the number two cylinder, the intake valve for the number three cylinder, and both valves for the number four cylinder.

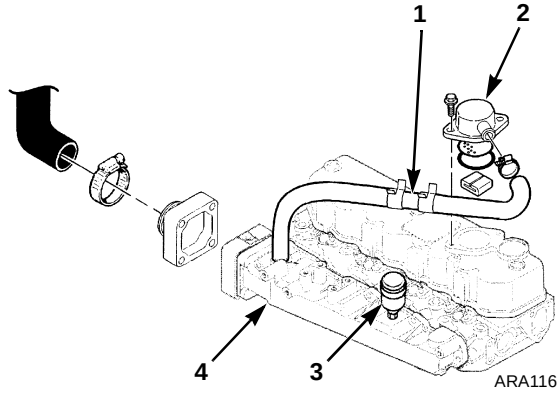
10. Replace the rocker arm cover, the cover for the timing mark access hole, and tighten the fuel injection lines when finished.

Crankcase Breather

The crankcase breather is located on top of the rocker arm cover. The crankcase breather system ducts crankcase gases formed in the crankcase directly to the air intake. Harmful vapors that would otherwise collect in the crankcase and contaminate the oil, or escape to the outside, are drawn back into the engine and burned.

Normal crankcase pressures with a new air cleaner are 0 to 1 in. (0 to 25 mm) H_2O of vacuum in low speed and 1 to 2 in. (25 to 51 mm) H_2O of vacuum in high speed. The vacuum will increase as the air cleaner gets dirty and becomes more restrictive. The crankcase breather and the breather hose should be inspected when the air cleaner element is replaced to make sure they are not plugged or damaged.

NOTE: The breather hose must be routed so it slopes down from the crankcase breather to the intake manifold. This prevents condensation from collecting in the breather hose. The condensation can plug the breather hose if it collects and freezes in the hose.



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1.	Restrictor
2.	Crankcase Breather
3.	Air Restriction Indicator
4.	Intake Manifold

Figure 35: Crankcase Breather

EMI 3000 Air Cleaner

The EMI 3000 air cleaner is a dry element air cleaner used in late model units. Replace the EMI 3000 air cleaner element when the air restriction indicator reads 25 in. of vacuum, or at 3,000 hours or 2 years, whichever occurs first. The EMI 3000 air cleaner element has a nameplate that reads “EMI 3000.” It cannot be interchanged with air filters used on previous Thermo King trailer units, however it can be retrofit on previous units by using the EMI 3000 Air Cleaner Assembly.

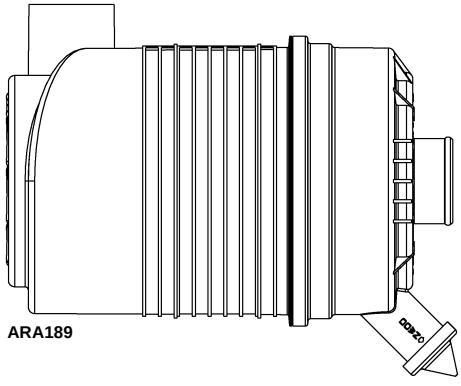
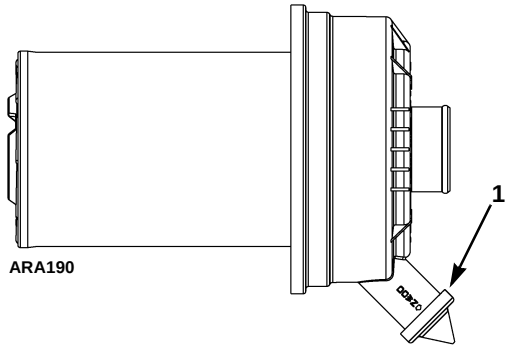


Figure 36: EMI 3000 Air Cleaner Assembly



1.	Dust Ejector Must Point Down When Installed

Figure 37: EMI 3000 Air Filter Element

Air Restriction Indicator

Excessive restriction of the air intake system reduces the flow of air to the engine affecting horsepower output, fuel consumption and engine life.

An air restriction indicator is installed in the air intake manifold. Visually inspect the restriction indicator periodically to assure the air filter is not restricted. Service the air filter when the yellow diaphragm indicates 25 in. of vacuum. Press the reset button on the bottom of the restriction indicator after servicing the air filter.

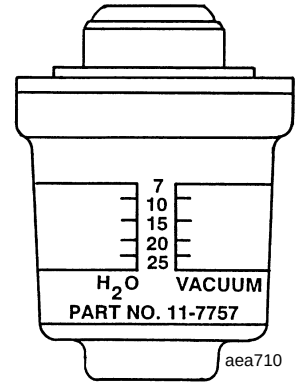


Figure 38: Air Restriction Indicator

Belts

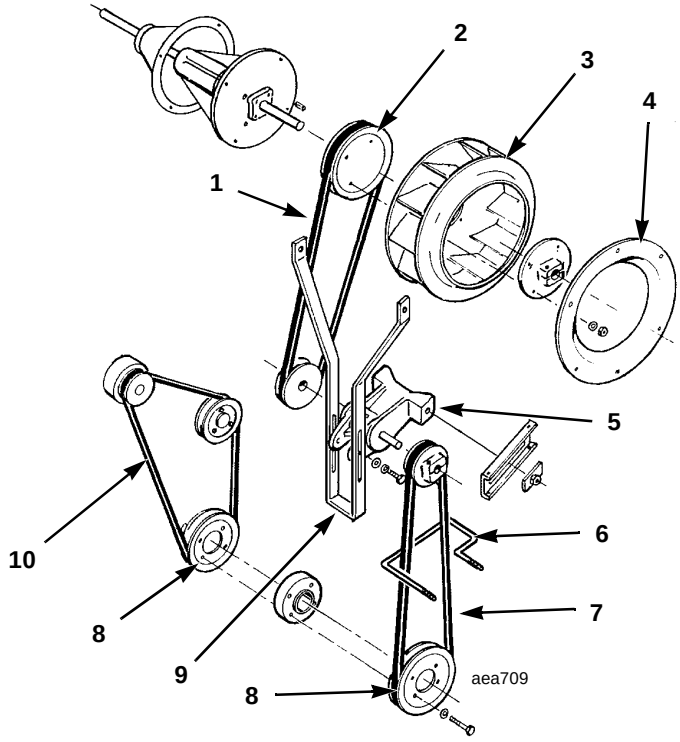
Belts should be regularly inspected during unit pre-trip inspections for wear, scuffing or cracking. Belt tension should also be checked during scheduled maintenance inspections. Belts that are too loose will whip and belts that are too tight put too much strain on the belt fibers and bearings.

Using belt tension gauge, P/N 204-427, is the best method of checking belts for tightness. Install the belt gauge in the center of the longest belt span. Press the plunger so the hook will engage the belt. Make sure the hook is on the face of the belt, not in a notch. Release the plunger with a quick motion and without pulling on the belt. Then read the dial. Use an average of three readings.

NOTE: Do not attempt to remove or install belts without loosening adjustments. Belts that are installed by prying over pulleys will fail prematurely due to internal cord damage.

CAUTION: Do not attempt to adjust belts with the unit running.

CAUTION: With the unit On/Off switch in the On position, the unit may start operation at any time without prior warning. Switch the unit On/Off switch to the Off position before performing maintenance or repair procedures.



1.	Upper Fan Belt	6.	Belt Guide
2.	Condenser Fan Pulley	7.	Lower Fan Belt
3.	Condenser Fan	8.	Engine Pulley
4.	Condenser Inlet Ring	9.	Idler Adjusting Arm
5.	Idler Assembly	10.	Alternator Belt

Figure 39: Model 30 Belt Arrangement

Model 30 Belt Adjustments

Alternator Belt Adjustment

The alternator belt tension should read 35 on the belt gauge.

1. Loosen the alternator pivot bolt and the adjusting arm bolt.
2. Move the alternator on the adjusting arm slots to adjust the belt to 35 on the belt tension gauge.
3. Tighten the adjusting arm bolt and alternator pivot bolt.

Upper and Lower Fan Belt Adjustment

The upper fan belt should read 74 and the lower fan belt should read 67 on the belt tension gauge.

NOTE: Both the upper and lower fan belts are adjusted at the same time in one procedure.

NOTE: If a fan belt is loose or damaged, replace the belt (see Fan Belt Removal and Installation procedure).

1. Loosen the idler assembly pivot bolts and the idler adjusting arm bolts.
2. Push in or pull out on the idler adjusting arm to “center” the idler assembly between the belts and balance the tension equally between the upper and lower belts.
3. Tighten both idler adjusting arm bolts and both idler assembly pivot bolts.

   NOTE: If the idler assembly binds when moving for belt adjustment, loosen the upper idler support bracket mounting bolts to free up the assembly. Check the main idler retainer nut assembly for proper alignment between the nut and the support bracket slots.

Model 30 Fan Belt Replacement

NOTE: Do not attempt to remove or install the belts without loosening the adjustments. Belts that are installed by prying over pulleys will fail prematurely due to internal cord damage.

Lower Fan Belt

Removal

1. Loosen both idler adjusting arm bolts and both idler pulley assembly bolts.
2. Push the idler adjusting arm IN. The lower fan belt will come off the engine pulley. Move the arm OUT far enough to clear the roadside idler mounting bracket.

Installation

1. Slip the belt into the groove of the idler pulley.
2. Push the idler adjusting arm back in toward the unit.
3. Slip the belt onto the pulley groove on the engine.
4. Pull the idler adjusting arm back OUT and adjust the belts to the proper tension.
5. Tighten the idler assembly pivot bolts and the idler adjusting arm bolts.

Upper Fan Belt

Removal

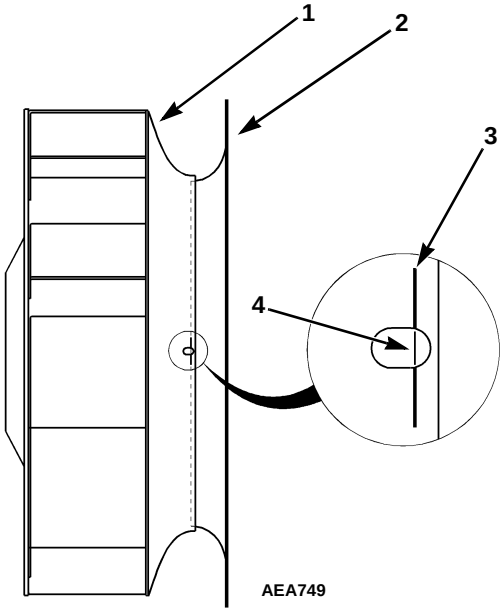
1. Loosen the idler adjusting arm bolts and remove the lower fan belt (see (Lower Fan Belt Removal).
2. Push the idler adjusting arm in and the idler assembly up. The upper belt should become slack and slip down out of the idler pulley groove.
3. Pull the idler adjusting arm OUT. The upper fan belt should slip off the idler pulley as the idler pulley hub clears the curbside idler mounting bracket.
4. Loosen the two condenser fan hub to the shaft clamping bolts.
5. Tap the blower wheel with a soft hammer to drive the blower wheel up the fan shaft to provide 1/2 in. (13 mm) clearance between the blower wheel and the inlet ring.

NOTE: If the condenser fan does not slide on the fan shaft with light tapping, remove the small access panel located on the condenser coil header above the radiator tank. Thread a 1/4-20 x 1 in. diameter bolt into the end of the fan shaft. Tighten the bolt and washer down on the condenser fan hub to loosen the blower wheel. Drive the blower wheel back to provide 1/2 in. (13 mm) clearance between the blower wheel and condenser fan inlet ring.

6. Lift the belt up over the condenser blower wheel and remove it from the unit.

Installation

1. Slip the belt over the condenser blower wheel and place it in the condenser fan pulley.
2. Drive the condenser blower wheel out toward the condenser fan inlet ring using a soft hammer.
3. Position the blower wheel so the edge of the inlet ring lines up with the alignment mark on the blower wheel.



1.	Blower Wheel
2.	Inlet Ring
3.	Alignment Mark
4.	Edge of Inlet Ring

Figure 40: Condenser Blower Alignment

4. Check the radial clearance between the blower wheel and inlet ring with a gauge wire. Check around the entire circumference to the inlet ring and blower wheel (see Condenser and Evaporator Fan Location under Structural Maintenance).
5. Torque the blower hub clamping bolts to 18 ft-lb (24 N•m).
6. Seat the upper belt in the blower wheel pulley groove.
7. Push inward on the idler adjusting arm and slip the belt into the idler pulley groove.
8. Pull the idler adjusting arm forward and install the lower fan belt.

Model 50 Belt Adjustments

Alternator Belt Adjustment

The alternator belt tension should read 29 on the belt tension gauge.

1. Loosen the alternator pivot bolt and the adjusting arm bolt.
2. Move the alternator on the adjusting arm slot to adjust the belt to 29 on the belt tension gauge.
3. Tighten the adjusting arm bolt and alternator pivot bolt.

Compressor Belt Adjustment

The compressor drive belts should read 79 on the belt tension gauge.

1. Loosen the back-up hex nut on the belt tensioner compression spring adjustment screw.
2. Move the hex nuts on the compression spring adjustment screw to adjust the belt tension to 79 on the belt tension gauge.
3. With the proper belt tension adjustment, tighten the back-up hex nut to the adjustment hex nut on the compression spring adjustment screw.

Water Pump Belt Adjustment

The water pump belt tension should be 35 on the belt tension gauge.

1. Remove the bolts from the water pump pulley.
2. Remove the pulley sliding section and add or remove shims to adjusting the belt tension gauge.
3. Reinstall the belt on the pulley and replace the sliding pulley section on the pulley.
4. Tighten the mounting belts on the water pump pulley.
5. The belt tension should read 35 on the belt tension gauge.

Fan Belt Adjustment

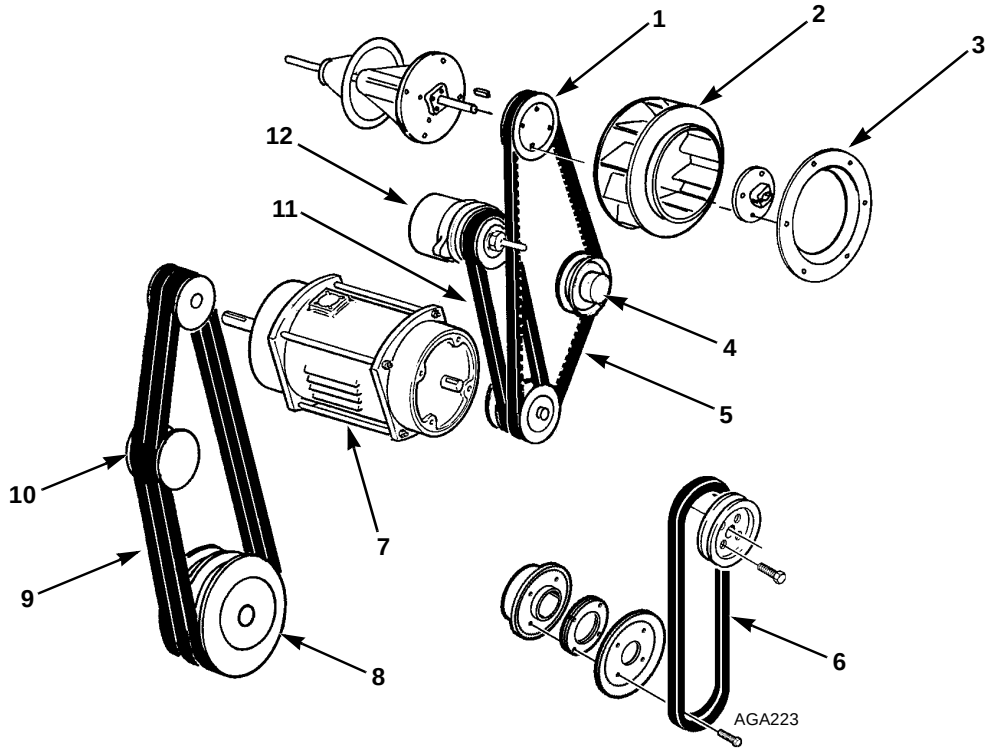
The fan belt tension should read 74 on the belt tension gauge.

1. Loosen the idler pulley mounting bolts.
2. Move the idler pulley assembly to adjust the belt tension to 74 on the belt tension gauge.
3. Tighten the idler pulley mounting bolts.

Model 50 Compressor Belt Replacement

Removal

1. Loosen the back-up hex on the belt tensioner compression spring adjustment screw.



1.	Condenser Fan Pulley	7.	Electric Motor
2.	Condenser Fan	8.	Compressor Pulley
3.	Condenser Inlet Ring	9.	Compressor Belts
4.	Idler Pulley	10.	Belt Tension Adjustment Idler
5.	Fan Belt	11.	Alternator Belt
6.	Water Pump Belt	12.	Alternator

Figure 41: Model 50 Belt Arrangement

2. Support the compressor and unbolt the compressor form the flywheel housing (leave the refrigeration lines connected).
3. Move the hex nuts on the compression spring adjustment screw to relieve belt tension.
4. Swing the compressor assembly away from the flywheel housing.
5. Remove the belts through the gap between the clutch and the flywheel.

Installation

1. Install the belts on the clutch pulley through the gap between the clutch and the flywheel.
2. Place the compressor in position and install the mounting bolts.
3. Adjust the hex nuts on the compression spring adjustment to tighten the belts to 79 on the belt tension gauge.
4. Tighten the back-up hex nut on the belt tension compression spring adjustment screw.

Model 50 Fan Belt Replacement

NOTE: Do not attempt to remove or install the belts without loosening the adjustments. Belts that are installed by prying over pulleys will fail prematurely due to internal cord damage.

Removal

1. Loosen the idler pulley mounting bolts.
2. Move the idler pulley assembly to obtain enough slack. to remove the belt from the idler and the electric motor.
3. Loosen the two condenser fan hub to the shaft clamping bolts.
4. Tap the blower wheel with a soft hammer to drive the blower wheel up the fan shaft to provide 13 mm (1/2 in.) clearance between the blower wheel and the inlet ring.

   NOTE: If the condenser fan does not slide on the fan shaft with light tapping, remove the small access panel located on the condenser coil header above the radiator tank. Thread a 1/4-20 x 1 in. diameter bolt into the end of the fan shaft. Tighten the bolt and washer down on the condenser fan hub to loosen the blower wheel. Drive the blower wheel back to provide 13 mm (1/2 in.) clearance between the blower wheel and condenser fan inlet ring.
5. Lift the belt up over the condenser blower wheel and remove it from the unit.

Installation

1. Slip the belt over the condenser blower wheel and place it in the condenser fan pulley.
2. Drive the condenser blower wheel out toward the condenser fan inlet ring using a soft hammer.
3. Position the blower wheel so the edge of the inlet ring lines up with the alignment mark on the blower wheel. Refer to Figure 40 “Condenser Blower Alignment” on page 68.
4. Check the radial clearance between the blower wheel and inlet ring with a gauge wire. Check around the entire circumference to the inlet ring and blower wheel (see “Condenser and Evaporator Fan Location” under Structural Maintenance).
5. Torque the blower hub clamping bolts to (18 ft-lb) 24 N•m.
6. Seat the upper belt in the blower wheel pulley groove.
7. Place the belt in the idler and electric motor pulleys.
8. Move the idler pulley assembly to adjust the belt tension to 74 on the belt tension gauge.
9. Tighten the idler pulley mounting bolt.

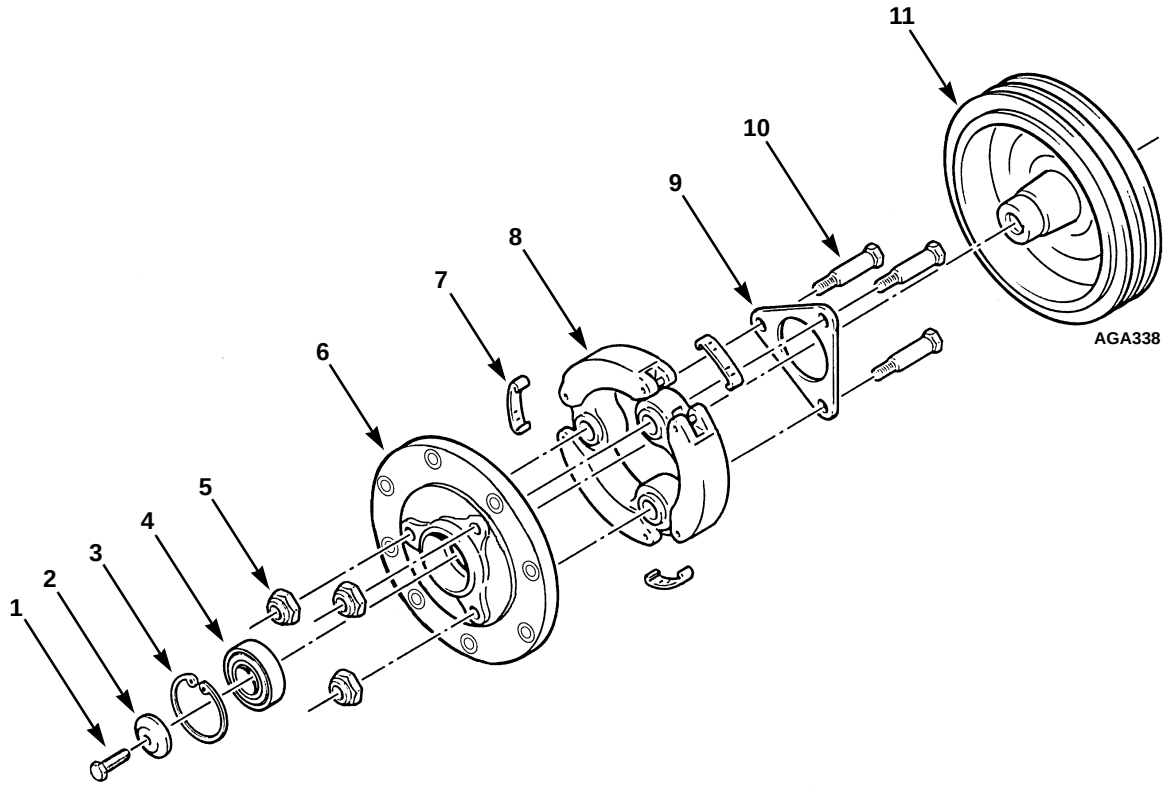
Clutch (Model 50)

Periodically inspect the clutch for worn bearings, worn friction shoes and for broken springs. To inspect the clutch:

1. Loosen the back-up hex nut and move the hex nuts on the compression spring adjustment screw to relieve the tension on the compressor belts.
2. Support the compressor and unbolt the compressor from the bell housing studs.
3. Remove the compressor from the bell housing and turn the compressor to provide better access to the clutch.

NOTE: The refrigeration lines may be removed from the compressor to allow more movement of the compressor for better access to the clutch.

4. Remove the compressor belts.
5. Remove the clutch mounting bolt and special washer.
6. Remove the clutch with a clutch puller.
7. Remove the key from the compressor crankshaft and inspect the key and the crankshaft for wear, burrs, or damage.
8. To disassemble the clutch, press the pulley out of the bearing.



1.	Clutch Mounting Bolt	7.	Spring
2.	Special Washer	8.	Friction Shoe
3.	Snap Ring	9.	Mounting Bolt Plate
4.	Bearing	10.	Friction Shoe Mounting Bolt
5.	Lock Nut	11.	Pulley
6.	Hub		

Figure 42: Clutch

9. Inspect the friction shoes and springs.
    a. Replace the friction shoes if the linings are worn to a thickness of less than 1/16 to 3/32 in. (1.6 to 2.4 mm).
    b. Replace the springs if they are worn or broken.
10. To replace the friction shoes:
    a. Remove the springs from the friction shoes.
    b. Remove the lock nuts from the friction shoe mounting bolts.
    c. Use a soft hammer to tap the friction shoe mounting bolts out of the hub and remove them from the friction shoes.
    d. Attach the new friction shoes to the hub with the mounting bolt plate, the mounting bolts, and the lock nuts. Torque the lock nuts to 30 to 35 ft-lb (41 to 47 N•m).
11. To replace the bearing:
    a. Remove the snap ring and press the bearing out of the hub.
    b. Press the new bearing into the hub and install the snap ring.
12. To assemble the clutch, press the pulley into the bearing.
13. Place the key in the compressor crankshaft.
14. Place the clutch on the compressor crankshaft and align the keyway with the key.

CAUTION: Do not allow the key to be pushed out of place behind the clutch during clutch installation.

15. Install the special washer and the clutch mounting bolt. Torque the clutch mounting bolt to 90 ft-lb (122 N•m).
16. Reinstall the compressor drive belts.
17. Reinstall the compressor on the bell housing studs.
18. Install and tighten the flatterers, lock washers and nuts on the studs.
19. Readjust the compressor drive belts.

Refrigeration Maintenance

NOTE: The following procedures involve servicing the refrigeration system. Some of these service procedures are regulated by Federal, and in some cases, by State and Local laws.

In the USA all regulated refrigeration service procedures must be performed by an EPA certified technician, using approved equipment and complying with all Federal, State and Local laws.

Refrigerant Charge

Testing The Refrigerant Charge With An Empty Trailer

If the unit has an insufficient charge of refrigerant, the evaporator will be "starved" and the box temperatures will rise even though the unit is operating. The suction pressure will drop as the refrigerant charge decreases. If the unit has an overcharge of refrigerant, the unit may not cool properly and the suction and discharge pressure may be high. The charge may be determined by inspection of the refrigerant through the receiver tank sight glasses with the following conditions established:

1. Place a test box over the evaporator.
2. Install a gauge manifold.
3. Use Service Test Mode [HSC] to run the unit in high speed cool. Refer to the appropriate Diagnostic Manual for specific information about the Service Test Mode.
4. Use the microprocessor thermometer to monitor the return air temperature.
5. Run the unit on high speed cool until the air in the box is at 0 F (-18 C). By allowing the box to leak a small amount, you will be able to maintain 0 F (-18 C).
6. The suction pressure should be 13 to 18 psi (90 to 124 kPa).
7. The discharge pressure should be at least 275 psi (1896 kPa).
8. If the pressure is below this, it can be raised by covering a portion of the condenser grille with a piece of cardboard to block condenser airflow.
9. Under these conditions, refrigerant should be visible in the receiver tank sight glass. If refrigerant is not visible in the receiver tank sight glass, the unit is low on refrigerant.

Testing the Refrigerant Charge with a Loaded Trailer

1. Install a gauge manifold.
2. Use Service Test Mode [HSC] to run the unit in high speed cool. Refer to the appropriate Diagnostic Manual for specific information about the Service Test Mode.
3. Build up and maintain 275 psi (1896 kPa) of head pressure. If the pressure is below this, it can be raised by covering the roadside condenser grille with a piece of cardboard to block condenser air flow.
4. Cool the compartment to the lowest temperature required.
5. Check suction pressure. It should be 13 to 25 psi (90 to 165 kPa).
6. Under these conditions, refrigerant should be visible in the receiver tank sight glass. If refrigerant is not visible in the receiver tank sight glass, the unit is low on refrigerant.

Testing for an Overcharge

Use the following procedure to identify a Thermo King unit with an excessive refrigerant charge:

1. Install a calibrated gauge manifold on the compressor.
2. Use Service Test Mode [HSC] to run the unit in high speed cool. Refer to the appropriate Diagnostic Manual for specific information about the Service Test Mode.
3. Operate the unit in high speed cool long enough to stabilize system pressures and reduce the box temperature to approximately 60 F (16 C) or colder.
4. Observe discharge pressure and cover the condenser to increase the discharge pressure approximately 75 to 100 psi (500 to 690 kPa) above observed pressure.

NOTE: If the liquid level in the receiver sight glass drops during step 4, the unit is not overcharged and it is not necessary to complete the procedure.

5. Remove the condenser cover to rapidly reduce discharge pressure.
6. Observe the receiver tank sight glass and the unit discharge pressure.
7. By the time the discharge pressure drops approximately 50 psi (345 kPa), the liquid level in the receiver tank should drop.
   a. When the discharge pressure stabilizes, the liquid level will rise.
   b. If the liquid level will not drop, the unit most likely has an overcharge of refrigerant. The refrigerant level should be adjusted.

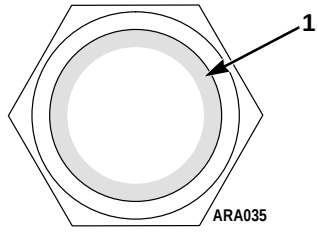
To adjust the refrigerant level:

1. Stop the unit and remove some refrigerant with an approved refrigerant recovery device.
2. Perform a refrigerant level check and repeat the overcharge test.
3. If the liquid level is low, add refrigerant as follows:
   a. Connect a refrigerant tank to the gauge manifold service line and purge the line.
   b. Mid seat the compressor suction service valve.
   c. Set the refrigerant tank for liquid removal and open the hand valve.
   d. Operate the unit in high speed cool.
   e. Observe the suction pressure and slowly open the gauge manifold low pressure hand valve to allow liquid refrigerant to flow into the compressor suction service valve.
   f. Control the liquid flow so the suction pressure increases approximately 20 psi (138 kPa).
   g. Maintain a discharge pressure of at least 275 psi (1896 kPa) while adding refrigerant.
   h. Close the hand valve on the refrigerant tank when the liquid level approaches the top of the receiver sight glass.
4. Repeat the overcharge test.

Moisture Indicating Sight Glass

The receiver tank is equipped with a moisture indicating sight glass. The outer edge of the sight glass has a colored ring approximately 0.1 in. (2.5 mm) thick. The color of the ring indicates the moisture content of the refrigerant, but it is not completely reliable.

- Green = Dry
- Chartreuse = Caution
- Yellow = Wet



1.	Colored Ring

Figure 43: Moisture Indicating Sight Glass

A system has to run for at least 15 minutes to change the color of the indicator ring after the moisture content of the system has been changed. For example, evacuating a system to remove the moisture will not change the color of the indicator ring until the system has been recharged and then operated for at least 15 minutes.

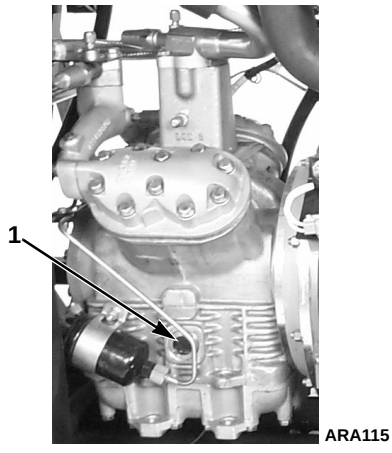
Refrigerant Leaks

Use a reliable leak detector (e.g., electronic detector or Halide torch) 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.

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.



1.	Sight Glass

Figure 44: Checking Compressor Oil

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

Install a gauge manifold on the compressor.

Operate the unit on Cool with a 20 psi (138 kPa) minimum suction pressure and a 185 psi (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 1/4 to 1/2 up in the sight glass.

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 1/4 to 1/2 up in the sight glass.

If the box is empty, you can run the unit on the heat cycle instead of the defrost cycle.

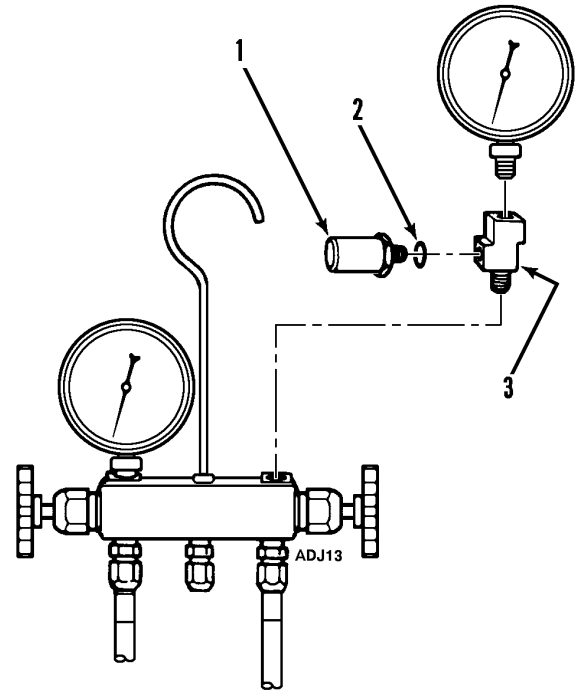
NOTE: Use refrigeration compressor oil ONLY. Polyol Ester P/N 203-413 is required for R-404A.

To add compressor oil pump down the compressor and equalize the pressure to slightly positive. Disconnect the compressor oil filter return line from the top of the compressor and add the oil. Reattach the oil filter return line to the compressor. Evacuate the compressor before opening the service valves.

High Pressure Cutout Switch (HPCO)

The HPCO is located on the compressor discharge manifold. If the discharge pressure rises above 470 psi (3241 kPa), the HPCO opens the 8D circuit, de-energizing the fuel solenoid. To test the HPCO, rework a gauge manifold following Figure 45 “High Pressure Cutout Manifold”.

1. Connect the gauge manifold to the compressor discharge service valve with a heavy duty, black jacketed thick wall #HCA 144 hose with a 900 psi (6204 kPa) working pressure rating.
2. Use Service Test Mode [HSC] to run the unit in high speed cool.



1.	Relief Valve (66-6543)
2.	O-Ring (33-1015)
3.	Adapter Tee Weather Head No. 552X3

Figure 45: High Pressure Cutout Manifold

3. Raise the discharge pressure of the compressor first by blocking the condenser coil air flow by covering the condenser grille with a piece of cardboard. If this does not raise the discharge pressure to the cutout level of the HPCO, increase the engine speed by overriding the throttle solenoid. This should increase the discharge pressure enough to cause the HPCO to cut out.

NOTE: The discharge pressure should never be allowed to exceed a pressure of 470 psi (3241 kPa).

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.

Three-Way Valve Condenser Pressure Bypass Check Valve

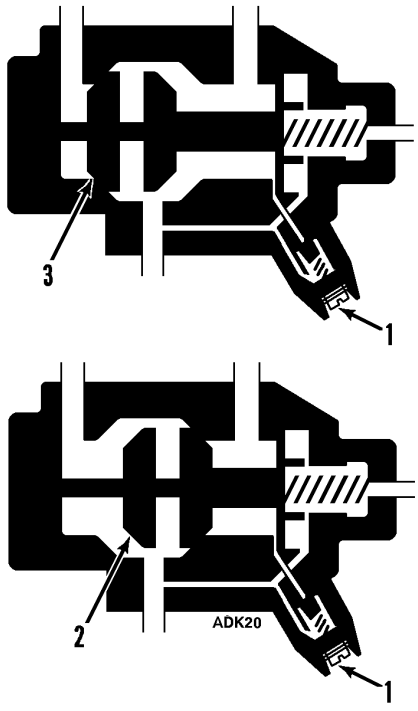
A three-way valve condenser pressure bypass check valve is used in this unit. This check valve controls the bypass flow of refrigerant gas between the condenser inlet line and the compressor discharge line.

The check valve is closed when the unit is running on cool, or whenever the discharge pressure is higher than the condenser pressure.

When the unit is running on defrost or heat, if the condenser pressure is higher than the discharge pressure, the check valve opens and the condenser pressure is bled off until it drops to the level of the discharge pressure. The purpose of the valve is to improve heating/defrosting ability and three-way valve response.

To check the operation of the valve:

1. Remove the condenser pressure bypass check valve cap from the three-way valve.
2. Using a screwdriver, gently turn the check valve stem in until the valve is front seated.
3. Install a gauge manifold set on the compressor.
4. Close (front seat) the receiver tank outlet valve.



1.	Check Valve
2.	Heating/Defrost Position
3.	Cooling Position

Figure 46: Three-way Valve Condenser Pressure Bypass Check Valve

5. Operate the unit on cool and pump down the low side to 20 in. Hg (-68 kPa) of vacuum.
6. Stop the unit. The condenser and suction pressures should remain stable, indicating no leaks.
7. Shift the three-way valve to the heat position. Low side gauge will raise slightly. High side gauge will drop to approximately zero. Gauges will equalize.
8. Gauges will remain in this position approximately zero if the three-way valve seals properly toward the condenser and the condenser pressure bypass check valve seals properly.
9. Back seat condenser pressure bypass check valve stem against snap ring. Both gauges should rise indicating the condenser pressure bypass check valve is properly releasing condenser pressure into the discharge tube and evaporator.

10. Replace the cap on the condenser pressure bypass check valve.

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

11. Open the receiver tank return outlet valve, remove the gauges and return the unit to normal operation.

Electronic Throttling Valve (ETV)

The Electronic Throttling Valve (ETV) is a variable position valve operated by a stepper motor. The ETV is located in the suction line between the evaporator and the heat exchanger. The ETV system also uses discharge and suction pressure transducers, and a hot gas bypass valve.

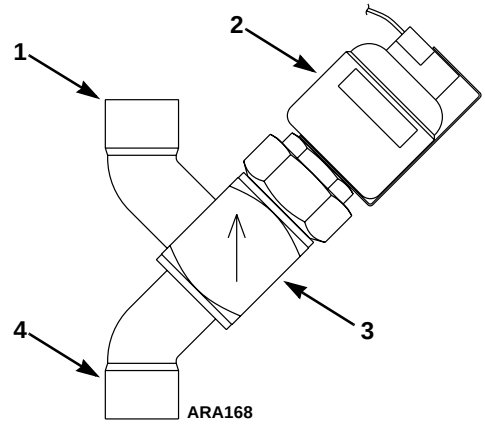
The ETV has two internal coils. The microprocessor operates the valve by energizing the coils with a variable frequency ac signal. The valve position can be monitored with the **GAUGE** key [ETV.P]. Zero (0) indicates the valve is fully closed and 800 indicates the valve is fully open.

The microprocessor tests the ETV every time the unit is started. Alarm Code 89 indicates the refrigeration system pressures did not respond as expected during the test. This may be caused by a malfunction of the ETV or by a refrigeration system problem such as low refrigerant level, a frozen expansion valve, or a restriction in suction line. The microprocessor ignores the test results if the box temperature or the ambient temperature is below 10 F (-12 C). The ETV test can also be performed using the Service Test Mode (Service Procedure A34A in TK 50566).

Use the **GAUGE** key to check the operation of the ETV during the ETV test. The valve position [ETV.P] should be 0 at the start of the test when the valve is fully closed, and should go to a higher value when the valve is opened. The suction pressure [SUC.P] should decrease while the valve is fully closed, and should begin to increase when the valve is opened.

Refer to Service Procedure G03A, the Electronic Throttling Valve (ETV) Test, and Alarm Code 89 in the THERMOGUARD µP-VI Microprocessor Controller Diagnostic Manual TK 50566 for complete information about the testing and operation of the ETV.

Refer to “Electronic Throttling Valve (ETV)” on page 90 of this manual for removal and installation procedures.



1.	Outlet
2.	Stepper Motor
3.	Valve Body
4.	Inlet

Figure 47: Electronic Throttling Valve

Pressure Transducers

The discharge pressure transducer and the suction pressure transducer supply pressure information to the microprocessor. These pressures can be monitored with the **GAUGE** key. [DIS.P] is the discharge pressure. [SUC.P] is the suction pressure. The readings can be checked by comparing them to the readings on a gauge manifold set attached to the compressor. Refer to Service Procedure D03A, the Pressure Sensor Test, and Alarm Codes 87 and 109 in the THERMOGUARD µP-VI Microprocessor Controller Diagnostic Manual TK 50566 for more information about the testing and operation of the pressure transducers.

Hot Gas Solenoid

The hot gas solenoid (or hot gas bypass valve) is used in conjunction with the electronic throttling valve to reduce the capacity of the unit during modulation. This normally closed solenoid valve is located in the refrigeration line that connects the discharge line to the hot gas line. The hot gas solenoid is energized (opened) at full modulation. The hot gas solenoid is de-energized (closed) when modulation is discontinued.

Refer to THERMOGUARD µP-VI Microprocessor Controller Diagnostic Manual TK 50566 for information about testing the hot gas solenoid. See the Refrigeration Service Operation chapter of this manual for removal and installation procedures.

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.

Compressor

Removal

1. Pump down the low side and equalize the pressure to slightly positive.
2. Loosen the compressor belts on Model 50 units.
3. Front seat the discharge and suction service valves.
4. Recover the refrigerant remaining in the compressor.
5. Unbolt the discharge and suction service valves from the compressor.
6. Disconnect the high pressure cutout switch, the pilot solenoid line, and remove the compressor oil filter.
7. Support the compressor and remove the compressor mounting bolts from the flywheel housing.
8. Lift the service valves out of the way.
9. Slide the compressor to the left until the coupling pins are clear, and remove the compressor belts from Model 50 units.
10. Remove the compressor from the front of the unit. Keep the compressor ports covered to prevent dust, dirt, etc., from falling into the compressor.

    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. Slide the compressor into the unit.
2. Place the compressor in position, install the compressor belts on Model 50 units, and install the mounting bolts.

    NOTE: The compressor drive coupling or clutch will only slide onto the coupling pins in either of two positions, which are 180 degrees apart.
3. Install the service valves using new gaskets soaked in compressor oil. Connect the high pressure cutout switch, the pilot solenoid valve line, and install the compressor oil filter.
4. Pressurize the compressor and test for refrigerant leaks.
5. If no leaks are found, evacuate the compressor.
6. Back seat the suction and discharge service valves.
7. Tighten the compressor belts on Model 50 units.
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.

Compressor Coupling Removal (Model 30)

1. After the compressor has been removed from the unit, use the appropriate Allen tool provided with removal tool P/N 204-991 to loosen the center bolt which holds the coupling to the compressor shaft.
2. Attach the tool to the coupling with the provided socket head screws and spacers. 2 sets of spacers are provided with the tool, use the short spacers with shallow compressor mounting flanges and the longer set for deeper flanges. The side with the countersunk holes should be toward the coupling.
3. To prevent the tool and crankshaft from rotating, use one of the compressor to engine mounting screws to pin the tool to the flange. If a nut is used to prevent the bolt from falling out, the nut should not be tightened.

4. Use torque wrench and the appropriate Allen tool to unscrew the coupling mounting screw. Apply a maximum of 90 ft-lb of torque to the screw.
5. Once the center screw has been loosened, back the head against the tool and it should push the coupling off the crankshaft as you continuing turning the center screw in a counter-clockwise direction. Using this tool will prevent the coupling from popping off because the center bolt and flatwasher will hold it in place.

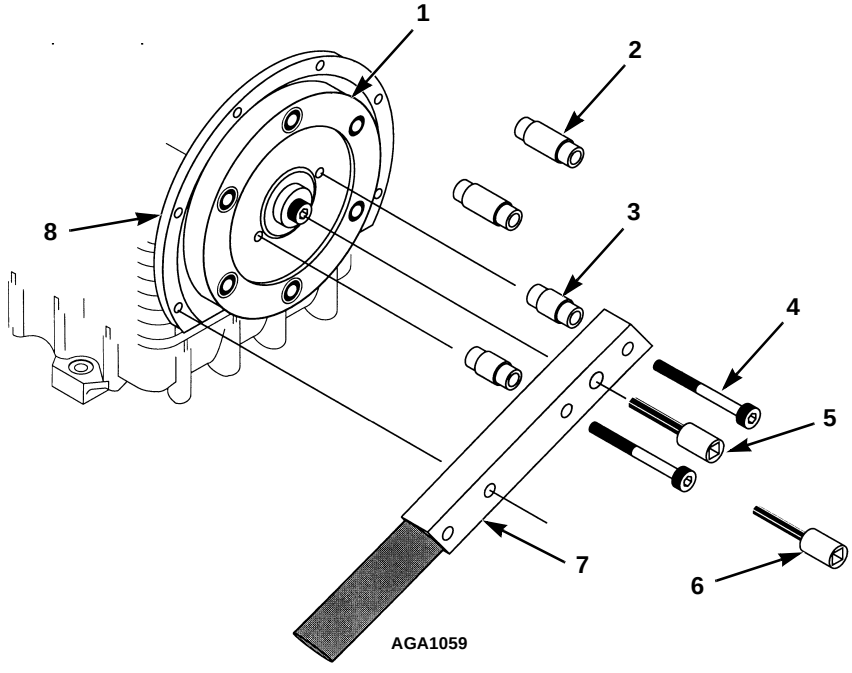
Compressor Coupling Installation (Model 30)

In a tapered fit joint the entire twisting load should be handled by the friction fit between the two tapered parts. The key is only a backup and is used to index the parts correctly. When a taper fit is machined and assembled properly a key is not needed. In fact, if the key is not installed correctly it may be worse than no key at all! If the key does not fit easily into the keyway, it will push the tapered components apart and the reduced friction could lead to slippage and premature failure.

The following procedure requires the key to be fitted after the tapers are pulled together with 20 ft-lb (27 N•m) torque. This insures that the key cannot hold the tapers apart when the final bolt torque is applied.

Use the following procedure to install a compressor coupling on the compressor crankshaft.

1. Clean the compressor shaft taper and coupling bore taper with a solvent that leaves no oily residue (such as naphtha, lacquer thinner, brake cleaner or the like).
2. Inspect both mating surfaces for burrs, oxidation and other surface imperfections. Dress with crocus cloth if necessary and re-clean as required.



1.	Coupling	5.	10 mm Allen Tool (for large shaft compressor)
2.	Long Spacers (supplied with tool)	6.	5/16 Allen Tool (for small shaft compressors)
3.	Short Spacers (supplied with tool)	7.	Coupling Removal Tool (P/N 204-991)
4.	Socket Head Bolts (supplied with Tool)	8.	Engine Mounting Flange

Figure 48: Compressor Coupling Removal Tool

3. **Using no lubricants**, set the coupling on the crankshaft and align the keyways using the Keyway Tool (P/N 204-972). Insert the tapered end of the tool into the keyway and gently move the coupling on the shaft while pressing the tool into the keyway. This will align the keyway in the crankshaft with the keyway in the coupler.

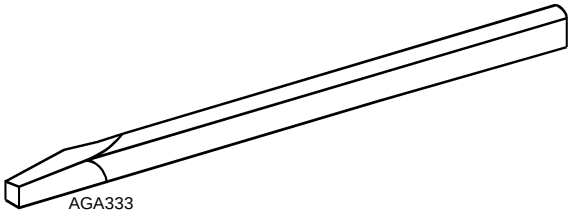
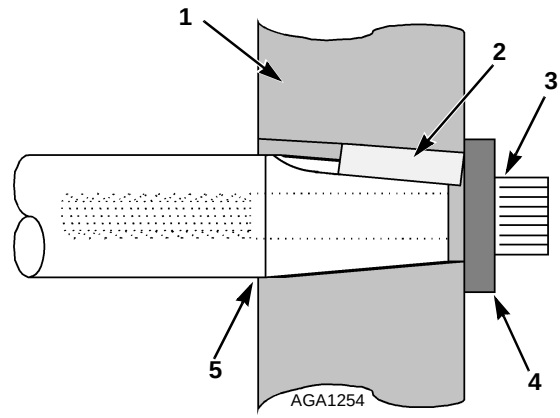


Figure 49: Keyway Tool P/N 204-972

CAUTION: If you are assembling a used coupler or crankshaft and the tool does not fit easily there is a problem with one of the keyways! Do not remove the coupler and place the key in the crankshaft keyway and then drop the coupler on. If the tool does not fit, the key will not fit, and it will hold the taper in the coupler off the taper on the shaft. Check both keyways for burrs or corrosion. A key can be coated with fine lapping compound and used as a lapping tool to clean the keyways.

4. Remove the Keyway Tool and check the fit of the new key (P/N 55-9024). It should fit into the keyway with a light press fit requiring only a minimum of light tapping. If the key does not fit properly, remove the coupler and inspect the keyways and key for burrs or other problems. Recheck the fit as shown above.
5. When the key fits properly, remove the coupling and key from the shaft.
6. Re-install the coupling and align the keyways with the Keyway Tool.
7. **Do not install the key at this time.** Install the flat washer and bolt and pre-torque to 20 ft-lb (27 N•m). Remove the bolt and washer.
8. Install the key in the keyway. As above, it should fit with a light press fit requiring only a minimum of light tapping. **Do not install the key into the keyway beyond the front face of the coupling.** If tapped in farther it may cause the coupling to move off center on the shaft.



1.	Compressor Coupling or Clutch
2.	Key tapped flush with outside face of coupling. Do not tap key any farther into keyway.
3.	Torque bolt to 90 ft-lb (122 N•m)
4.	Washer
5.	Spray this area with corrosion inhibitor after assembling.

Figure 50: Compressor Coupling Installation

9. Re-install the bolt and heavy flat washer and snug the bolt down by hand. Torque the bolt to 90 ft-lb (122 N•m).
10. Spray a corrosion inhibitor (such as spray paint) on the exposed part of the shaft and the joint between the shaft and the coupling. This prevents moisture from wicking into the joint and causing corrosion.

Condenser Coil

Removal

1. Recover the refrigerant charge.
2. Open the roadside condenser fan grille.
3. Drain engine coolant from the expansion tank. Unbolt and remove the expansion tank from the condenser coil frame.
4. Remove the condenser coil mounting bolts. Remove the mounting clamps from the condenser inlet line.
5. Unsolder the inlet line and liquid line connections. Lift the coil from the unit.

Installation

1. Clean the fittings for soldering.
2. Place the coil in the unit and install the mounting bolts.
3. Solder the inlet line and liquid line connections.
4. Pressurize the refrigeration system and test for leaks. If no leaks are found, evacuate the system.
5. Install the clamps on the condenser inlet line.
6. Install the engine coolant expansion tank and refill half way with engine coolant.
7. Close hinged roadside condenser fan grille.
8. Recharge the unit with proper refrigerant and check the compressor oil.

Discharge Vibrasorber

Removal

1. Recover the refrigerant charge.
2. Heat the connections on the vibrasorber until the vibrasorber can be removed.

CAUTION: Use a heat sink, P/N 204-584 or wrap the vibrasorber with wet rags to prevent damaging the vibrasorber.

Installation

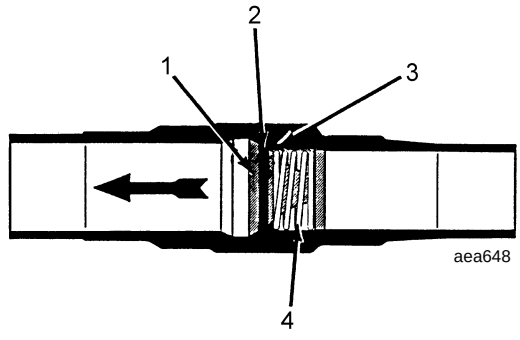
1. Prepare the vibrasorber and tubing fittings by cleaning thoroughly.
2. Solder the vibrasorber connections.

CAUTION: Use a heat sink, P/N 204-584 or wrap the vibrasorber with wet rags to prevent damaging the vibrasorber.

3. Pressurize the system and test for leaks. If no leaks are found, evacuate the system.
4. Charge the unit with the proper refrigerant and check the compressor oil level.

In-line Condenser Check Valve

This unit uses an in-line condenser 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 51: Cross Section of In-line Condenser Check Valve

Condenser Check Valve Replacement

Removal

1. Recover the refrigerant charge.
2. Place a heat sink on the check valve.
3. Unsolder the lines and remove the check valve.

Installation

NOTE: 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 refrigerant flow through the valve.
3. Place a heat sink on the check valve.
4. Solder the inlet and outlet connections.
5. Pressurize the refrigeration system and test for leaks.
6. If no leaks are found, evacuate the system.
7. Recharge the unit with proper refrigerant and check the compressor oil.

Bypass Check Valve

Removal

1. Pump down the low side and equalize the pressure to slightly positive.
2. Close the bypass service valve.
3. Unscrew the flare nut from the check valve.
4. Unscrew the check valve from the bypass valve.

CAUTION: The receiver tank outlet tube may be bent if a back-up wrench is not used on the fitting.

Installation

1. Coat the fittings on the bypass check valve with compressor oil and install on the service valve fitting. Tighten it securely, and use a back-up wrench.
2. Install and tighten the bypass flare nut on the check valve outlet. Hold the check valve with a back-up wrench on the hex.
3. Pressurize the low side and test for leaks. If no leaks are found, evacuate the system.
4. Open the bypass service valve and place the unit in operation.

Receiver Tank

Removal

1. Recover the refrigerant charge.
2. Unsolder the inlet, outlet, and bypass check valve lines from the receiver tank. Use a heat sink on the bypass check valve.
3. Unsolder and remove the bypass check valve from the receiver tank. Use a heat sink on the bypass check valve.
4. Remove the high pressure relief valve from the receiver tank.
5. Unbolt the mounting brackets and remove the receiver tank from the unit.

Installation

1. Install the high pressure relief valve in the receiver tank.
2. Solder the bypass check valve onto the receiver tank. Use a heat sink on the bypass check valve.
3. Place the receiver tank in the unit and install the mounting bolts and nuts loosely. Position the receiver tank so that the sight glass is clearly visible through the viewing hole in the mounting bracket.
4. Solder the inlet, outlet, and bypass check valve lines to the receiver tank. Use a heat sink on the bypass check valve.
5. Tighten the receiver tank mounting hardware securely.
6. Pressurize the refrigeration system and check for leaks. If no leaks are found, evacuate the system.
7. Recharge the unit with proper refrigerant.

Filter Drier

Removal

1. Pump down the refrigeration system and equalize the pressure to slightly positive.
2. Disconnect the nuts at the ends of the drier.

3. Loosen the mounting hardware and remove the drier.

Installation

1. Place the new O-rings in the ORS fittings on the ends of the drier.
2. Install the new drier and tighten the mounting hardware.
3. Install and tighten the inlet nut. Hold the drier with a back-up wrench on the hex behind the inlet fitting.
4. Release a small amount of refrigerant to purge the air through the drier. Then tighten the outlet nut.
5. Pressurize the system and inspect for leaks. If no leaks are found, open the refrigeration valves and place the unit in operation.

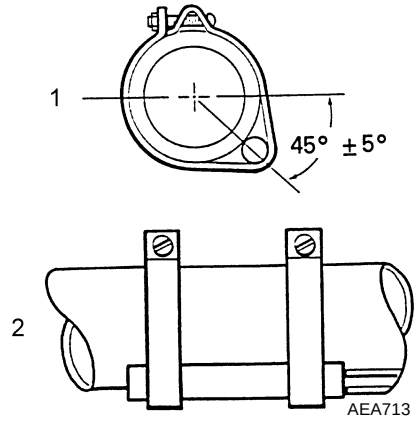
Expansion Valve Assembly

Removal

1. Pump down the low side and equalize the pressure to slightly positive.
2. Remove the evaporator access panels.
3. Remove the feeler bulb from the clamp. Note the position of the feeler bulb on the suction line.
4. Disconnect the equalizer line from the suction line.
5. Disconnect the inlet liquid line and unsolder the distributor from the expansion valve.
6. Remove the expansion valve mounting bolt and remove the expansion valve from the unit.

Installation

1. Install and bolt the expansion valve assembly in the unit.
2. Connect the inlet liquid line and solder the distributor to the expansion valve.
3. Connect the equalizer line to the suction line.
4. Clean the suction line to a bright polished condition. Install the feeler bulb clamps and the 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 operation will be faulty. Wrap with insulating tape.



1.	End View
2.	Side View

Figure 52: Location of Expansion Valve Bulb

5. Pressurize the low side and test for leaks. If no leaks are found, evacuate the low side.
6. Replace 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

Heat Exchanger

Removal

1. Pump down the low side and equalize the pressure to slightly positive.
2. Remove the upper and lower evaporator access panels.
3. Remove the mounting bolts that hold the heat exchanger on the bulkhead.
4. Disconnect the equalizer line from the suction line.

5. Disconnect the liquid outlet line from the expansion valve.
6. Note the position of the feeler bulb on the side of the suction line. Remove the expansion valve feeler bulb from the suction tube.
7. Unsolder the suction line at the evaporator coil end.
8. Unsolder the remaining outlet suction line and inlet liquid line connections from the condenser side of the bulkhead. Remove any putty from around the lines before unsoldering the connections.
9. Slide the heat exchanger assembly out of the evaporator housing.

Installation

1. Clean the tubes for soldering.
2. Place the heat exchanger assembly in the evaporator housing and install the mounting hardware loosely.
3. Solder the liquid inlet and the suction outlet line connections on the condenser side of the bulkhead. Seal the openings through the bulkhead with putty when the refrigerant lines have cooled off.
4. Solder the suction line connection to the evaporator coil.
5. Connect the equalizer line to the suction line and the liquid outlet line to the expansion valve.
6. Pressurize the low side and test for leaks. If no leaks are found, evacuate the low side.
7. Tighten the heat exchanger mounting hardware securely.
8. Clean the suction tube to a brightly polished condition. Install the feeler bulb clamps and the 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 with insulating tape.
9. Replace the upper and lower evaporator access panels.
10. Open the refrigeration valves and place the unit in operation.

Evaporator Coil

Removal

1. Pump down the low side and equalize the pressure to slightly positive.
2. Remove the upper and lower rear access panels.
3. Remove the roadside and curbside evaporator access panel mounting channels.
4. Disconnect the sensors.
5. Remove the feeler bulb from the suction line clamp. Note the position of the feeler bulb on the suction line.
6. Unsolder the distributor from the expansion valve.
7. Unsolder the hot gas line and the suction line from the evaporator coil.
8. Remove the mounting bolts, lift and slide the coil from the housing.

Installation

1. Place the evaporator coil in the evaporator housing and install the mounting bolts.
2. Solder the hot gas line and suction line connections to the evaporator coil.
3. Connect the distributor to the expansion valve.
4. Replace and connect the sensors.
5. Pressurize the low side and test for leaks. If no leaks are found, evacuate the low side.
6. Clean the suction line to a bright polished condition. Install the 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 operation will be faulty. Wrap with insulating tape.
7. Replace the roadside and curbside evaporator access panel mounting channels.
8. Replace the upper and lower rear access panels.

9. Open the refrigeration valves and place the unit in operation. Check the refrigerant charge and compressor oil. Add as required.

Accumulator

Removal

1. Pump down the low side and equalize the pressure to slightly positive.
2. If applicable, disconnect the water lines from the accumulator.
3. Unsolder the inlet and outlet suction lines from the accumulator.

CAUTION: Use a heat sink or wrap vibrasorber with wet rags to prevent damaging the vibrasorber.

4. Disconnect the tee fitting from the accumulator tank.
5. Unbolt and remove the accumulator from the unit.

Installation

1. Place the accumulator in the unit and tighten the mounting bolts and nuts.
2. Solder the inlet and outlet suction lines to the accumulator.

CAUTION: Use a heat sink or wrap vibrasorber with wet rags to prevent damaging the vibrasorber.

3. If applicable, connect the water lines to the accumulator tank.
4. Connect the tee fitting and lines to the accumulator.
5. Pressurize the low side and test for refrigerant leaks. If no leaks are found, evacuate the low side.
6. Open the refrigeration valves and place the unit in operation. Check the refrigerant charge and the compressor oil, and add as required.

Three-way Valve Repair

NOTE: The three-way valve can be repaired in the unit if leakage or damage to the Teflon seals should occur. There is usually enough give in the copper tubing to separate the three sections of the valve without unsoldering any tubes.

Removal/Disassembly

1. Recover the refrigerant charge.
2. Clean the exterior surface of the valve.
3. Remove the line from the three-way valve to the pilot solenoid.
4. Loosen the four 1/4 in. Allen head screws (DO NOT REMOVE OR CAP MAY POP OFF); use tool P/N 204-424 to break the gasket at each side of the center section.

CAUTION: Do not force the tool into the brass or against the bolts.

Figure 53: Gasket Tool P/N 204-424

5. Remove the four bolts from the valve.
6. Remove the top cap and spring.
7. Remove the spring clip which secures the stem to the piston. Slide piston off the stem.
8. Remove the seat and stem assembly.
9. Inspect the following parts for wear or damage:
   a. Bottom cap, sealing and support area.
   b. Seat, sealing surface.
   c. Top cap, sealing and support surface.

The following parts will be discarded:

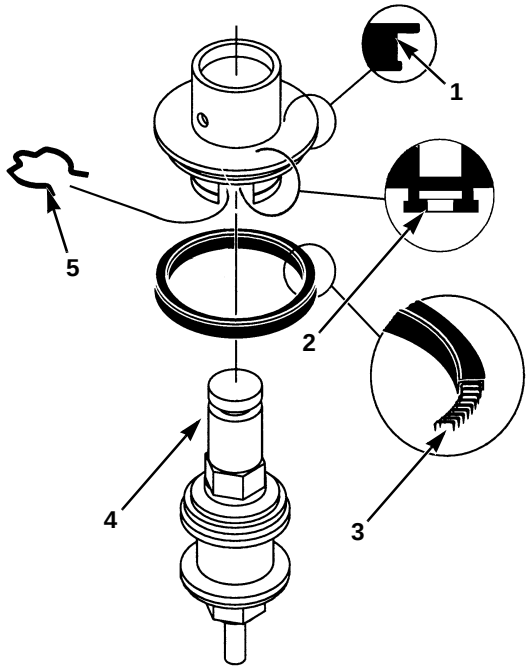
a. Stem assembly.

b. All gaskets.

c. Piston seal.

10. Remove the screen. If any particles drop from the screen into the discharge line, the discharge line must be removed at the compressor.

NOTE: The valve body cannot be reconditioned. Seat positions change and improper sealing will result.



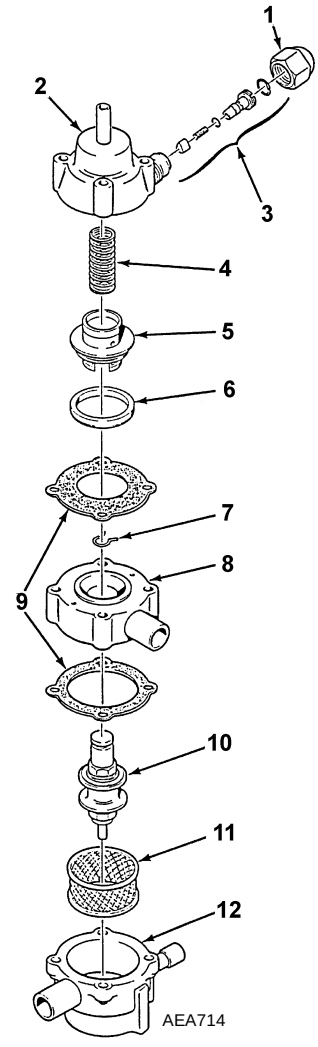
1.	Seal Groove in Piston
2.	Connecting Notch in Piston
3.	Internal Spring in Seal
4.	Connecting Groove in Stem
5.	Retaining Clip

Figure 54: Piston and Stem Parts

Assembly/Installation

After cleaning and inspecting all parts, reassemble the valve.

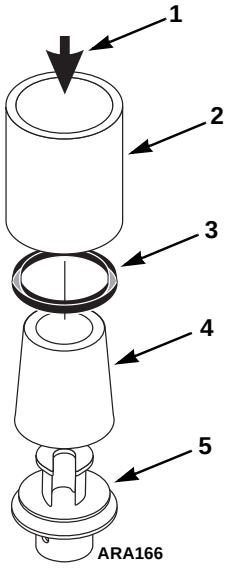
1. Install the screen in the bottom cap.
2. Install the new stem in the bottom cap.
3. Install new gaskets on both sides of the seat. Oil the gaskets in compressor oil before installing.



1.	Cap	7.	Clip
2.	Top Cap	8.	Seat
3.	Check Valve	9.	Gaskets
4.	Spring	10.	Stem Assembly
5.	Piston	11.	Screen
6.	Seal	12.	Bottom Cap

Figure 55: Three-Way Valve

4. Use the three-way valve seal installation tool P/N 204-1008 to install a new seal on the piston. This prevents the seal from being stretched and damaged.
   a. Place the tapered tool over the piston.
   b. Lubricate the seal with refrigeration oil.
   c. Slide the seal onto the tapered tool with the spring side facing away from the piston.
   d. Use the pipe to hand press the seal onto the piston.



1.	Press by Hand	4.	Tapered Tool
2.	Pipe	5.	Piston
3.	Seal		

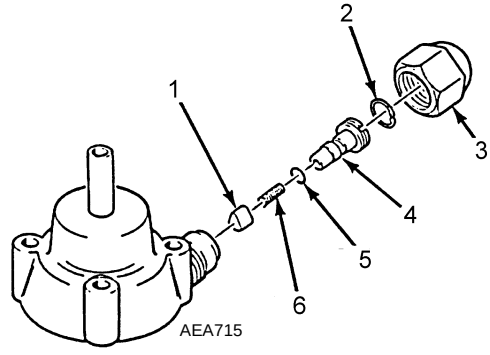
Figure 56: Seal Installation with Tool P/N 204-1008

5. Place the piston slot on the stem and secure with spring clip. The open part of the clip should be on the opposite side of the piston slot.
6. Install the spring and top cap.
7. Line up the passageways in the cap and body. Failure to line up the holes will result in improper operation of the valve.
8. Install the bolts and tighten in rotating sequence.
9. Install the pilot line and pressurize the system with refrigerant to check for leaks.
10. If there are no leaks, evacuate the system and recharge with the proper refrigerant.
11. Run the unit to check for proper three-way valve operation.

Three-Way Valve Condenser Pressure Bypass Check Valve Repair

Removal

1. Recover the refrigerant charge.
2. Unscrew the condenser pressure bypass check valve cap from the three-way valve.
3. Remove the snap ring.



1.	Teflon Check Valve	4.	Stem
2.	Snap Ring	5.	O-ring
3.	Cap	6.	Spring

Figure 57: Teflon Check Valve Assembly

4. Unscrew the check valve stem by using a screwdriver in the slot provided.

   NOTE: The spring and valve are held in by the stem. While removing the stem, use care so the spring and valve are not lost.

5. Remove the spring and Teflon check valve.
6. Inspect the check valve seat in the three-way valve.
7. If replacement parts are needed, a P/N 60-163 kit must be used which includes the Teflon check valve, spring, O-ring, valve stem and snap ring.

Installation

1. Coat the O-ring with compressor oil and install it on the check valve stem.
2. Insert the spring into the hole in the check valve stem and then install the Teflon check valve on the other end of the spring with the hole in the valve towards the spring.
3. Coat the entire assembly with compressor oil and install the assembly into the Teflon check valve seat in the three-way valve.

CAUTION: The Teflon check valve must be inserted with the flat side against the valve seat to ensure proper sealing.

4. Screw the check valve stem into the three-way valve until the snap ring can be installed.
5. Install the snap ring.
6. Unscrew (back seat) the check valve stem against the snap ring.

   NOTE: The valve stem must be back seated during normal unit operation.

7. Coat sealing area in the cap with compressor oil, install and tighten the cap on the three-way valve.
8. Pressurize the refrigeration system and test for leaks. If no leaks are found, evacuate the system.
9. Recharge the unit.

Pilot Solenoid

Removal

1. Recover the refrigerant.
2. Disconnect the wires and remove the coil from the valve.
3. Unsolder the refrigeration lines.
4. Remove the mounting bolts and remove the valve.

Installation

1. Remove the coil from the valve.
2. Place the valve in the unit and install the mounting bolts.
3. Solder the refrigeration lines to the valve.
4. Install the coil and connect the wires.
5. Pressurize the refrigeration system and test for leaks. If no leaks are found, evacuate the system.
6. Recharge the unit with the proper refrigerant and check the compressor oil.

Suction Vibrasorber

Removal

1. Pump down the low side and equalize pressure to slightly positive.
2. Unsolder the suction hose from the suction service valve. Unsolder the connection to the accumulator and remove from the unit.

Installation

1. Prepare the suction hose and tube fittings for soldering by cleaning thoroughly.
2. Solder the vibrasorber to the suction service valve.

CAUTION: Use a heat sink or wrap vibrasorber with wet rags to prevent damaging the vibrasorber.

3. Solder the suction hose connection to the accumulator.
4. Pressurize the low side and check for leaks. If no leaks are found, evacuate the system.
5. Open the refrigeration valves and place the unit in operation.

High Pressure Cutout Switch

Removal

1. Pump down the low side and equalize the pressure to slightly positive.
2. Front seat the discharge and suction service valves. Recover the refrigerant remaining in the compressor.
3. Disconnect the wires and remove the high pressure cutout switch from the compressor discharge manifold.

Installation

1. Apply a refrigerant Loctite to the threads of the high pressure cutout switch.
2. Install and tighten the high pressure cutout switch and reconnect the wires.
3. Pressurize the compressor and test for leaks.
4. If no leaks are found, open the refrigeration service valves and place the unit in operation.

High Pressure Relief Valve

Removal

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

Installation

1. Apply a refrigerant oil to the O-ring 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 the proper refrigerant and check the compressor oil.

Discharge Pressure Transducer

Removal

1. Recover the refrigerant charge.
2. Disconnect the wires and remove the discharge pressure transducer.

Installation

1. Apply a refrigerant Loctite to the threads of the discharge pressure transducer.
2. Install and tighten the discharge pressure transducer and reconnect the wires.
3. Pressurize the refrigeration system and test for leaks. If no leaks are found, evacuate the system.
4. Recharge the unit with the proper refrigerant and check the compressor oil.

Suction Pressure Transducer

Removal

1. Pump down the low side and equalize pressure to slightly positive.
2. Disconnect the wires and remove the suction pressure transducer.

Installation

1. Apply a refrigerant Loctite to the threads of the suction pressure transducer.
2. Install and tighten the suction pressure transducer and reconnect the wires.
3. Pressurize the low side and check for leaks. If no leaks are found, evacuate the low side.
4. Open the refrigeration valves and place the unit in operation.

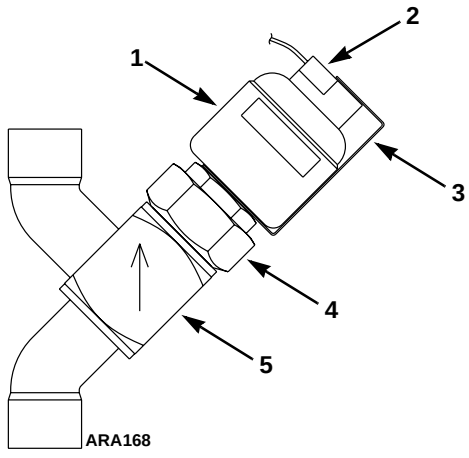
Electronic Throttling Valve (ETV)

Removal

1. Attach a gauge manifold to the compressor.
2. Pump down the low side and equalize the pressure to slightly positive.
3. Remove the evaporator access panels.
4. Remove the clip and disconnect the ETV harness connector from the stepper motor.
5. Unscrew the large nut that attaches the stepper motor and piston assembly to the valve body. The torque on the nut is approximately 100 ft-lb (136 N•m). Hold the valve body with backup wrench to prevent damage to the refrigeration tubing.

CAUTION: Unscrew the large nut. Do not unscrew the small nut.

WARNING: If the ETV is stuck in the closed position, much of the refrigerant charge may be trapped in the evaporator. If you hear refrigerant begin to flow through the valve when the stepper motor and piston assembly are loosened, unscrew the stepper motor and piston assembly no more than four turns and check the suction (low side) pressure on the gauge manifold. If the suction pressure has increased from the pressure to which it was equalized after the low side pump down, refrigerant is trapped and must be recovered. Screw the stepper motor and piston assembly back into the valve body. Attach a refrigerant recovery device to the service port on the receiver tank outlet valve. Midseat the receiver tank outlet valve, and recover the refrigerant charge. The stepper motor and piston assembly may then be removed.



1.	Stepper Motor	4.	Large Nut
2.	Harness Connector	5.	Valve Body
3.	Clip		

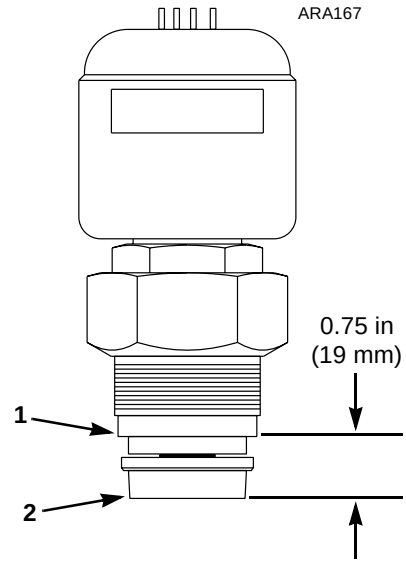
Figure 58: Electronic Throttling Valve

6. If the complete ETV assembly is being replaced, unsolder and remove the valve body. It may be necessary to unsolder the tubes above or below the valve body to obtain enough clearance to remove the valve body. Note the position of the valve body so the new one will be placed in the same position. The new ETV could interfere with the evaporator access panel if it is not placed in the same position as the old one.

Installation

1. If an ETV service kit (stepper motor and piston assembly) is being installed, go to step 2. If a complete ETV assembly is being installed, proceed as follows:
   a. Remove the stepper motor and piston assembly from the valve body on the new ETV assembly.
   b. Clean the tubes for soldering.
   c. Place the new valve body (and any tubes that were removed) in the same position from which the old one was removed. The new ETV could interfere with the evaporator access panel if it is not placed in the same position as the old one. The arrow on the valve body must point up, which is the direction of refrigerant flow from the evaporator to the heat exchanger.
   d. Solder the tubing connections. Use a heat sink on the valve body to prevent damage.
   e. Allow the valve body to cool before installing the stepper motor and piston assembly.
2. Check the stepper motor and piston assembly to make sure the piston is an open position. In an open position the bottom edge of the piston is 0.75 to 1.25 in. (19 to 32 mm) from the bottom edge of the brass nut. The piston retracts to open and extends to close.

   NOTE: The ETV cannot be opened manually. See the following CAUTION.



1.	Bottom Edge of Brass Nut
2.	Bottom Edge of Piston

Figure 59: Stepper Motor and Piston Assembly with Piston in Fully Open Position

CAUTION: The ETV may stick in the closed position if the stepper motor and piston assembly is installed with the piston in the closed position. In the closed position the bottom edge of the piston is 1.5 in. (38 mm) from the bottom edge of the brass nut. If there is any doubt about the position of the piston, connect the ETV harness to the stepper motor and piston assembly and use the evacuation [EVAC] mode in the Service Test Mode to place the piston in the fully open position. Refer to Service Procedure A34A, the Service Test Mode, in the THERMOGUARD μP-VI Microprocessor Controller Diagnostic Manual TK 50566 for information about placing the unit in the evacuation [EVAC] mode. After placing the piston in the fully open position, disconnect the ETV harness from the stepper motor and piston assembly.

3. Lubricate the piston and threads on the new stepper motor and piston assembly with refrigeration oil.
4. Screw the new stepper motor and piston assembly into the valve body.
5. Torque the nut to approximately 100 ft-lb (136 N•m). Hold the valve body with backup wrench to prevent damage to the refrigeration tubing.

CAUTION: Tighten the large nut. Do not tighten the small nut.

6. Connect the ETV harness connector to the stepper motor. Take care when making the connection. The connector attaches to the ETV in only one position.
7. Install the clip and secure it with a band wrap.
8. Pressurize the low side and test for leaks.
9. If no leaks are found, evacuate the low side.
10. Install the evaporator access panels.
11. Open the refrigeration valves and place the unit in operation. Check the operation of the ETV.

Compressor Oil Filter Change

This unit is equipped with a compressor oil filter. The compressor oil filter should be changed when the drier is replaced.

1. Pump down the low side and equalize the pressure to slightly positive.
2. Front seat the discharge and suction service valves. Remove the remaining refrigerant from the compressor.
3. Disconnect the oil lines from the compressor oil filter. Hold the oil filter with back-up wrench on the hex behind the ORS fitting.
4. Remove the clamp and the compressor oil filter.
5. Coat the new O-rings with clean compressor oil and place them in the ORS fittings on the ends of the new compressor oil filter.
6. Fasten the new compressor oil filter in place with the clamp.
7. Attach and tighten the oil lines to the compressor oil filter. Hold the oil filter with a back-up wrench on the hex behind the ORS fitting.

8. Evacuate the compressor and filter to a maximum of 500 microns to remove trapped air.
9. Open the service valves, operate the system, and check the compressor oil filter for leaks.

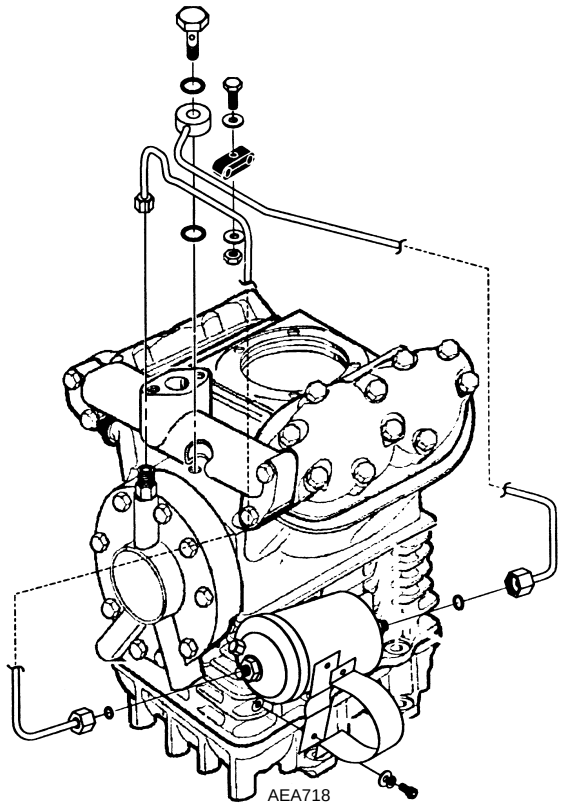


Figure 60: Compressor Oil Filter

Hot Gas Solenoid Valve

Removal

1. Recover the refrigerant charge.
2. Disconnect the wires and remove the coil for the valve.
3. Unsolder the lines and remove the valve.

Installation

1. Clean the tubes for soldering.
2. Remove the coil and place the valve in position.
3. Solder the inlet and outlet connections. After the valve cools, install the coil.
4. Pressurize the refrigeration system and test for leaks.
5. If no leaks are found, evacuate the system.
6. Recharge the unit with proper refrigerant and check the compressor oil.

Unit and Engine Mounting Bolts

Check and tighten all unit and engine mounting bolts during scheduled maintenance inspections. Torque the unit mounting bolts to 60 ft-lb (81 N•m). Torque the engine mounting bolts to 150 ft-lb (203 N•m).

Unit Inspection

Inspect the unit during 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.

Condenser, Evaporator, 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 airflow. Repair bent fins and any other noticeable damage.

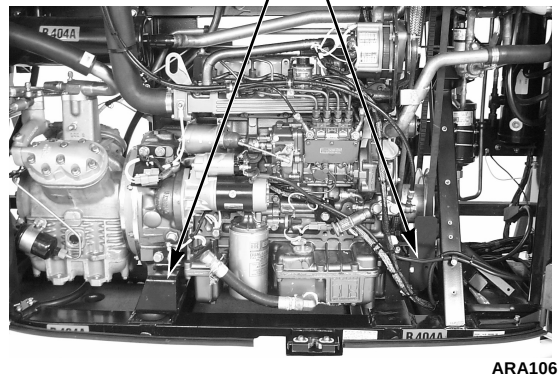
Defrost Drains

Clean the defrost drains during scheduled maintenance inspections to be sure the lines remain open.

Unit Installation

All nuts that hold the unit to the trailer are accessible using an impact wrench with a 10 in. extension, ball-type swivel and a deep-well socket.

NOTE: The nuts for mounting the unit should be elastic stop nuts (Nylock type).



1.	Check Bolts for Tightness

Figure 61: Unit and Engine Mounting Bolts

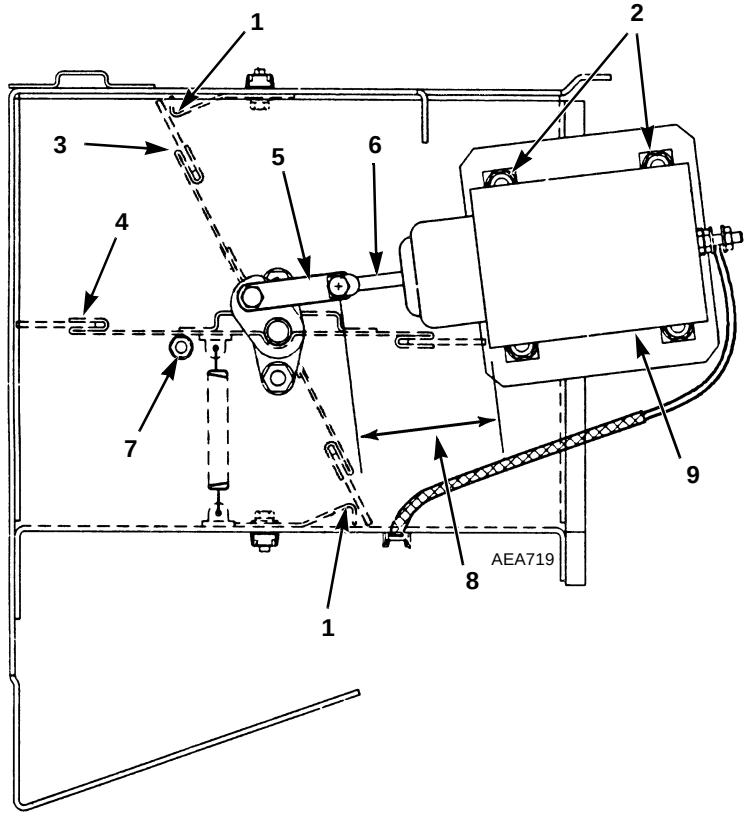
Defrost Damper

Check the damper during scheduled maintenance inspections for shaft wear, end play, and the ability to stop the air flow.

Position the damper so that air flow is stopped on the top and bottom edges with the solenoid plunger bottomed out.

To adjust the damper:

1. Remove the damper assembly from the evaporator.
2. Disconnect the damper link from the eye bolt.
3. Check Distance A, the distance from the shoulder on the solenoid to the center of the hole in the eye bolt. Distance A should be 2.75 in. (69.85 mm) with the solenoid de-energized.
4. If necessary, adjust Distance A to the proper dimension by loosening the locknut on the end of the solenoid plunger and turning the eye bolt. Tighten the locknut when Distance A is correct.
5. Connect the damper link to the eye bolt.
6. Energize the solenoid (apply 12 volts dc) and check the damper blade to make sure that both edges contact the damper housing. If necessary, adjust this by loosening the solenoid mounting bolts and moving the solenoid. Tighten the solenoid mounting bolts when both edges of the damper blade contact the damper housing.
7. Adjust the damper blade stops so they contact the edges of the damper blade. This keeps the damper from sticking closed.



1.	Stop	6.	Eye Bolt
2.	Mounting Bolts	7.	Round Stop
3.	Closed Position	8.	Distance A 2.75 in. (69.85 mm)
4.	Open Position	9.	Solenoid
5.	Damper Link		

Figure 62: Defrost Damper Adjustment

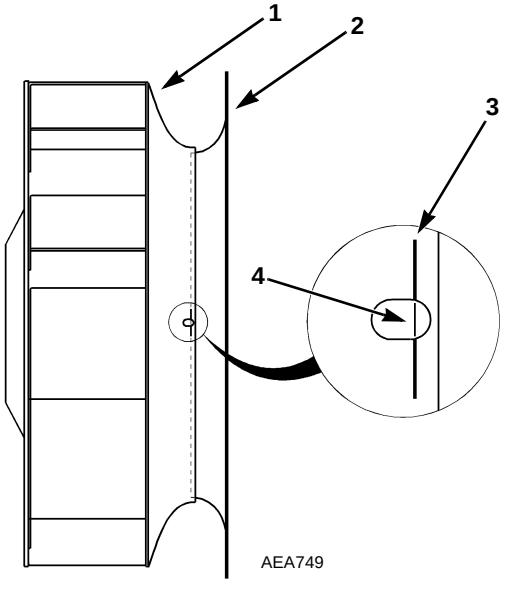
8. De-energize and energize the damper several times to make sure that the damper operates correctly and seals properly.
9. Make sure the damper blade rests on the round stops when the damper is open. Adjust the round stops if necessary.
10. Install the damper assembly in the evaporator.

Condenser and Evaporator Fan Location

When mounting the condenser or evaporator fan and hub assembly on the fanshaft, the blowers and inlet orifices must be properly aligned for proper air flow and to prevent damage to the blower.

Condenser Fan Blower

1. Loosen the condenser inlet ring (spinning) on the condenser coil bulkhead.
2. Slide the blower towards the inlet ring until it contacts the inlet ring. This centers the inlet ring in the blower orifice.
3. Tighten the inlet ring securely.
4. Slide the blower away from the inlet ring.



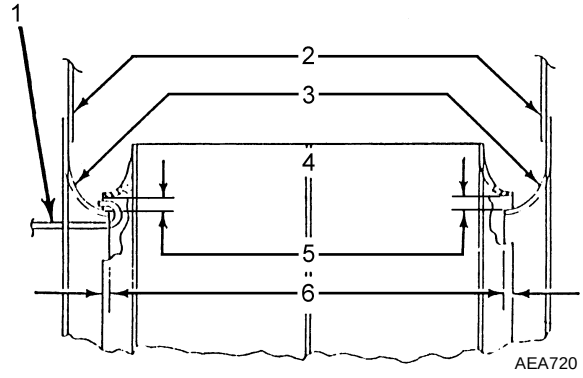
1.	Blower Wheel	3.	Alignment Mark
2.	Inlet Ring	4.	Edge of Inlet Ring

Figure 63: Condenser Blower Alignment

5. Pass a gauge wire completely around the blower orifice to check for uniform clearance.
6. Spin the blower by hand to check for blower distortion.
7. Position the blower so the edge of the inlet ring lines up with the alignment mark on the blower.
8. Torque blower hub bolts to 18 ft-lb (24 N•m).

Evaporator Fan Blower

1. Loosen the inlet rings on the sides of the blower housing.
2. Center the blower wheel in the blower housing with equal overlap on both inlet rings. The overlap on each ring should be approximately 0.15 in. (3.8 mm).
3. Tighten the hub bolts that hold the blower wheel on the fanshaft.
4. Center the inlet rings in the blower orifices. Tighten the inlet rings securely.
5. Check the radial clearance by passing a wire completely around the circumference of the inlet rings and the blower wheel.
6. Torque the blower hub bolts to 18 ft-lb (24 N•m).



1.	Check Clearance with a Wire
2.	Blower Housing Sides
3.	Inlet Rings
4.	Evaporator Blower
5.	Radial Clearance
6.	Equalize Blower Inlet Overlap

Figure 64: Evaporator Fan Location

Fan Shaft Assembly

The unit is equipped with a one-piece fan shaft assembly that contains tapered roller bearings in a sealed oil reservoir.

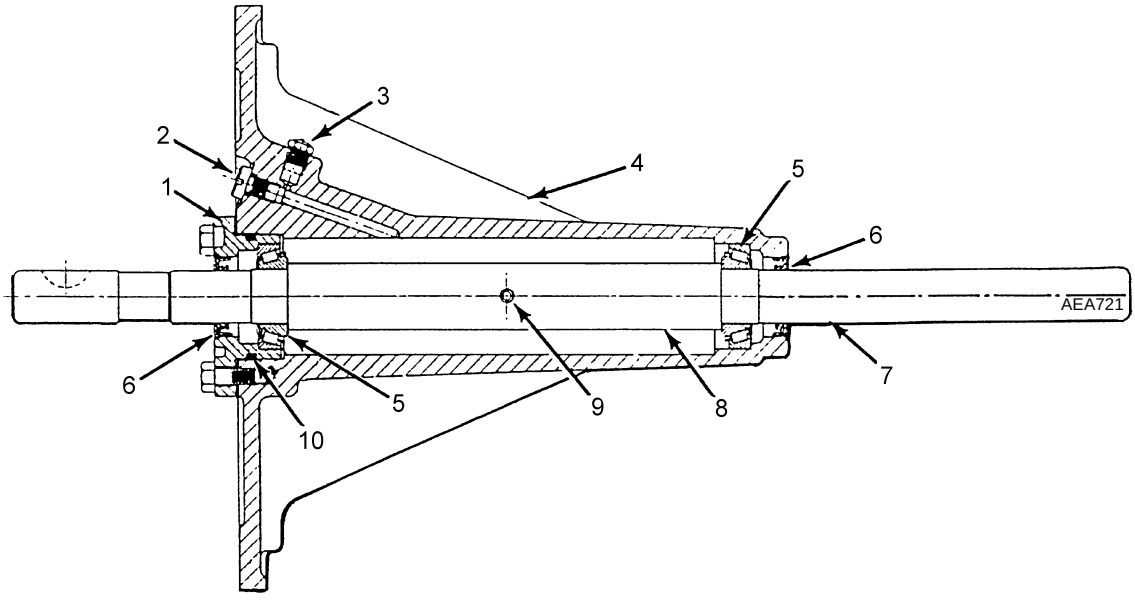
This assembly does not require any maintenance. There is a level plug and a fill plug, but they are not normally used except after removal and repair of the fan shaft assembly. The condenser and evaporator end oil seals should be checked during the pre-trip inspection for oil leakage. If there is any sign of leakage, the fan shaft assembly should be removed and repaired.

NOTE: The fan shaft assembly requires a special lubricant, Thermo King P/N 203-278.

Fan Shaft Assembly Overhaul

Disassembly

1. Remove the fan shaft assembly from the unit. Remove both oil plugs and drain the oil from the housing.
2. After draining the oil from the housing, remove the four retaining bolts from the condenser end of the assembly.
3. To remove the shaft from the assembly, tap the opposite end of the shaft with a soft hammer. After the shaft has been removed, clean all parts in clean solvent.
4. Using a punch, remove the oil seal from the evaporator end of the assembly. With the seal removed, clean the housing in clean solvent.
5. Check the condition of the vent. If it is loose or damaged, it must be repaired or replaced.
6. After all the parts are cleaned, inspect the bearings and bearing races for wear or damage.
7. If necessary, remove the bearings by tapping them off the shaft with a hammer and a punch. Be careful not to damage the shaft with the punch.
8. The bearing races can now be driven out with a punch and replaced in the same manner.



1.	Cap and Shims	6.	Oil Seal
2.	Oil Plug Screw (Use Oil P/N 203-278)	7.	Shaft
3.	Breather Vent	8.	Sleeve
4.	Housing	9.	Pin
5.	Roller Bearing	10.	O-ring

Figure 65: Fan Shaft Assembly

Reassembly

1. Tap the new bearings on the shaft with a pipe.
2. Install new oil seals after replacing the bearing races.
3. Replace the shaft in the housing. Install a new seal in the retainer cap. Use the original shims and replace the O-ring if needed.
4. Install the retainer cap assembly over the shaft, then install the bolts.
5. Torque the bolts in a criss-cross pattern in equal steps to 80 in-lb (9.04 N•m).
6. Lock the assembly in a vise and set up a dial indicator to read end-play. To measure the end-play, rotate the shaft while pushing in one direction and set the dial indicator to '0'. Now rotate the shaft and pull in the opposite direction while reading the dial indicator. End-play should be 0.001 to 0.005 in. (0.025 to 0.127 mm). If end-play is incorrect, use different shims to obtain correct end-play.

Shims available from the Service Parts Department	
0.020 in. (0.500 mm)	Thermo King P/N 99-4231
0.007 in. (0.177 mm)	Thermo King P/N 99-2902
0.005 in. (0.127 mm)	Thermo King P/N 99-2901

7. After correct end-play is obtained, add oil for the bearings.
8. Lock the assembly in a vise with the vent facing up. Pour the oil (P/N 203-278) through the top plug until it runs out of the side hole. The assembly holds 2.2 oz (65 ml). Check the condition of the O-ring used on the plugs and replace if necessary. Install the top and side plugs. Clean up any spillage.
9. Place the assembly on the workbench with the vent up. Rotate the shaft by hand. The shaft should be free enough to rotate without having to hold the housing.

CAUTION: When installing the fan shaft assembly, make sure that the vent is mounted facing up.

Idler Assembly

The unit is equipped with a one-piece idler assembly that contains tapered roller bearings in a sealed oil reservoir. This assembly does not require any maintenance. There is a level plug and a fill plug, but they are not normally used except after removal and repair of the idler assembly. The roadside end oil seal and the curbside end oil seal should be checked during the pre-trip inspection for oil leakage. If there is any sign of leakage, the idler assembly should be removed and repaired.

Idler Assembly Overhaul

Disassembly

1. Remove the idler assembly from the unit. Remove both oil plugs and drain the oil from the housing.
2. After draining the oil from the housing, remove the four retaining bolts from the curbside end of the assembly.
3. To remove the shaft from the assembly, tap the opposite end of the shaft with a soft hammer. After the shaft has been removed, clean all the parts in clean solvent.
4. Using a punch, remove the oil seal from the curbside end of the assembly. With the seal removed, clean the housing in solvent.
5. Check the condition of the vent. If it is loose or damaged, it must be repaired or replaced.
6. After all the parts are cleaned, inspect the bearings and bearing races for wear or damage.
7. To replace the bearings, first drive bearing off shaft with a punch at notch in the base of the shaft.

Reassembly

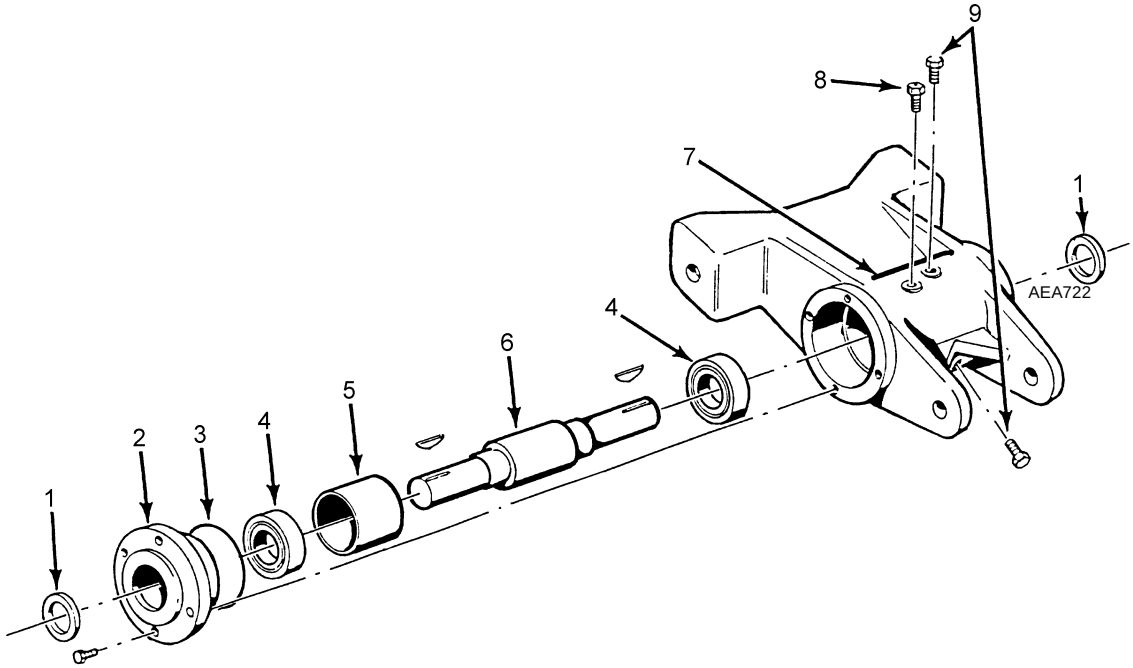
1. Install the new bearings on the shaft with a pipe. Place the pipe over the shaft and drive bearing down. Turn the shaft upside down, and use the pipe to drive the other bearing down.
2. Install a new oil seal on the curbside end of the assembly after replacing the bearing race and splash guard.

3. Replace the shaft in the housing. Install a new seal in the retainer cap. Use the original shims and replace the O-ring if needed.
4. Install the retainer cap assembly over the shaft, then install the bolts.
5. Torque the bolts in a criss-cross pattern in equal steps to 80 in-lb (9.04 N•m).
6. Lock the assembly in a vise and set up a dial indicator to read end-play. To measure the end-play, rotate the shaft while pushing in one direction, and set the dial indicator to '0'. Now rotate the shaft and pull in the opposite direction while reading the dial indicator. End-play should be 0.001 to 0.005 in. (0.025 to 0.127 mm). If end-play is incorrect, use different shims to obtain correct end-play.

Shims available from the Service Parts Department	
0.020 in. (0.500 mm)	Thermo King P/N 99-4231
0.007 in. (0.177 mm)	Thermo King P/N 99-2902
0.005 in. (0.127 mm)	Thermo King P/N 99-2901

7. After the correct end-play is obtained, add approximately 1.5 oz (44 ml) of oil for the bearings.
8. Lock the assembly in a vise with the vent facing up. Pour the oil through the top plug until it runs out of the side hole. Check the condition of the O-ring used on the plugs and replace if necessary. Install the top and side plugs. Clean up any spillage.
9. Place the assembly on the workbench with the vent up. Rotate the shaft by hand. The shaft should be free enough to rotate without having to hold the housing.

CAUTION: Reinstall the assembly into the unit, making sure the vent is mounted facing up.



1.	Oil Seal	6.	Shaft
2.	Cap and Shims	7.	Housing
3.	O-ring	8.	Breather Vent
4.	Roller Bearing	9.	Oil Plug Screw (Use Oil P/N 203-278)
5.	Splash Guard Tube		

Figure 66: Idler Assembly

Mechanical Diagnosis

Condition	Possible Cause	Remedy
Engine will not crank	Electrical problem	Check and repair electrical system
	Defective starter solenoid	Replace solenoid
	Defective starter	Repair starter
	Water in cylinders	Check for hydrostatic lock. Remove injectors and turn engine slowly
Starter motor turns but engine does not crank	Starter clutch defective	Replace
Engine cranks but fails to start	Fuel solenoid not energized	Check 8D and 8DP circuits and fuel solenoid pull-in relay. Check that YAN = YES in Super Guarded Access. Refer to appropriate Microprocessor Diagnostic Manual.
	Fuel solenoid defective or stuck	Replace
	Fuel injection pump defective	Replace pump
	Air heater defective	Replace
	No fuel or wrong fuel	Fill with proper fuel
	Fuel pump defective	Replace pump
	Air in fuel system	Bleed air
	Compression low	Overhaul engine
	Injection nozzles defective	Replace nozzles
	Incorrect timing	Adjust timing
	Air cleaner clogged	Replace air filter
	Exhaust plugged	Clean exhaust
	Defective HPCO	Replace HPCO
Engine stops after starting	Air in injection pump	Bleed fuel system
	Fuel filter obstructed	Replace filter element
	High head pressure	Eliminate cause of high head pressure
	Vent of fuel tank obstructed	Unclog vent
	Clogged fuel tank or fuel lines	Clean fuel tank and fuel lines

Condition	Possible Cause	Remedy
Engine does not develop full power	Air intake system clogged	Clean air intake system
	Fuel tank vent clogged	Unclog vent
	Clogged fuel tank or fuel lines	Clean fuel tank and fuel lines
	Speed adjustment wrong	Adjust speed
	Insufficient fuel volume leaving filter	Check for dirty filter or air in system
	Air cleaner clogged	Replace air filter
	Delivery of fuel pump insufficient	Repair pump
	Injection pump timing off	Adjusting timing
	Nozzles defective	Repair or replace nozzles
	Compression low or unbalanced	Overhaul engine
	Worn injection pump plungers, delivery valve defective, injection rate too low, gum formations	Repair or replace pump
Engine speed too high	Misadjusted high speed solenoid	Adjust high speed solenoid
	Defective injection pump	Repair injection pump
Engine fails to stop when unit is OFF	Fuel solenoid defective	Replace
	Injection pump defective	Replace pump
Engine knocks heavily	Air in system	Bleed fuel system
	Injection pump not timed	Retime injection pump
	Wrong fuel	Change fuel
	Compression too low	Overhaul engine
	Injection nozzles fouled or opening pressure too low	Clean, repair or replace injection nozzles
	Delivery valve spring broken	Replace spring or repair injection pump
	Valve out of adjustment	Adjust valves
	Fuel return line plugged	Remove return line restriction
	Rod or main bearing worn	Replace rod or main bearings

Condition	Possible Cause	Remedy
Engine runs hot	Dirty radiator	Wash radiator
	Coolant level is low	Add coolant
	Cooling system heavily scaled	Cleaning cooling system
	Cylinder head gasket leaks	Replace cylinder head gasket. Use correct gasket
	Faulty thermostat	Check or replace thermostat
	Loose or worn water pump belt	Replace belt
Oil pressure low	Insufficient oil in pan	Add oil
	Faulty oil pressure switch	Check oil pressure switch. Replace if necessary
	Oil control valve defective	Check oil pressure control valve
	Worn oil pump, camshaft, main or connecting rod bearings, loose oil gallery plug	Repair engine
High oil consumption	Oil leakage	Check and eliminate possible causes at rocker arm cover, oil lines, oil filter, front timing cover or crankshaft seals
	Damaged valve seals	Replace seals on valve stem
	Worn valve stem	Replace valves
	Broken piston rings or cylinder bore worn or scored	Have engine repaired and rebored. Replace broken piston rings
	Clogged air cleaner system	Unclog air cleaner

Engine Emits Excessive Smoke

WHITE SMOKE

Fuel is not burning

- Air or water in fuel
- Incorrect timing
- Poor compression
- Faulty injectors

BLACK SMOKE

Excessive Fuel to Air Ratio

- Type of fuel used
- Cold engine
- Excessive load
- Clogged air intake system
- Faulty nozzles
- Poor compression
- Restricted exhaust
- Faulty injection pump

BLUE SMOKE

Oil Consumption

- Poor compression
- Defective valve seals

Electric Standby Diagnosis

Condition	Possible Cause	Remedy
Unit switch OFF—LCD Blank	Battery discharged	Charge or replace battery
	Faulty battery cable connections	Clean battery cables
	Fuse link blown	Check for short circuit and replace fuse link
	Fuse F12 blown	Check for short circuits and replace fuse
	Microprocessor switch turned OFF	Check switch
	Open circuit	Check 2, 2P, 2PS, and 2PA circuits
Unit switch ON—LCD backlight does not come on	Faulty On/Off switch	Check On/Off switch
	Fuse F21 blown	Check for short circuit and replace fuse
	Open circuit	Check 2A, 2AA, 8, and 8F circuits
Unit switch ON and LCD backlight ON but motor will not start and run	Diesel/Electric switch on DIESEL	Place switch on ELECTRIC
	Unit in NULL	Check setpoint and box temperature
	Faulty Diesel/Electric switch	Check switch
	Faulty K7 relay	Check K7 relay
	Fuse F4 or F16 blown	Check for short circuit and replace fuse
	Faulty HPCO	Check HPCO
	Open or faulty overload relay	Determine cause and rest or replace overload relay
	Faulty PSM	Check PSM
	Faulty motor contactor	Check motor contactors
	Open circuit	Check 8F, 7K, 7ES, 7E, 7EA, 7EH, 7EB, 7EC, CH, L1, L2, and L3 circuits
	Faulty drive motor	Check drive motor
	Faulty electric standby power source	Check electric standby power source
Evaporator heaters do not heat	Fuse F1 blown	Check for short circuit and replace fuse
	Faulty heater contactor	Check heater contactor
	Open circuit	Check 7EH, 26E, L1, L2, L3, BRN, BLU and BLK circuits
	Faulty heaters	Check heaters

Refrigeration Diagnosis

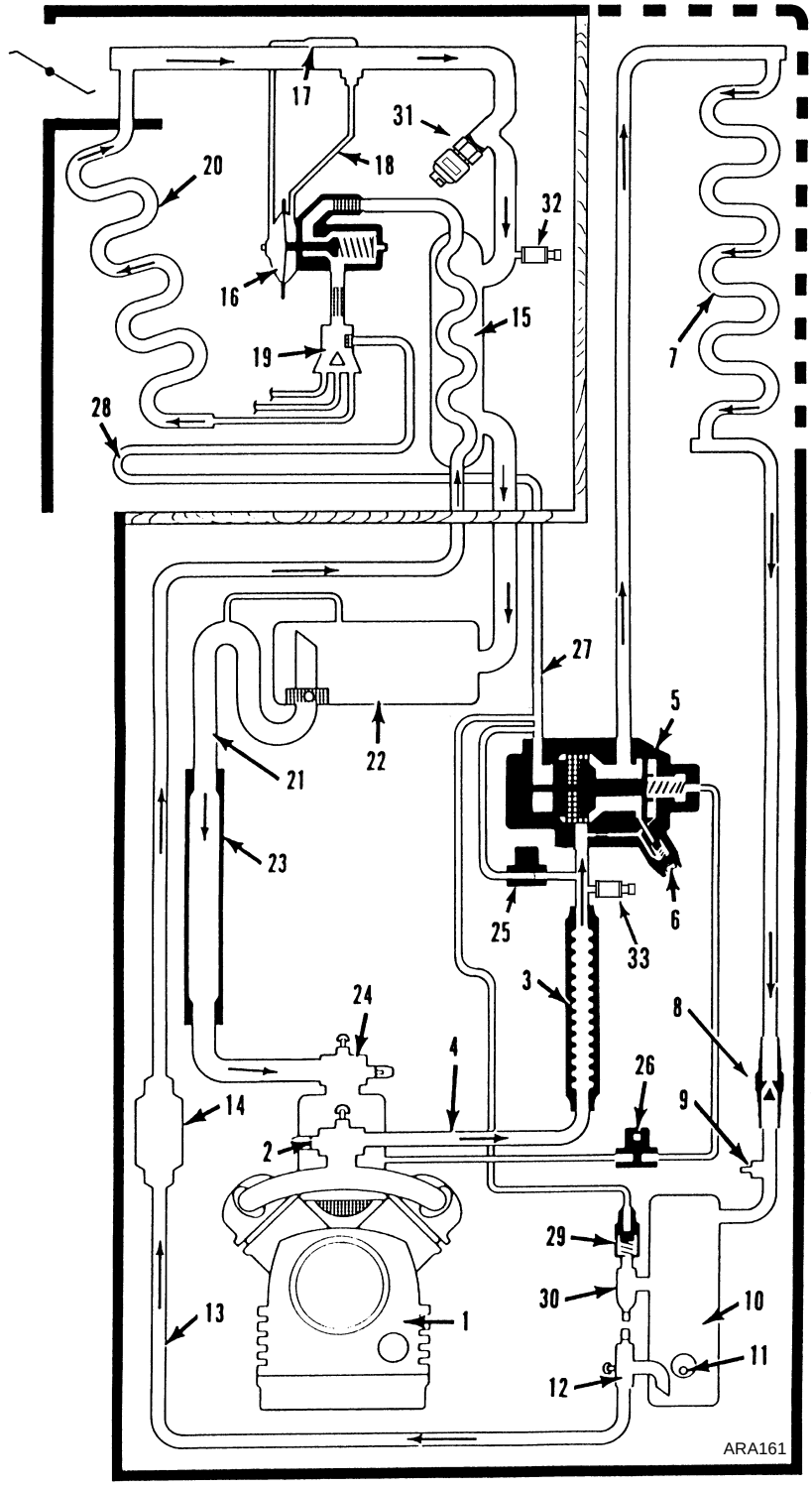
Rapid cycling between cool and heat	Unit cools in heat and defrost cycle	Unit heats in refrigeration cycle	High head pressure	Low head pressure	High suction pressure	Low suction pressure	No suction pressure	Unit operating in a vacuum	Receiver sight glass empty	Suction line frosting back	Unable to pump 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
					•						•						Compressor suction valves leaking
															•		Too much compressor oil in system
														•			Faulty oil pump in compressor
														•			Faulty compressor drive coupling
														•			Compressor bearing loose or burned out
				•							•	•	•	•			Broken valve plate in compressor
						•									•		Expansion valve power element lost its charge
					•					•							Expansion valve feeler bulb improperly mounted
					•					•					•		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
																•	Defrost damper stays open
						•		•							•		Defrost damper stuck closed
							•										Suction service valve back seated
	•	•		•	•						•		•		•	•	Faulty three-way valve
	•	•									•				•	•	Faulty pilot solenoid

Rapid cycling between cool and heat	Unit cools in heat and defrost cycle	Unit heats in refrigeration cycle	High head pressure	Low 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**
	•															•	Loose or broken electrical connections
•					•	•		•							•		Sensor out of calibration
					•	•	•	•									Compound pressure gauge out of calibration
											•						Leaky receiver tank outlet valve
											•						Leaky bypass check valve
																•	Leaky condenser check valve
																•	Faulty three-way condenser pressure bypass check valve
						•	•	•							•	•	Faulty ETV
				•	•						•				•	•	Hot gas bypass valve stuck open or leaking

Refrigeration Diagrams

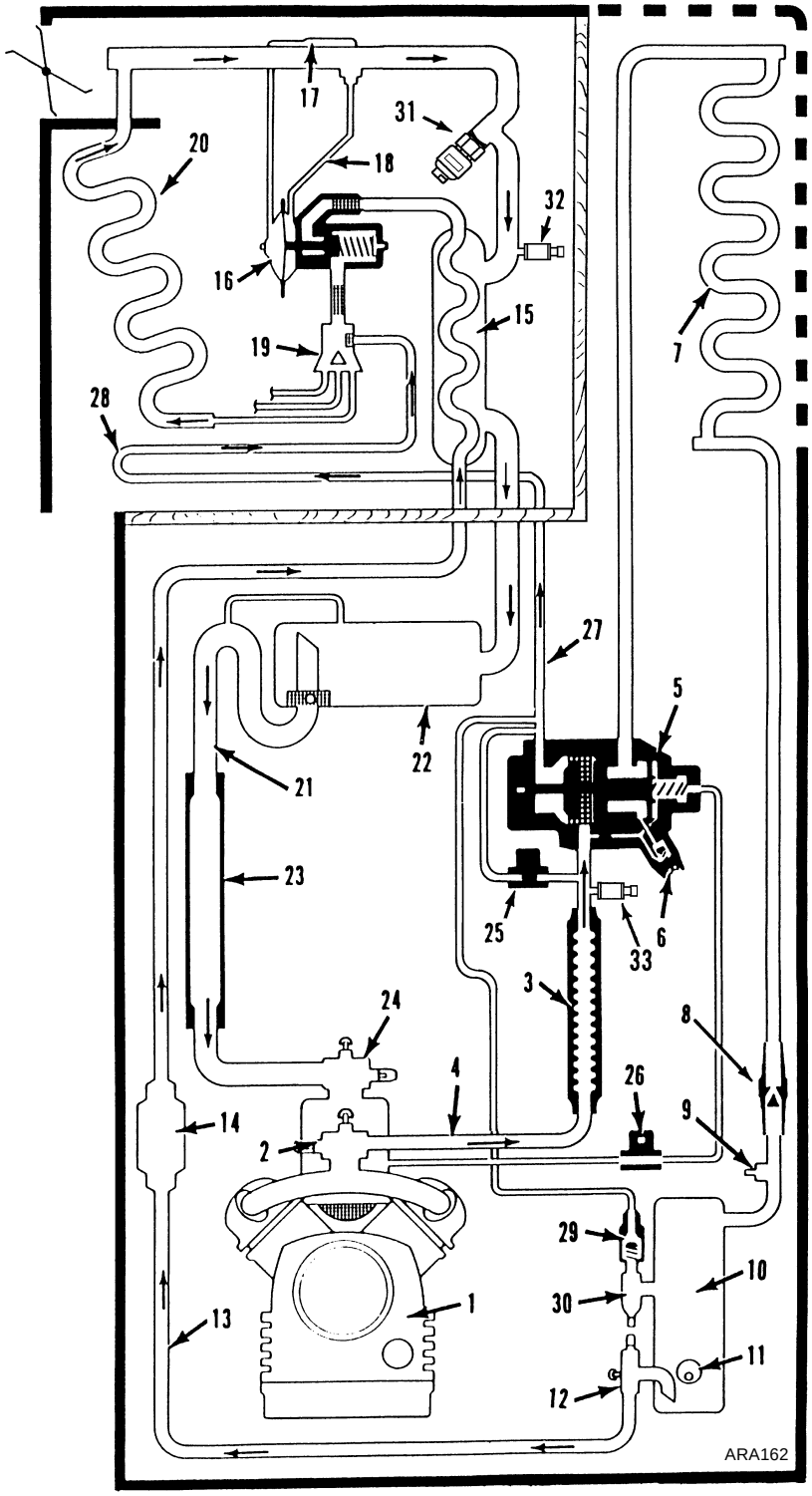
Cool Cycle

1.	Compressor
2.	Discharge Service Valve
3.	Discharge Vibrasorber
4.	Discharge Line
5.	Three-way Valve
6.	Three-way Valve Bypass Check Valve
7.	Condenser Coil
8.	Condenser Check Valve
9.	High Pressure Relief Valve
10.	Receiver Tank
11.	Sight Glass
12.	Receiver Outlet Valve
13.	Liquid Line
14.	Drier
15.	Heat Exchanger
16.	Expansion Valve
17.	Feeler Bulb
18.	Equalizer Line
19.	Distributor
20.	Evaporator Coil
21.	Suction Line
22.	Accumulator
23.	Suction Vibrasorber
24.	Suction Service Valve
25.	Hot Gas Bypass Valve
26.	Pilot Solenoid
27.	Hot Gas Line
28.	Defrost Pan Heater
29.	Bypass Check Valve
30.	Bypass Service Valve
31.	Electronic Throttling Valve
32.	Suction Transducer
33.	Discharge Transducer



Heat/Defrost Cycle

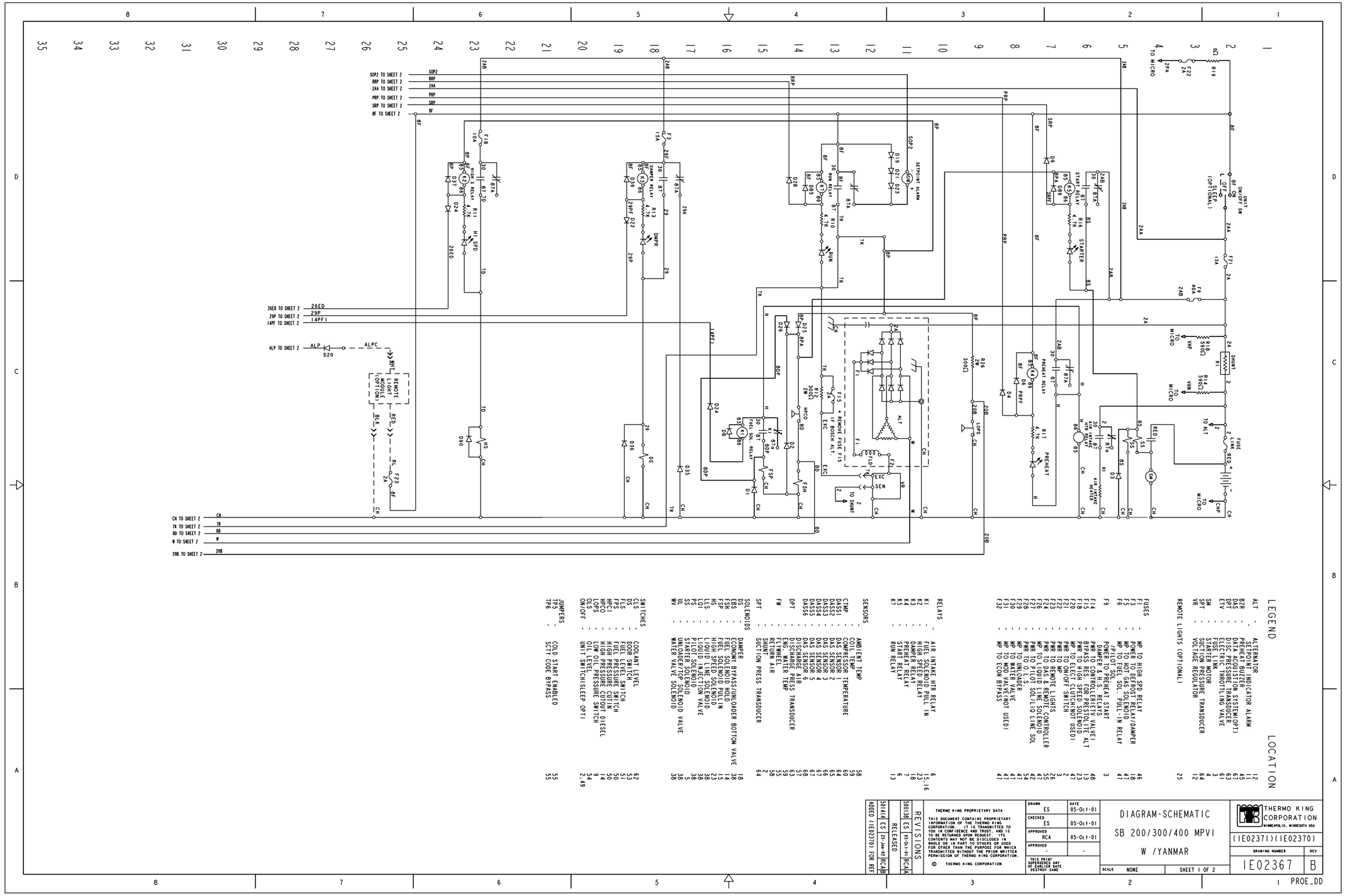
1.	Compressor
2.	Discharge Service Valve
3.	Discharge Vibrasorber
4.	Discharge Line
5.	Three-way Valve
6.	Three-way Valve Bypass Check Valve
7.	Condenser Coil
8.	Condenser Check Valve
9.	High Pressure Relief Valve
10.	Receiver Tank
11.	Sight Glass
12.	Receiver Outlet Valve
13.	Liquid Line
14.	Drier
15.	Heat Exchanger
16.	Expansion Valve
17.	Feeler Bulb
18.	Equalizer Line
19.	Distributor
20.	Evaporator Coil
21.	Suction Line
22.	Accumulator
23.	Suction Vibrasorber
24.	Suction Service Valve
25.	Hot Gas Bypass Valve
26.	Pilot Solenoid
27.	Hot Gas Line
28.	Defrost Pan Heater
29.	Bypass Check Valve
30.	Bypass Service Valve
31.	Electronic Throttling Valve
32.	Suction Transducer
33.	Discharge Transducer



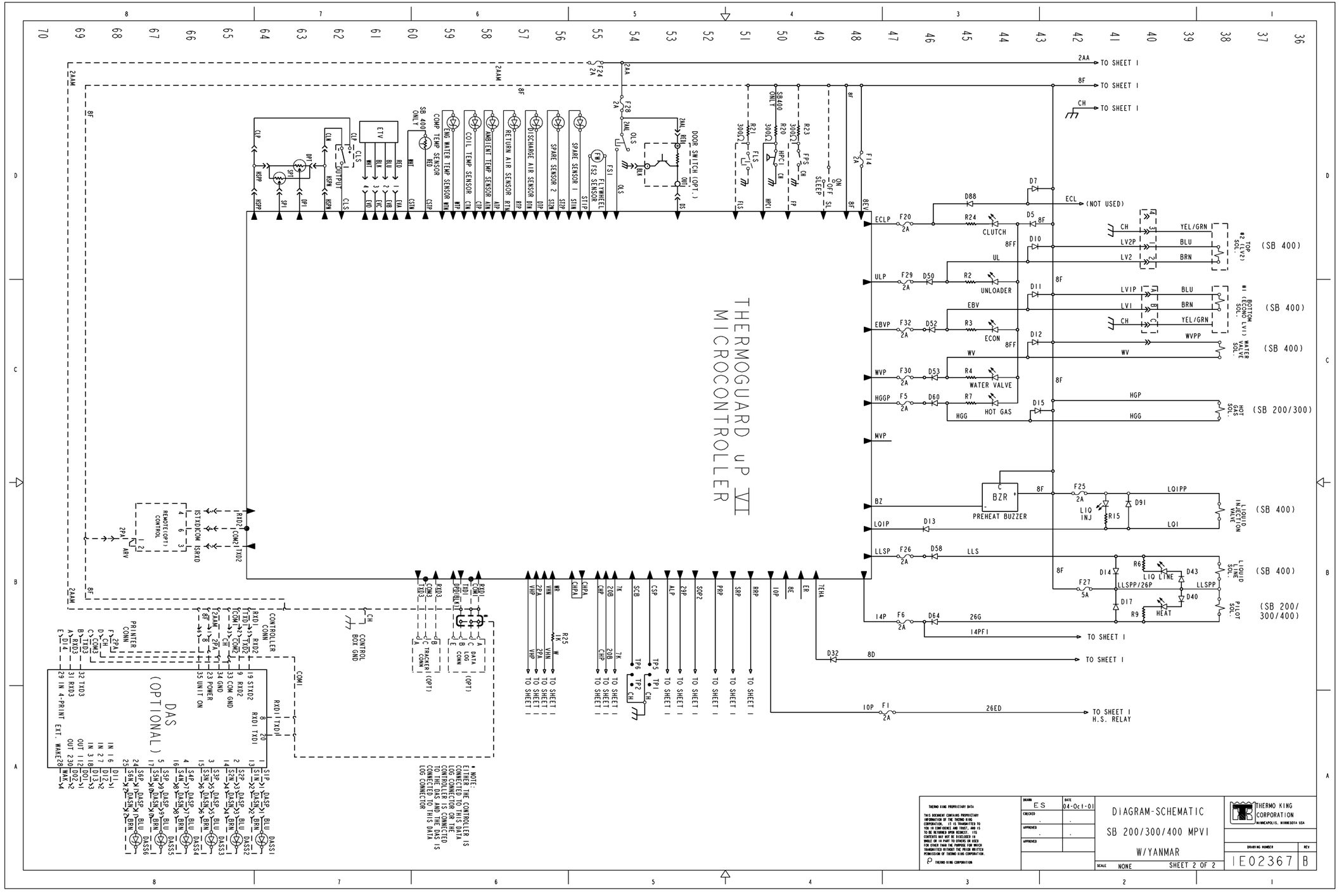
Index

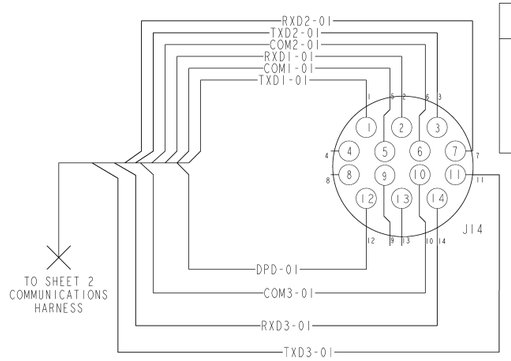
Wiring Diagram Index

Model 30 Schematic Diagram — Page 1 of 2



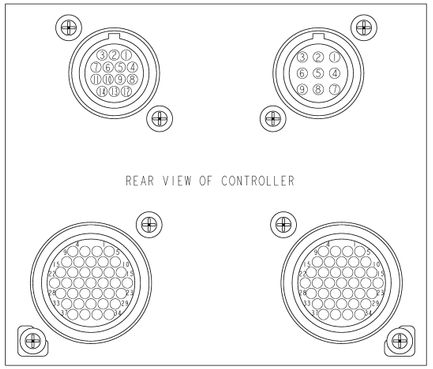
Model 30 Schematic Diagram — Page 2 of 2

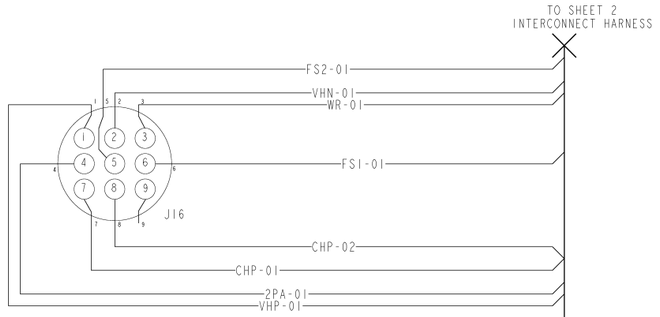


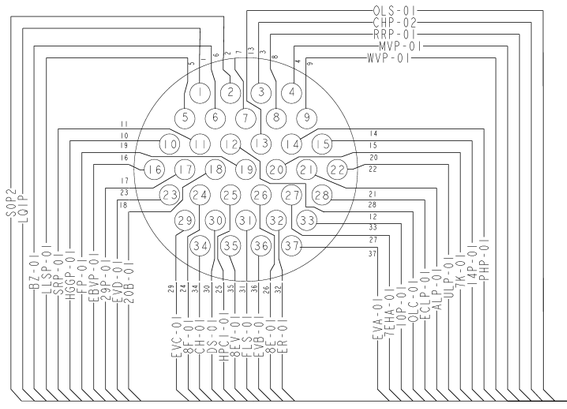


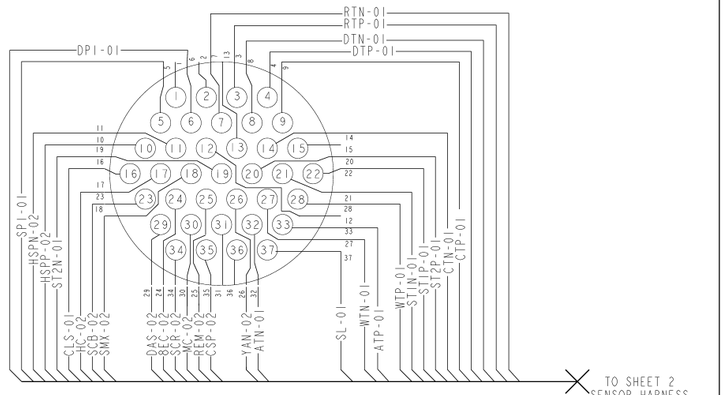
14 PIN CONNECTOR COMMUNICATION HARNESS			
1 - TXD1		8 - NOT USED	
2 - RXD1		9 - KEYING PIN	
3 - TXD2		10 - COM3	
4 - NOT USED		11 - TXD3	
5 - COM1		12 - DPD	
6 - COM2		13 - NOT USED	
7 - RXD2		14 - RXD3	

9 PIN CONNECTOR INTERCONNECT HARNESS
1 - VHP
2 - VHN
3 - WR
4 - 2PA
5 - FS2
6 - FS1
7 - CHP
8 - CHP
9 - KEYING PIN









37 PIN CONNECTOR INTERCONNECT HARNESS			
1 - LQIP	11 - SRP	21 - ALP	31 - FLS
2 - SOP2	12 - OLC	22 - ULP	32 - ER
3 - CHP	13 - OLS	23 - EVD	33 - IOP
4 - MVP	14 - PHP	24 - 8F	34 - CH
5 - LLSP	15 - 14P	25 - HPCI	35 - 8EV
6 - BZ	16 - EBVP	26 - 8E	36 - EVB
7 - KEYING PIN	17 - 29P	27 - 7EHA	37 - EVA
8 - RRP	18 - 20B	28 - ECLP	
9 - WVP	19 - FP	29 - EVC	
10 - HGGP	20 - 7K	30 - DS	

37 PIN CONNECTOR SENSOR HARNESS			
1 - NOT USED	11 - HSPN	21 - STIN	31 - NOT USED
2 - NOT USED	12 - NOT USED	22 - STIP	32 - ATN
3 - RTP	13 - NOT USED	23 - SCB	33 - ATP
4 - DTP	14 - CTN	24 - 8EC	34 - SCR
5 - SPI	15 - KEYING PIN	25 - REM	35 - CSP
6 - DPI	16 - CLS	26 - YAN	36 - NOT USED
7 - RTN	17 - HC	27 - WTN	37 - SL
8 - DTN	18 - SMX	28 - WTP	
9 - CTP	19 - ST2N	29 - DAS	
10 - HSPP	20 - ST2P	30 - MC	

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DIAGRAM - WIRING

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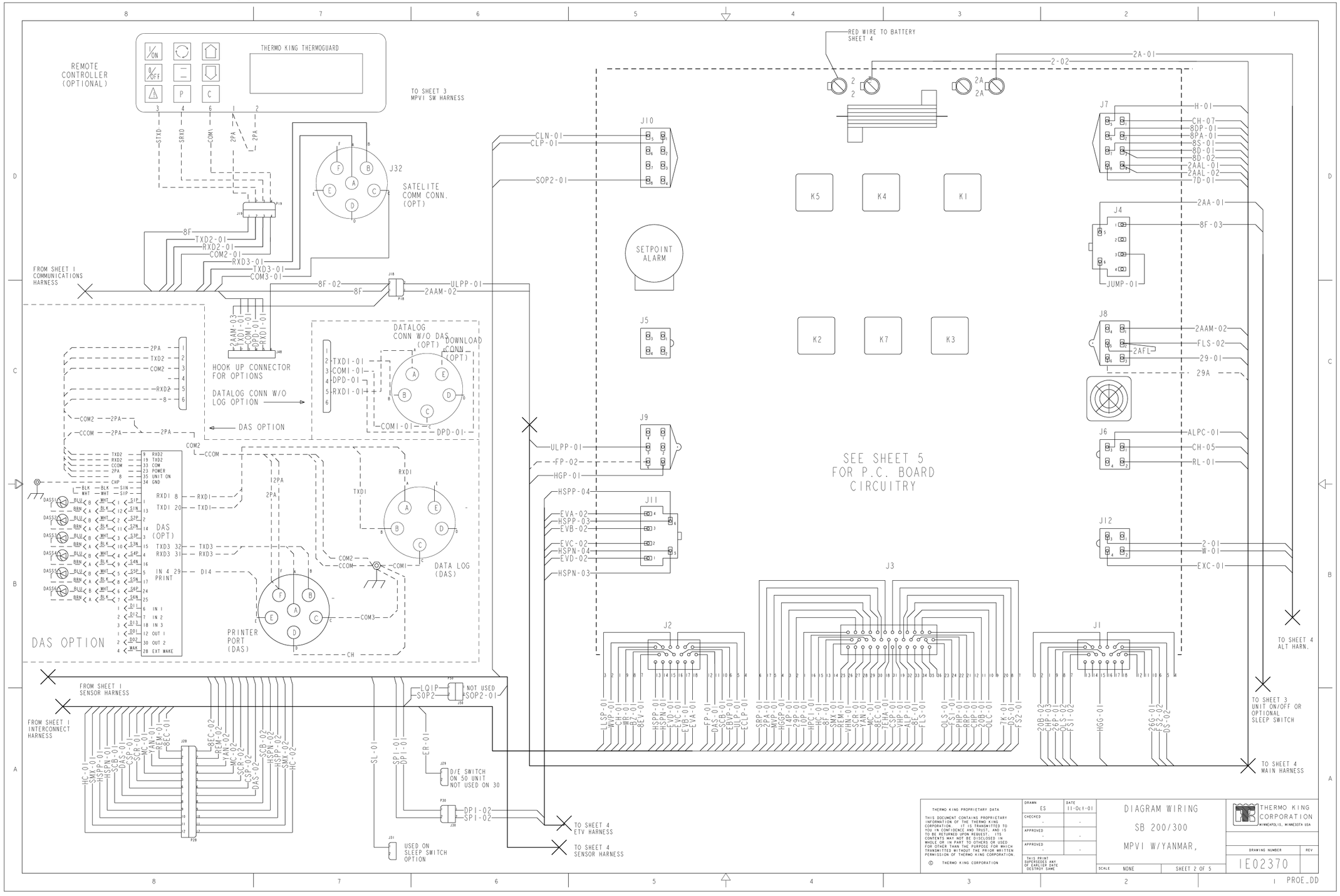
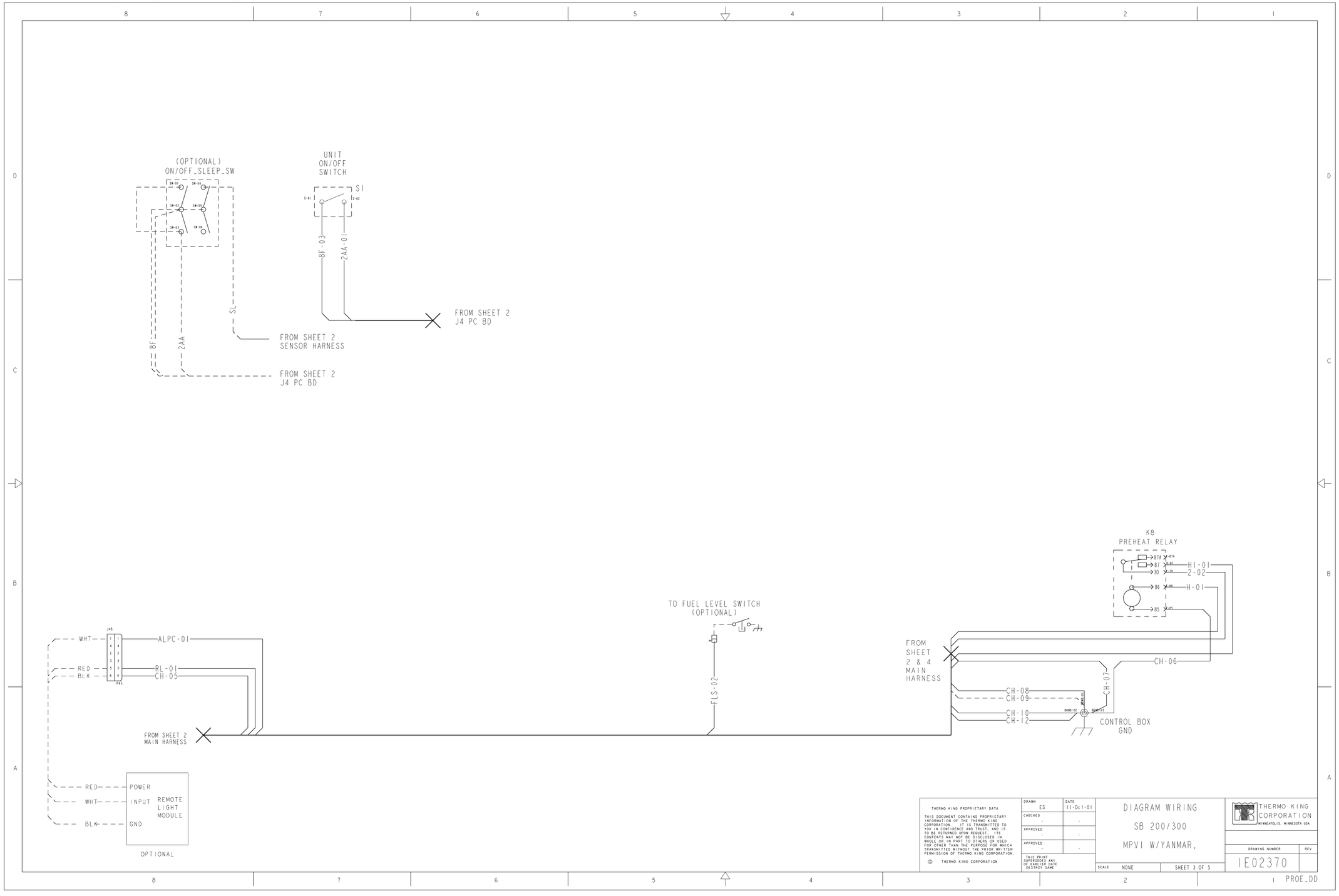
Model 30 Wiring Diagram — Page 2 of 5




(OPTIONAL)
ON/OFF_SLEEP_SW
UNIT
ON/OFF
SWITCH
S1
8F-03
2AA-01
SL
FROM SHEET 2
J4 PC BD
FROM SHEET 2
SENSOR HARNESS
8F
2AA
FROM SHEET 2
J4 PC BD
K8
PREHEAT RELAY
87A
87
30
86
85
H1-01
2-02
H-01
TO FUEL LEVEL SWITCH
(OPTIONAL)
FLS-02
FROM
SHEET
2 & 4
MAIN
HARNESS
CH-06
CH-07
CH-08
CH-09
CH-10
CH-12
BOND-02
CONTROL BOX
GND
J45
WHT
RED
BLK
ALPC-01
RL-01
CH-05
FROM SHEET 2
MAIN HARNESS
RED
WHT
BLK
POWER
INPUT
GND
REMOTE
LIGHT
MODULE
OPTIONAL
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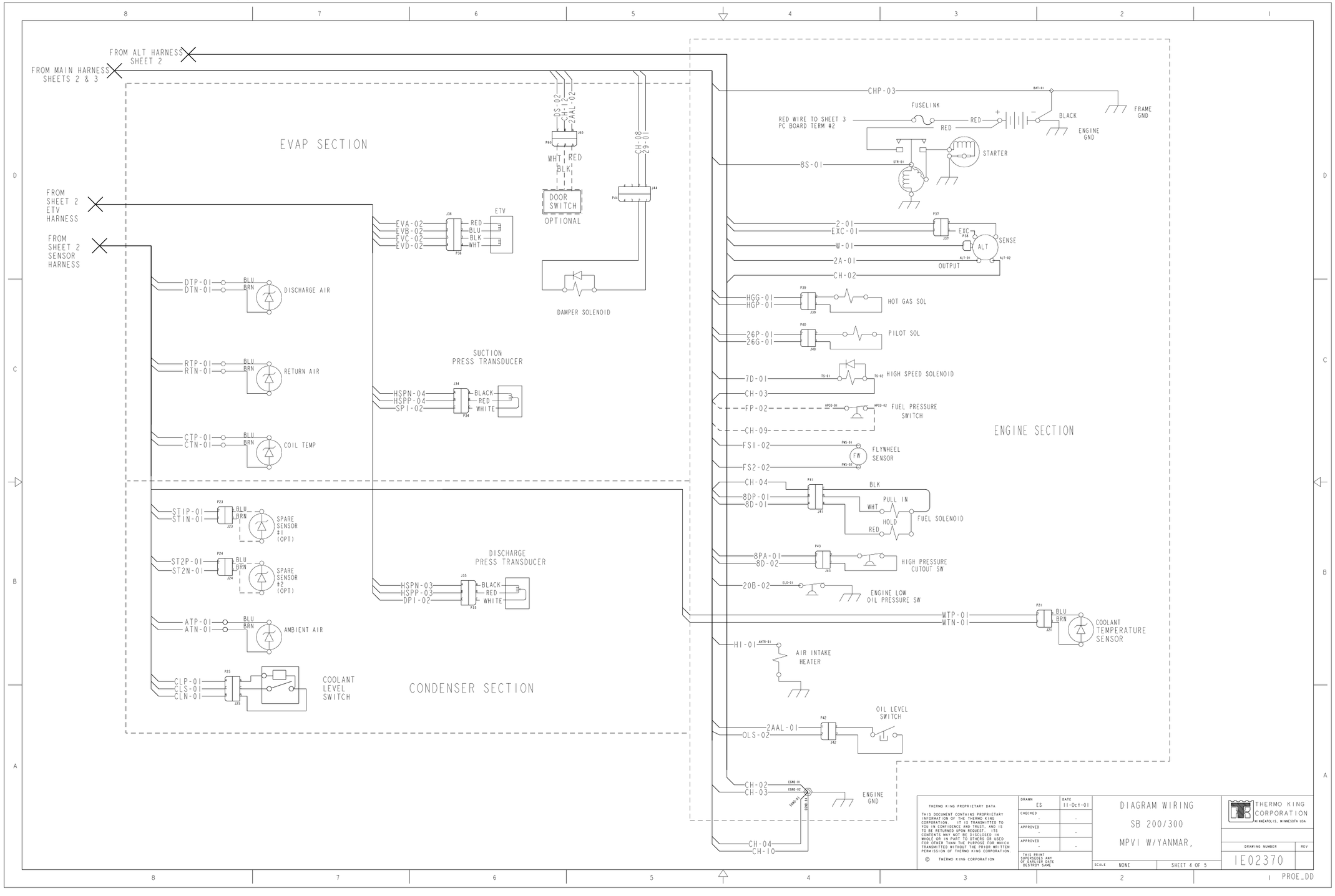
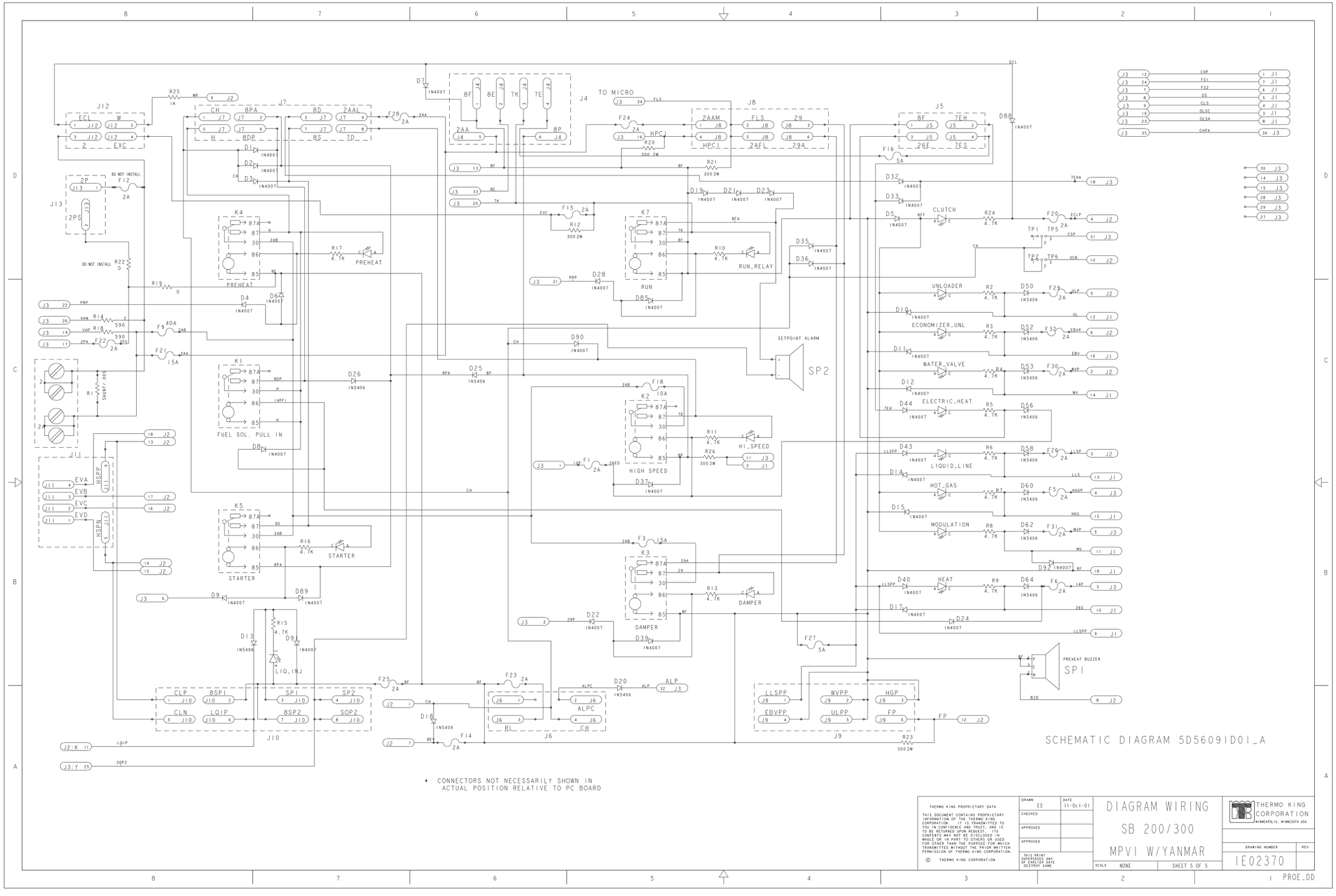
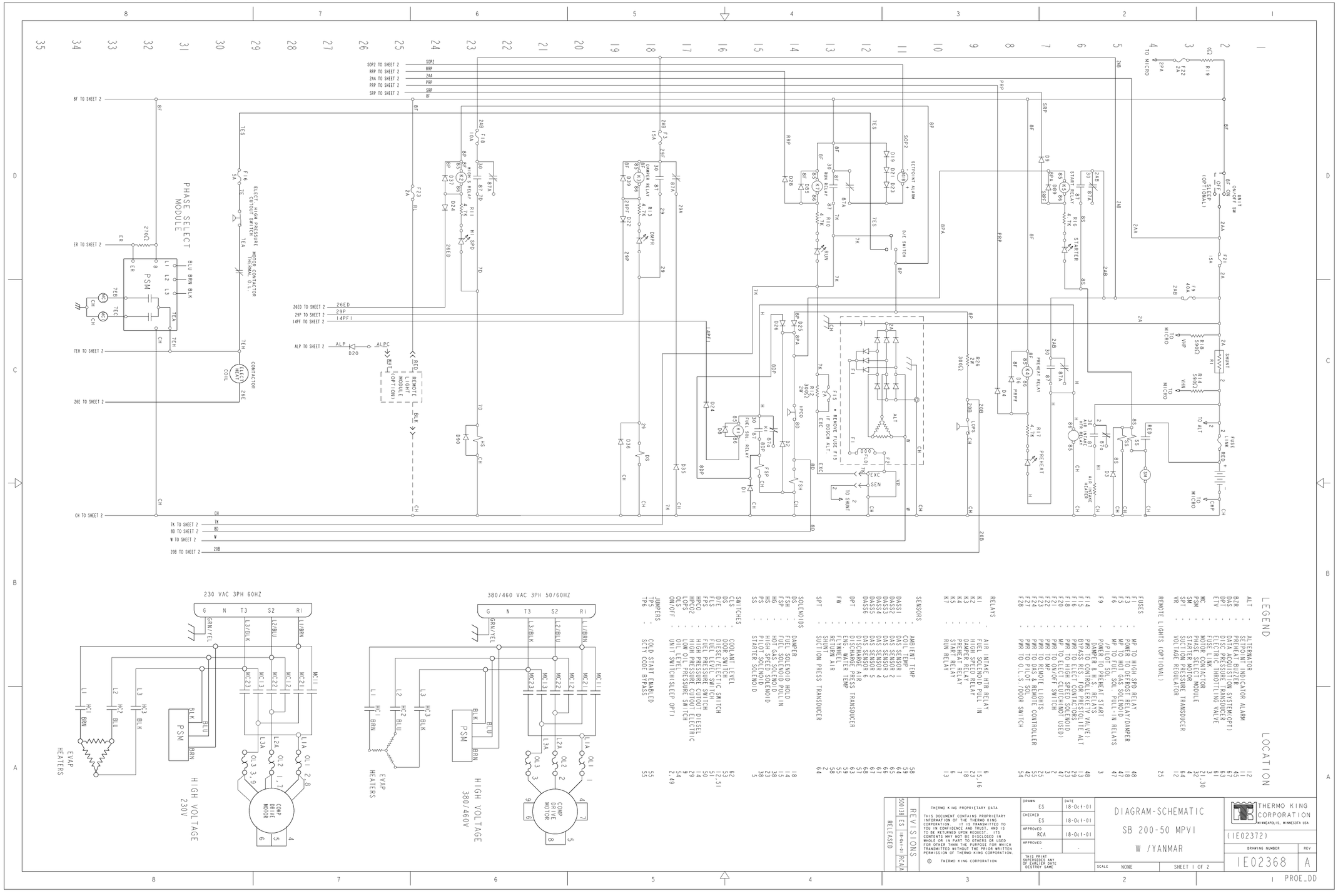
Model 30 Wiring Diagram — Page 4 of 5



Model 30 Wiring Diagram — Page 5 of 5



Model 50 Schematic Diagram — Page 1 of 2



LEGEND LOCATION

ALT	-	ALTERNATOR
BZR	-	SETPOINT INDICATOR ALARM
DAT	-	DISCHARGE AIR TEMPERATURE SYSTEM(OPT)
DPT	-	DISC PRESSURE TRANSDUCER
ETV	-	ELECTRIC THROTTLING VALVE
FUSES	-	
MC	-	MAIN CONTACTOR
PSM	-	PHASE SELECT MODULE
SM	-	STARTER MOTOR
SPT	-	SUCTION PRESSURE TRANSDUCER
VR	-	VOLTAGE REGULATOR
REMOTE LIGHTS (OPTIONAL)		
FUSES	-	
F1	-	MP TO HIGH SPD RELAY
F3	-	POWER TO DEFROST RELAY/DAMPER
F5	-	MP TO HOT GAS SOLENOID
F6	-	MP TO ETV SOL. PULL-IN RELAYS
F9	-	POWER TO PREHEAT START
F14	-	DAMPER & H.S. RELAYS
F15	-	BYPASS CONTROL (PRESTOLITE ALT
F16	-	PWR TO ELECT CONTACTORS
F18	-	PWR TO HIGH SPEED SOLENOID
F20	-	MP TO ELECT CLUTCH(NOT USED)
F22	-	PWR TO MP ON/OFF SWITCH
F23	-	PWR TO REMOTE LIGHTS
F24	-	PWR TO DAS & REMOTE CONTROLLER
F28	-	PWR TO O.L.'S /DOOR SWITCH
RELAYS	-	
K1	-	AIR INTAKE HTR RELAY
K2	-	FUEL SOLENOID PULL IN
K3	-	HIGH SPEED RELAY
K4	-	PREHEAT RELAY
K5	-	START RELAY
K7	-	RUN RELAY
SENSORS	-	
AMBIENT	-	AMBIENT TEMP
COMP	-	COMPARTMENT TEMP
DAS1	-	DAS SENSOR 1
DAS2	-	DAS SENSOR 2
DAS3	-	DAS SENSOR 3
DAS4	-	DAS SENSOR 4
DAS5	-	DAS SENSOR 5
DAS6	-	DAS SENSOR 6
DIS	-	DISCHARGE AIR
DPT	-	DISCHARGE AIR TRANSDUCER
ENG	-	ENGINE WATER TEMP
FW	-	FLYWHEEL
RET	-	RETURN AIR
SPT	-	SUCTION PRESS TRANSDUCER
SOLENOIDS	-	
DS	-	DAMPER
FSH	-	FUEL SOLENOID HOLD
FSP	-	FUEL SOLENOID PULL IN
HS	-	HIGH SPEED SOLENOID
PS	-	PILOT SOLENOID
SS	-	STARTER SOLENOID
SWITCHES	-	
CLS	-	COOLANT LEVEL
DS	-	DOOR SWITCH
D/E	-	DIESEL/ELECTRIC SWITCH
FPS	-	FUEL PRESSURE SWITCH
HPCO	-	HIGH PRESSURE CUTOUT DIESEL
HPCO2	-	HIGH PRESSURE CUTOUT ELECTRIC
OPS	-	OIL PRESSURE SWITCH
OLS	-	OIL LEVEL SWITCH
ON/OFF	-	ON/OFF SWITCH(SLEEP OPT)
JUMPERS	-	
TP1	-	COLD START ENABLED
TP2	-	SCTY CODE BYPASS

ALT	12
BZR	11
DAT	65
DPT	64
ETV	61
MC	63
PSM	62
SM	31, 30
SPT	4
VR	64
	12
	25
	48
	18
	47
	47
	3
	48
	13
	29
	23
	27
	3
	25
	55
	54
	6, 15, 16
	23
	7
	6
	13
	58
	64
	65
	66
	66
	66
	67
	68
	67
	59
	59
	58, 64
	18
	14
	38
	23
	38
	62
	53
	52, 51
	50
	14
	29
	54
	2, 49
	55
	55

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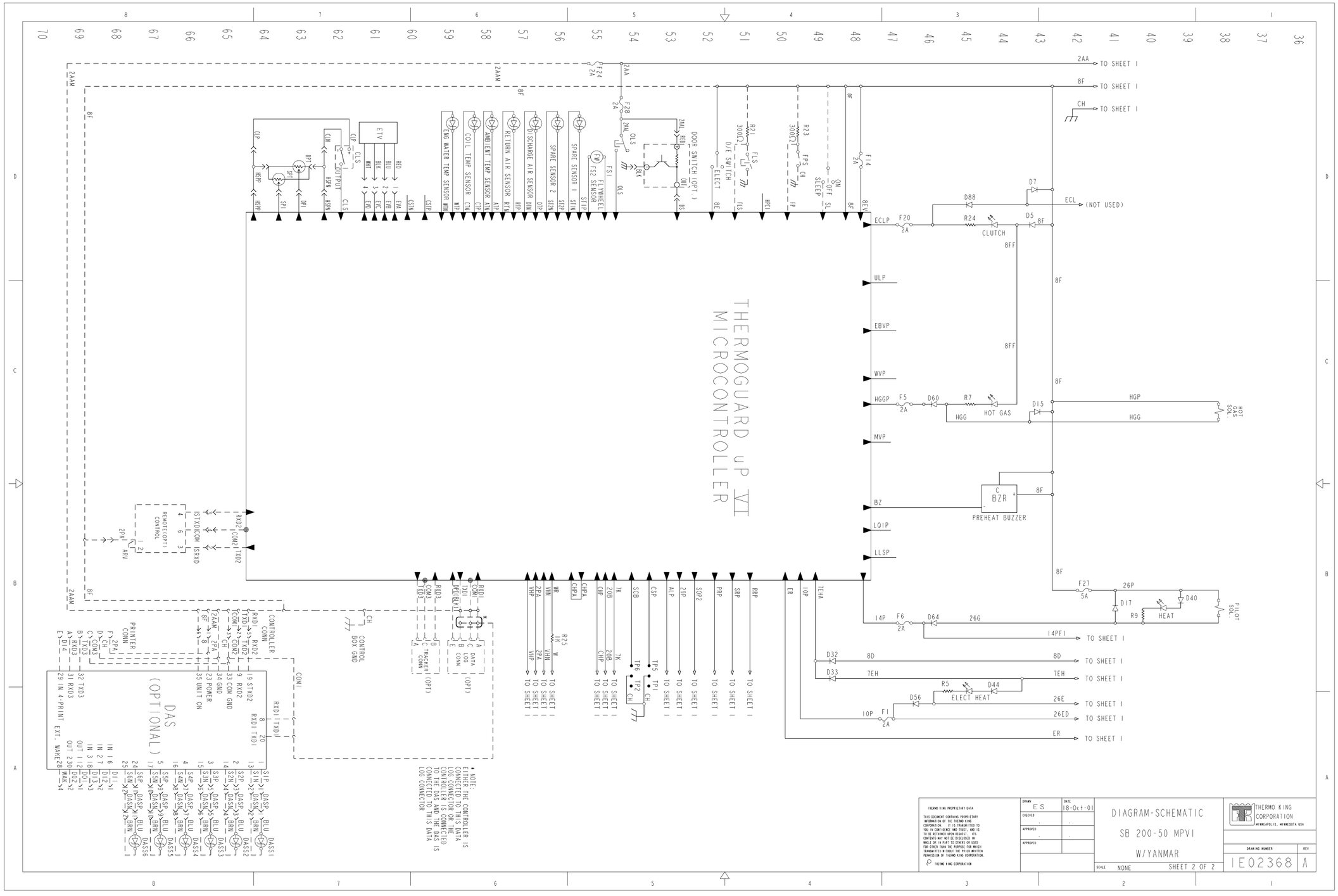
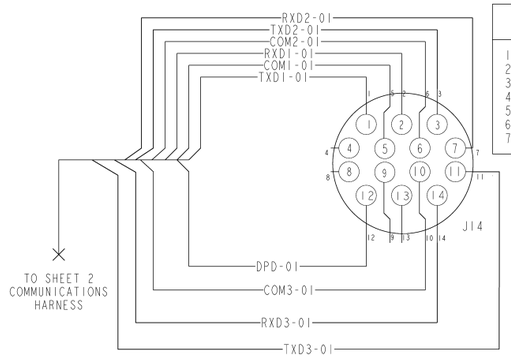
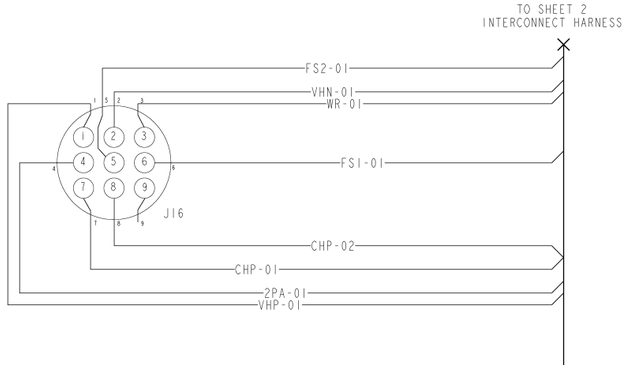
Model 50 Schematic Diagram — Page 2 of 2

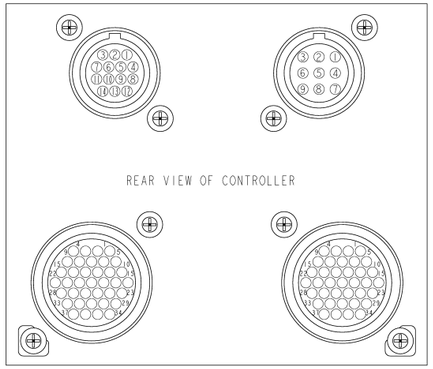


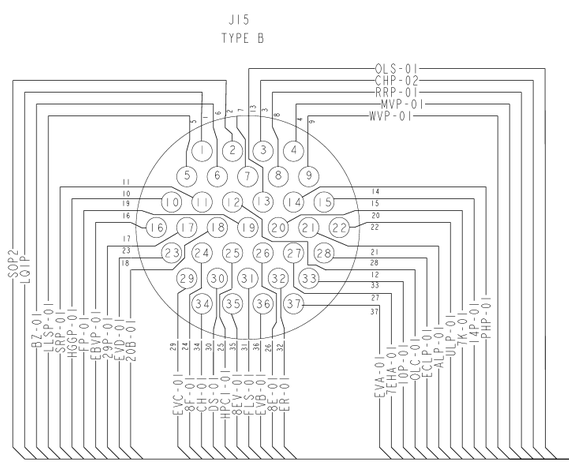


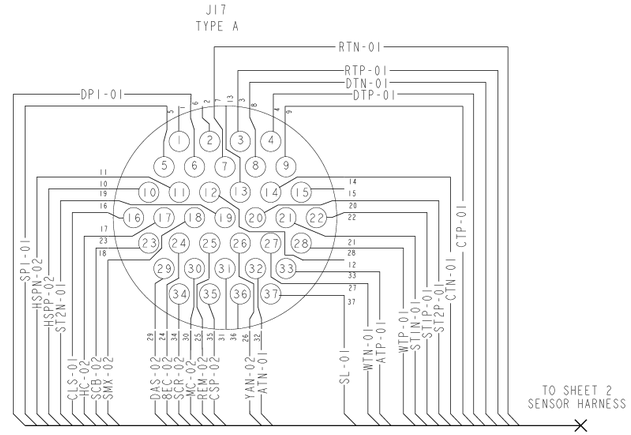
14 PIN CONNECTOR COMMUNICATION HARNESS			
1 - TXD1		8 - NOT USED	
2 - RXD1		9 - KEYING PIN	
3 - TXD2		10 - COM3	
4 - NOT USED		11 - TXD3	
5 - COM1		12 - DPD	
6 - COM2		13 - NOT USED	
7 - RXD2		14 - RXD3	

9 PIN CONNECTOR INTERCONNECT HARNESS
1 - VHP
2 - VHN
3 - WR
4 - 2PA
5 - FS2
6 - FSI
7 - CHP
8 - CHP
9 - KEYING PIN









37 PIN CONNECTOR INTERCONNECT HARNESS			
1 - LQIP	11 - SRP	21 - ALP	31 - FLS
2 - SOP2	12 - OLC	22 - ULP	32 - ER
3 - CHP	13 - OLS	23 - EVD	33 - IOP
4 - MVP	14 - PHP	24 - 8F	34 - CH
5 - LLSP	15 - I4P	25 - HPCI	35 - 8EV
6 - BZ	16 - EBVP	26 - 8E	36 - EVB
7 - KEYING PIN	17 - 29P	27 - 7EHA	37 - EVA
8 - RRP	18 - 20B	28 - ECLP	
9 - WVP	19 - FP	29 - EVC	
10 - HGGP	20 - 7K	30 - DS	

37 PIN CONNECTOR SENSOR HARNESS			
1 - NOT USED	11 - HSPN	21 - STIN	31 - NOT USED
2 - NOT USED	12 - NOT USED	22 - STIP	32 - ATN
3 - RTP	13 - NOT USED	23 - SCB	33 - ATP
4 - DTP	14 - CTN	24 - 8EC	34 - SCR
5 - SPI	15 - KEYING PIN	25 - REM	35 - CSP
6 - DPI	16 - CLS	26 - YAN	36 - NOT USED
7 - RTN	17 - HC	27 - WTN	37 - SL
8 - DTN	18 - SMX	28 - WTP	
9 - CTP	19 - ST2N	29 - DAS	
10 - HSPP	20 - ST2P	30 - MC	

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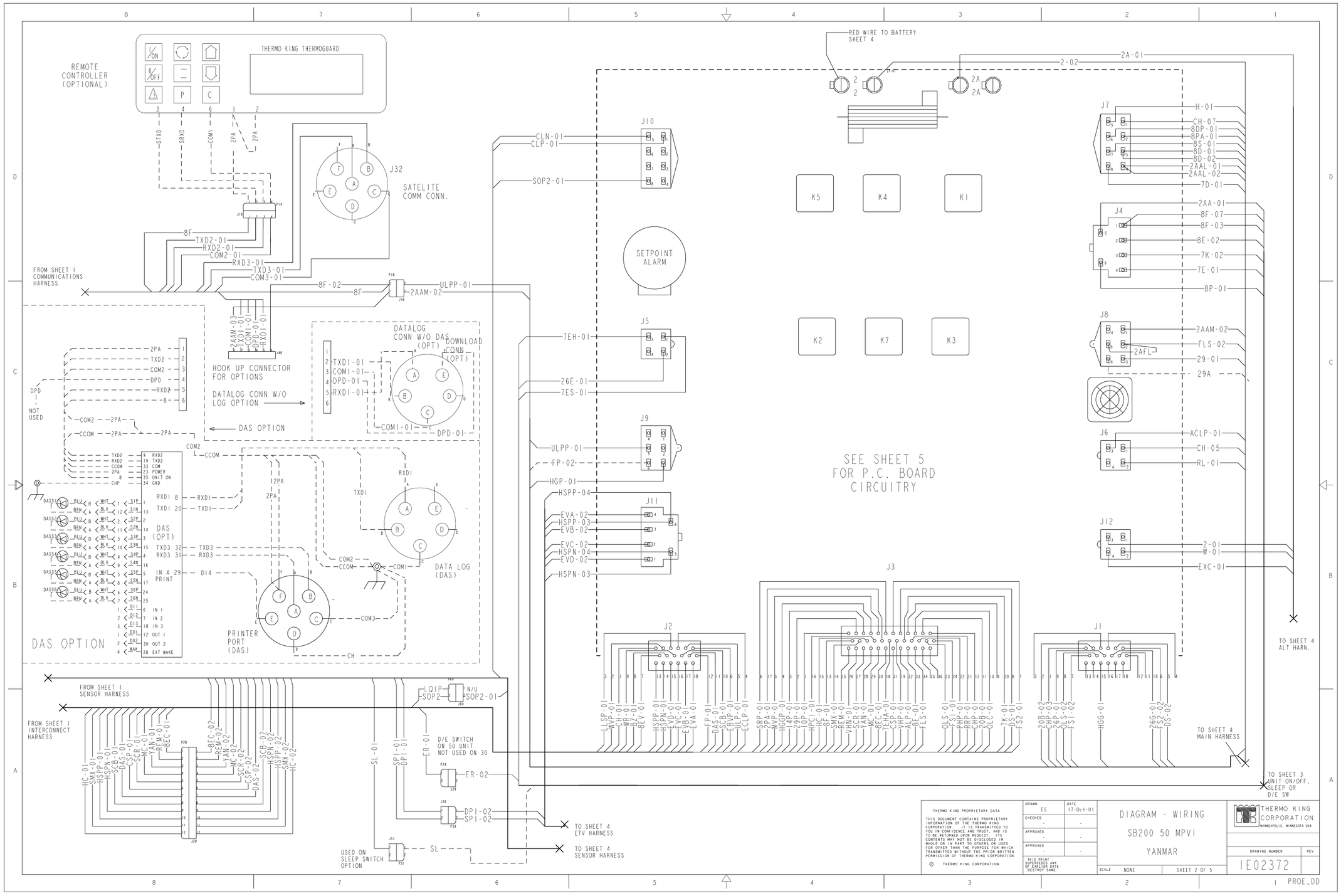
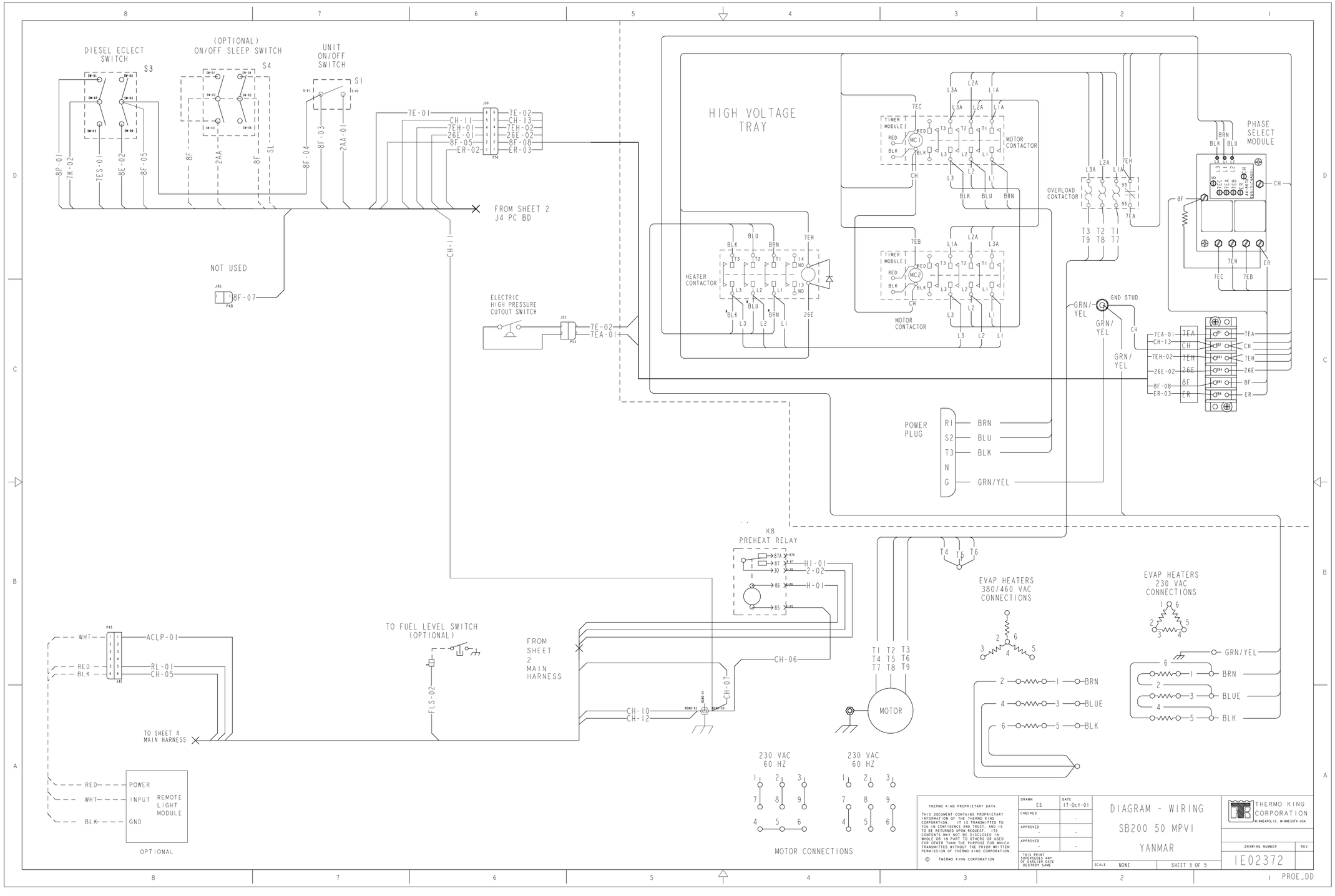
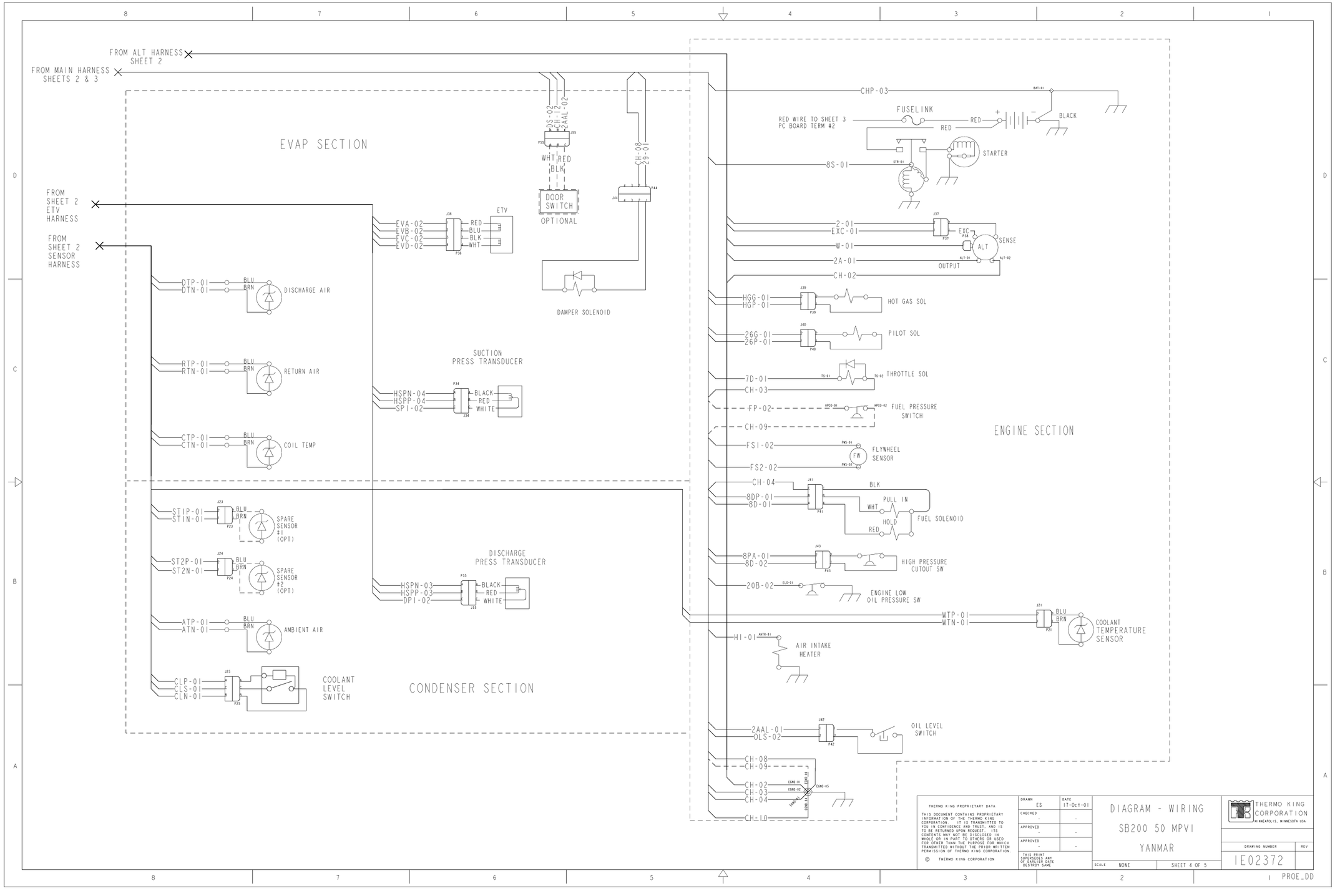


Model 50 Wiring Diagram — Page 3 of 5



Model 50 Wiring Diagram — Page 4 of 5



Model 50 Wiring Diagram — Page 5 of 5