Whisper

TK 50200-2-MM (Rev. 4, 04/02)

(For units with and without EMI 3000)

The maintenance information in this manual covers unit models:

SB-III 30 SR+ with TK486 Engine (048668)
SYSTEM SB-III 30 SR+ with TK486 Engine (915781)

For further information, refer to…

SB-III SR+ Whisper Edition Operator's Manual	**TK 50082**
SB-III Whisper Parts Manual	**TK 40991**
THERMOGUARD µP-V Microprocessor Controller Diagnosis Manual	**TK 50042**
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.

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.

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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.

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 qt. (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 104 F (-15 to 40 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	1425 to 1475 rpm
	High Speed Operation	2175 to 2225 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		11° to 13° 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 32). 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 qts (7.1 liters)

ENGINE (continued)

Radiator Cap Pressure	7 psi (48 kPa)
Drive	Direct to compressor; belts to fans, alternator and water pump

BELT TENSION	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

REFRIGERATION SYSTEM

Compressor	Thermo King X430
Refrigerant Charge—Type	13 lb (5.9 kg)—R-404A
Compressor Oil Charge	4.3 qt (4.1 liters)*
Compressor Oil Type	Polyol Ester type P/N 203-413
Throttling Valve Setting	23 to 25 psi (159 to 172 kPa)
Heat/Defrost Method	Hot gas
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
#2 Circuit Fuse (F9—2AA Circuit)	40 amp
Damper Fuse (F3—29F Circuit)	15 amp
High Speed Solenoid Fuse (F18—7D Circuit)	15 amp
#8 Circuit (F21—8F Circuit)	15 amp
Other Fuses	2, 3, or 5 amp
Battery Charging	12 volt, 37 Amp, brush type alternator
Voltage Regulator Setting	13.8 to 14.2 volts @ 77 F (25 C)

NOTE: The Alternator Field Fuse (F15) must be removed for the Bosch Alternator.

ELECTRICAL COMPONENTS

NOTE: Disconnect components from unit circuit to check resistance.

		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
Starter Motor—Gear Reduction Type		250-375*	
Modulation Valve (Optional)		1.7**	7.6
Hot Gas Bypass Valve (Optional)		1.1	11.1

**** On-the-engine cranking check. Bench test is approximately 80 amps on the gear reduction starter.***
*****Test at 12.5 Vdc.***

THERMOGUARD® µP-V MICROPROCESSOR TEMPERATURE CONTROLLER

Temperature Controller:

	Type	Electronic THERMOGUARD µP-V Microprocessor with digital thermostat, thermometer and fault indicator monitor
	Setpoint Range	-20 to 80 F (-29 to 27 C) Programmable setpoint range to 90 F (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 must be below 45 F (7.2 C)
Defrost Termination:	Coil Sensor	Terminates defrost with coil temperature above 57 F (13.9 C)
	Interval Timer	Terminates defrost 30 to 45 minutes (programmable) after initiation if coil sensor has not terminated defrost

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 Operator's 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 Air Cleaner" on page 52) 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.
	•	•	•	Check and adjust engine speeds (high and low speed).
	•	•	•	Check condition of drive coupling bushings per Service Bulletin T&T 171.
			•	Check condition of engine mounts.
	•	•	•	Replace standard (silver) fuel filter/water separator.
		•		Replace EMI 3000 (black) fuel filter/water separator.
				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
				Engine (continued)
			—	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 32).
			—	Test fuel injection nozzles at least every 10,000 hours.
				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.
				Refrigeration
•	•	•	•	Check refrigerant level.
	•	•	•	Check for proper suction pressure.
			•	Check compressor oil level and condition.
	•	•	•	Check throttling valve regulating pressure.
			•	Check compressor efficiency and pump down refrigeration system.
				Replace dehydrator and check discharge and suction pressure every 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

The Whisper 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. The unit uses hot gas to heat and defrost.

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. An in-line power pack provides direct drive power transfer from the engine to the compressor. A belt drive system transfers energy to the fans, the alternator, and the water pump.

THERMOGUARD µP V Microprocessor

The THERMOGUARD µP V is a microprocessor control system designed for a transport refrigeration system. The µP V integrates the following functions: thermostat, digital thermometer, hourmeters, oil pressure condition, water temperature gauge, ammeter, voltmeter, tachometer, mode indicator, refrigeration system controller, and diagnostic system.

The CYCLE-SENTRY system, an integral defrost timer and data recording are standard features. The refrigeration modulation system, tracker (a satellite communication system interface), remote controls and status lights are optional features.

The microprocessor mounts inside a weather tight control box. The LCD display is clearly 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 a CYCLE-SENTRY Fresh (CSFR) 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 Controller Operation & Diagnostic Manual for specific information about the CYCLE-SENTRY Fresh 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.
- Microprocessor controlled all season temperature control.
- Maintains minimum engine temperature in low ambient conditions.
- Battery Sentry keeps batteries fully charged during unit operation.
- Fixed preheat time.
- Preheat indicator buzzer.

Data Logging (Optional)

The Data Logging feature is optional equipment on the Whisper. The microprocessor records operational events and alarm codes as they occur and at preset intervals. This trip data can be retrieved (but not erased) from the microprocessor memory using an IBM® PC compatible laptop or desktop computer and Thermo King WinTrac™ 4.0 (or higher) software. The computer is connected to the Data Connector on the control box. A brief graphical or tabular report can then be printed on the Data Pac microprinter. More detailed reports may be printed in either a graphical or tabular format on a high speed printer external to the portable microcomputer.

Tracker (Optional)

The Tracker is an optional system that can be included in the microprocessor. The Tracker interfaces a satellite communication system (SCS) located in the tractor. The Tracker and the SCS are connected with a data cable. The Tracker transmits data (recorded in the microprocessor) through the SCS to a central location for processing. The Tracker transmits data at preset intervals or on demand depending on the type of SCS. Data can also be transmitted through a Tracker to the microprocessor with some systems.

Thermo King X430 Compressor

The unit is equipped with a Thermo King X430, four-cylinder compressor with 30 cu. in. (492 cm^3) displacement.

Refrigeration Modulation System (Optional)

The refrigeration modulation system provides precise control of the refrigeration system and the temperature of the cargo area. As the temperature of the return air begins to approach the setpoint, the microprocessor begins to close the modulation valve in the suction line between the evaporator and the heat exchanger. The microprocessor closes the modulation valve more as the return air temperature gets closer to the setpoint. When the temperature is near setpoint, the modulation valve is closed to its limit and the hot gas bypass valve is opened. When the temperature begins to move away from the setpoint, the modulation valve begins to open. The hot gas bypass valve remains open until the modulation valve is completely open, then the hot gas bypass valve closes. This provides very smooth and steady temperature control and the temperature does not oscillate above and below setpoint as much as it does in a unit that does not have modulation.

SEQUENCE OF OPERATION

When the unit is turned ON the LCD display, which normally shows the setpoint, the return air temperature, and the operating mode, is illuminated. The microprocessor relays and unit loads energize, and the unit will start 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. Also, the different versions of software that are used have some operational differences.

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.

The unit will operate in either the Fresh or Frozen range (formerly referred to as “Heat Lockout”). The Fresh-Frozen range transition point is programmable to either 24 F (-4 C) or 15 F (-9 C). The operation modes shown below utilize this range as programmed.

Continuous Mode, Setpoint at or Above Fresh-Frozen Range

Operating mode is controlled by the microprocessor. When the temperature is within a few degrees of setpoint, the temperature is considered to be in range and the in-range icon will turn on. The microprocessor will select the operating mode from the list of possible modes below:

- High Speed Cool
- Low Speed Cool
- Low Speed Modulated Cool (Optional)
- Low Speed Modulated Heat (Optional)
- Low Speed Heat
- High Speed Heat
- Defrost

CYCLE-SENTRY Mode, Setpoint at or Above Fresh-Frozen Range

Operating mode is controlled by the microprocessor. When the temperature is within a few degrees of setpoint, the temperature is considered to be in range and the in-range icon will turn on. The microprocessor will select the operating mode from the list of possible modes below:

- High Speed Cool
- Low Speed Cool
- Null (if engine temperature and battery are satisfied)
- Low Speed Heat
- High Speed Heat
- Defrost

Continuous Mode, Setpoint Below Fresh-Frozen Range

Operating mode is controlled by the microprocessor. When the temperature is within a few degrees of setpoint, the temperature is considered to be in range and the in-range icon will turn on. The microprocessor will select the operating mode from the list of possible modes below:

- High Speed Cool
- Low Speed Cool
- Low Speed Heat
- Defrost

CYCLE-SENTRY Mode, Setpoint Below Fresh-Frozen Range

Operating mode is controlled by the microprocessor. When the temperature is within a few degrees of setpoint, the temperature is considered to be in range and the in-range icon will turn on. The microprocessor will select the operating mode from the list of possible modes below:

- High Speed Cool
- Low Speed Cool
- Null (if engine temperature and battery are satisfied)
- Low Speed Heat (if engine temperature or battery are not satisfied)
- Defrost

Defrost

Defrost is initiated manually through the defrost prompt screen using the microprocessor Select and Enter keys. Defrost is initiated automatically on demand, by the defrost timer, or by the air switch.

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 difference between the return air temperature, discharge air temperature and coil temperature becomes excessive.

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. 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. This feature allows a shorter defrost timer to be used when the unit is out of range during a pulldown and more frequent defrost cycles may be beneficial.

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 Whisper (048668)
TK 486 Diesel Engine	•
X430 Compressor	•
Compressor Oil Filter	•
Top Mount Muffler	•
Thermo King Radiator	•
Stainless Steel Grille	•
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	•
THERMOGUARD Microprocessor Controller	•
Fuel Filter with Water Separator	•
Spin-On Full Flow Bypass (Dual Element) Oil Filter	•
Dealer Installed Synthetic Engine Oil	Opt
Side Mount Coolant Expansion Tank	•
Defrost Timer	•
CYCLE-SENTRY System	•
37 Amp Alternator	•
Refrigerant R-404A	•
Silicone Coolant Hoses	Opt
Fuel Heater	Opt
Fresh Air Exchange	Opt
Condenser Shutters	Opt
Top Screen	Opt
Refrigeration Modulation System	Opt
Remote Status Lights	Opt
Communications (Data Logging)	Opt
Tracker	Opt

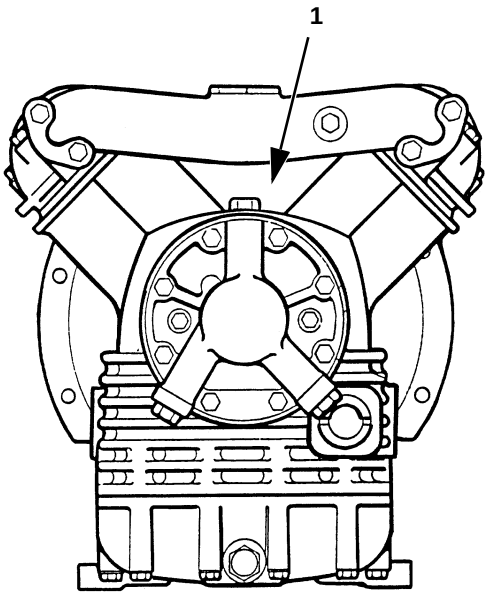
PROTECTION DEVICES	Unit Model Whisper (048668)
Engine Coolant Temperature Sensor	•
Engine Low Oil Pressure Switch	•
Engine Low Oil Level Switch	•
Evaporator Temperature Sensor	•
Refrigerant High Pressure Cutout Switch	•
High Refrigerant Pressure Relief Valve	•
12 Volt Fuse Link	•
Fuse in Main Power Circuit	•
Fuse in Control Circuit	•
Fuse in Modulation Valve Circuit	Opt
Fuse in Microprocessor Power Circuit	•
Relay Fuses	•
Remote Status Light Fuse	•

SERIAL NUMBER LOCATIONS

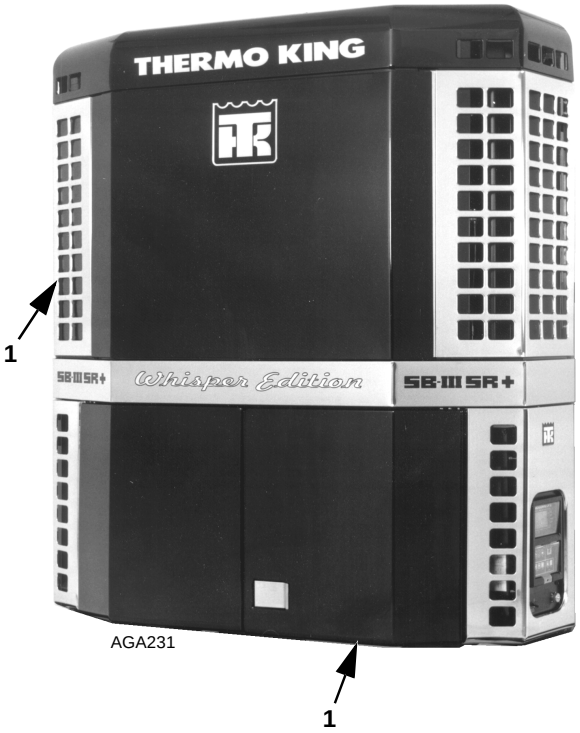
Unit: Nameplate on the curbside of the unit inside the top service access grille and on the roadside of the unit frame below control panel.

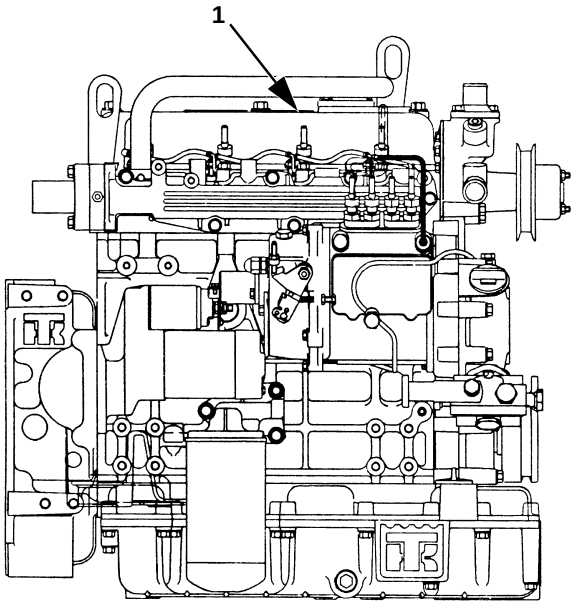
Engine: Nameplate on rocker arm cover.

Compressor: Stamped on the end above the oil pump.



1.	Serial Number Location

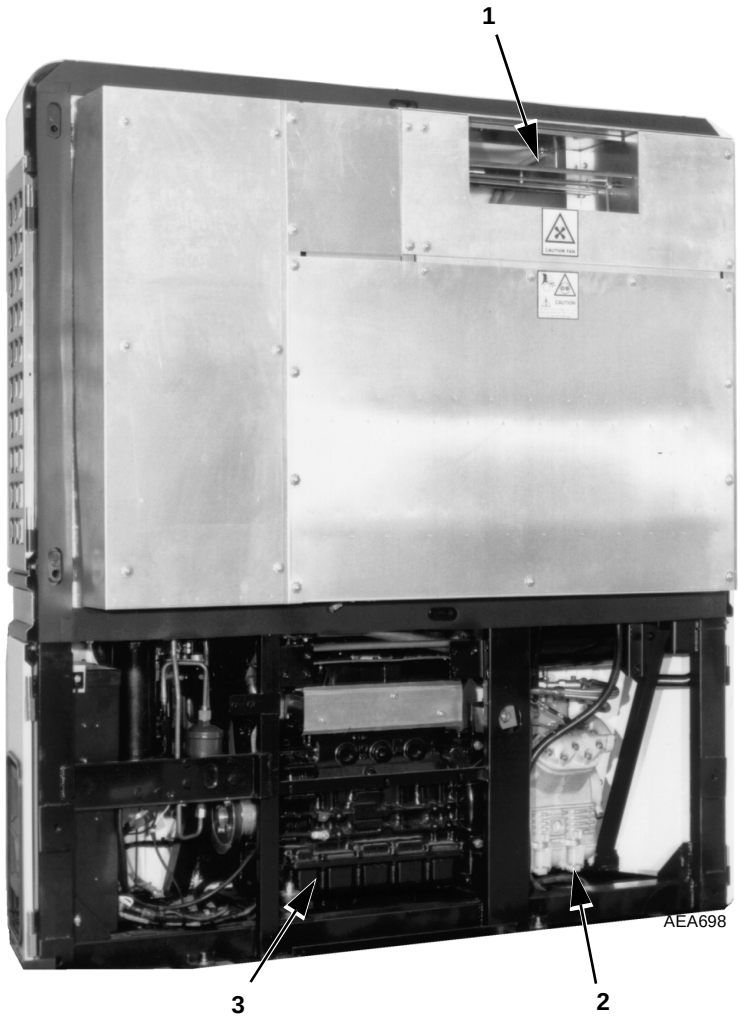




Unit Photos

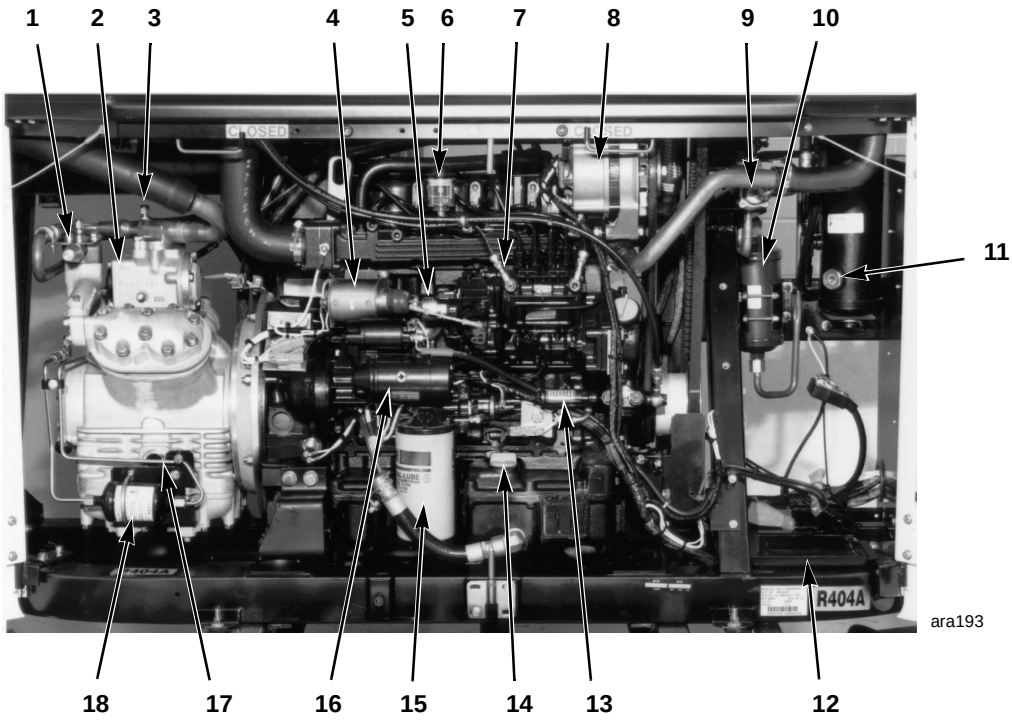
AGA231

Front View



1.	Defrost Damper
2.	X430 Compressor
3.	TK 486 Engine

Back View



1.	Discharge Service Valve	10.	Filter Drier
2.	Throttling Valve	11.	Receiver Tank Sight Glass
3.	Suction Service Valve	12.	Battery Tray
4.	Throttle Solenoid	13.	Hand Primer Pump
5.	Fuel Solenoid	14.	Dipstick
6.	Air Restriction Indicator	15.	Oil Filter (Standard Blue Filter Shown)
7.	Fuel Bleed Screw	16.	Starter
8.	Alternator	17.	Compressor Sight Glass
9.	Three-way Valve	18.	Compressor Oil Filter

Engine Compartment

1.	Display	3.	Keypad
2.	Microprocessor Control Panel	4.	Switch Panel

Control Panel

Operating Instructions

UNIT CONTROLS

Two sets of controls are used to operate a unit that has a THERMOGUARD Microprocessor Temperature Controller. The switch panel contains the switches that control the basic operation of the unit. The microprocessor control panel contains the display and the keypad that controls the operation of the microprocessor.

Switch Panel

ON-OFF Switch. This switch energizes the unit's electric control system.

1. ON Position. The unit will operate under the control of the microprocessor.
2. OFF Position. The electric control system is de-energized and the unit will not operate.
3. SLEEP Position (Optional). SLEEP MODE appears on the display. The unit starts as stops as required to keep the engine warm and the battery charged. The unit will not control the box temperature while in the Sleep Mode.

Microprocessor Control Panel

THERMOGUARD MICROPROCESSOR CONTROLLER. The THERMOGUARD Microprocessor Temperature Controller controls all unit functions to maintain the cargo at the proper temperature. The microprocessor also continuously monitors discharge and return air sensor temperatures and unit operational information.

The Microprocessor Control Panel contains the display screen and the keypad. The display shows various information. The keypad controls the operation of the microprocessor. Refer to the appropriate Operation Manual or Operation and Diagnosis Manual for detailed information about operating the microprocessor.

Microprocessor On-Off Switch

This switch is located in the side of the control box in the engine compartment. It should be placed in the OFF position to connect or disconnect the battery, or to service the microprocessor system. The clock/calendar must be reset if this switch has been placed in the OFF position.

UNIT INSTRUMENTS

1. MICROPROCESSOR DISPLAY. The display normally shows the setpoint, the return air temperature, and any active icons, which are:
   - CYCLE-SENTRY
   - High Speed
   - In-range
   - Modulation
   - Heat
   - Defrost
   - Cool
   - Electric
   - Setpoint
   - Return Air
   - Discharge Air
   - Alarm

   Pressing the SELECT key causes the display to show the other sensor readings. Pressing the CODE key causes the display to show the fault codes.
2. ALARM SYMBOL. The alarm symbol comes on whenever there is an alarm code stored in the microprocessor memory.

3. DATA INTERFACE. The Data Interface is a serial port that can be used to connect the microprocessor to an IBM® PC compatible computer.

4. 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.

5. COMPRESSOR OIL SIGHT GLASS. The compressor oil sight glass is used to check the relative level of compressor oil in the compressor sump.

6. 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 52) at 3,000 hours or two years (whichever occurs first) if air restriction indicator has not reached 25 in.

7. REMOTE STATUS LIGHT (Optional). 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

1. FUSE LINK (Current Limiter). The fuse link is located near the battery. The fuse link is located in the positive battery cable in late model units. The fuse link protects the electric system from a short in the 2 circuit.

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

   A 40 amp fuse (F9—#2 Circuit) protects the 2AA circuit, which is the main power circuit.

   A 15 amp fuse (F3—Damper) protects the 29F circuit, which supplies power to the damper solenoid.

   A 15 amp fuse (F18—High Speed Solenoid) protects the 7D circuit, which supplies power to the high speed solenoid.

   A 15 amp fuse (F21—#8 Circuit) protects the 8F circuit, which supplies power to various control relays and components.

   A number of 2, 3, or 5 amp fuses protect microprocessor circuits, control relay circuits, remote status light circuits (optional), and various components.

3. HIGH PRESSURE CUTOUT. The high pressure cutout is a pressure sensitive switch that is located in the compressor discharge manifold. If the discharge pressure rises above 470 psi (3241 kPa), the switch opens the 8D circuit to the fuel solenoid, which stops the engine.

4. 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 a high pressure line near the condenser. Its location is such that when the pressure is expelled from the valve, it would be directed away from anyone servicing the unit.

5. 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.

6. 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.

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 32 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 trailer, 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 Pretrip Inspection.

2. Adjust the setpoint to the desired load temperature (refer to the appropriate Operating Manual or Operation and Diagnosis 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 Operating Manual or Operation and Diagnosis 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 and hold the TK key for at least 3 seconds.

      - 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 Operation and Diagnosis Manual for detailed information about alarms).

   a. Correct the alarm conditions.

   b. Clear the alarms with the CLEAR key (refer to the appropriate Operation and Diagnosis 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 23.

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 Operation Manual or Operation and Diagnosis Manual for detailed information about CYCLE-SENTRY selection.

- The microprocessor has a CYCLE-SENTRY Fresh (CSFR) 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 Operation Manual or Operation and Diagnosis Manual for specific information about the CYCLE-SENTRY Fresh 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

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 pretrip.

1. Place the On-Off switch in the ON position.
2. 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.

If cooling or heating is required and the engine temperature is below approximately 90 F (32 C), but the engine fails to start automatically:

- Turn the On-Off switch to the OFF position.
- Check for and correct any alarm conditions and clear the alarm codes. View the alarms with the CODE key, clear the alarms with the CLEAR key, and then repeat the auto start procedure. Refer to the appropriate Operation and Diagnosis Manual for detailed information about alarms.
- If the engine will still not start, turn the On-Off switch to the OFF position, determine and correct the cause of the failure.

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 OIL PRESS key. The oil pressure should read OK, not LOW.

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

2. AMMETER. Check the ammeter reading by pressing the AMPS 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 SELECT key until the dEF (defrost) prompt screen appears, then press the ENTER key.

   Refer to the appropriate Operation Manual or Operation and Diagnosis 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)

Charging System Diagnostic Procedures

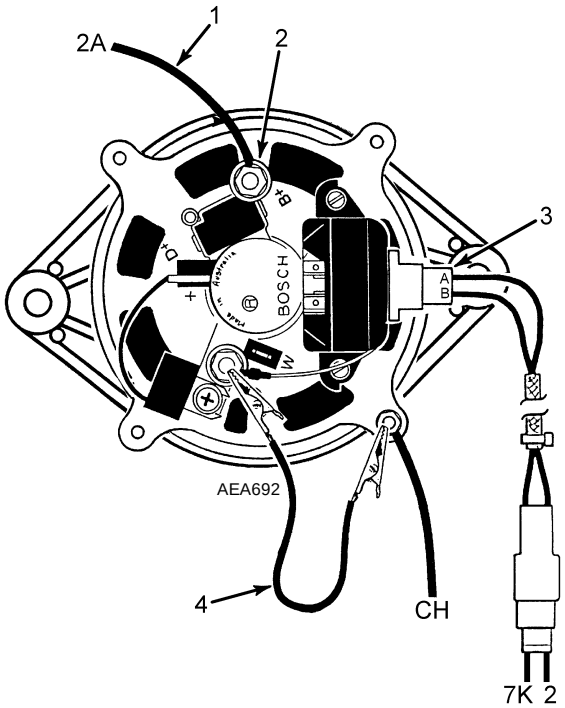
NOTE: Units manufactured with CYCLE-SENTRY and alternators with integral regulators MUST use replacement alternators with integral regulators.

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

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. Set the unit for continuous run operation and place the main On-Off switch in the ON position.
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. 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 1 to 3 volts.
   a. No voltage or a voltage reading below 1 volt 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:

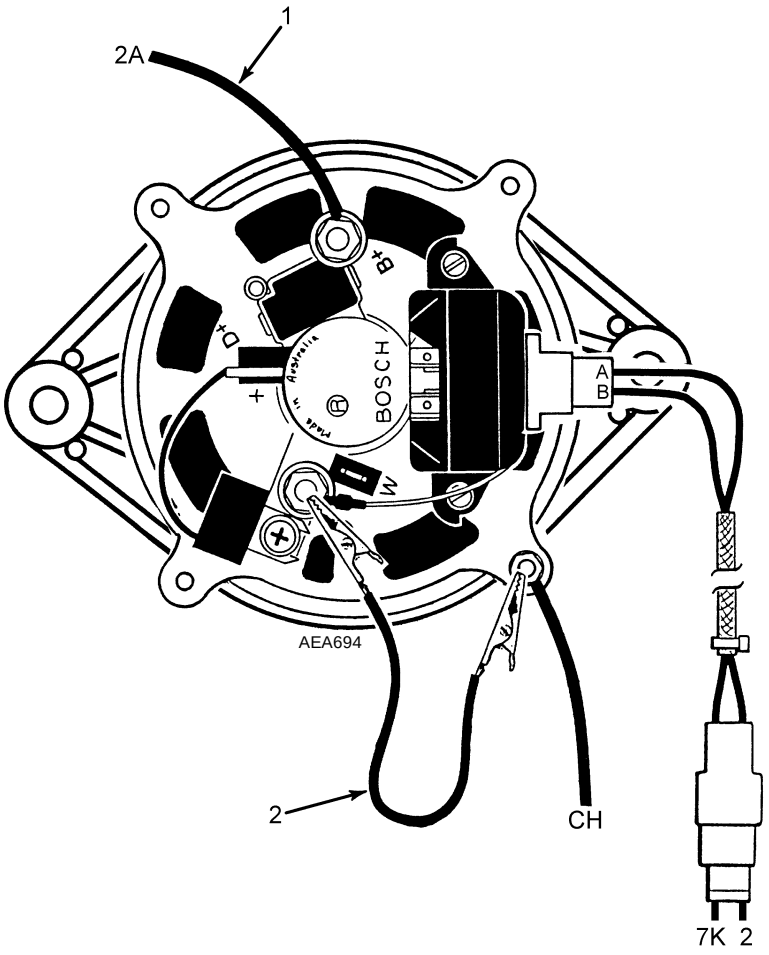
Alternator Rating	Field Current @ 12 Volts
23 Amp	1.0 to 3.0 Amps
37 Amp	3.5 to 4.5 Amps
65 Amp	4.0 to 5.0 Amps

   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	Receiver 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

Full Field Test

BATTERY

NOTE: The PROCESSOR On-Off switch must be placed in the OFF position before connecting or disconnecting the battery terminals. The PROCESSOR On-Off switch is located on the side of the control box inside the engine compartment.

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.

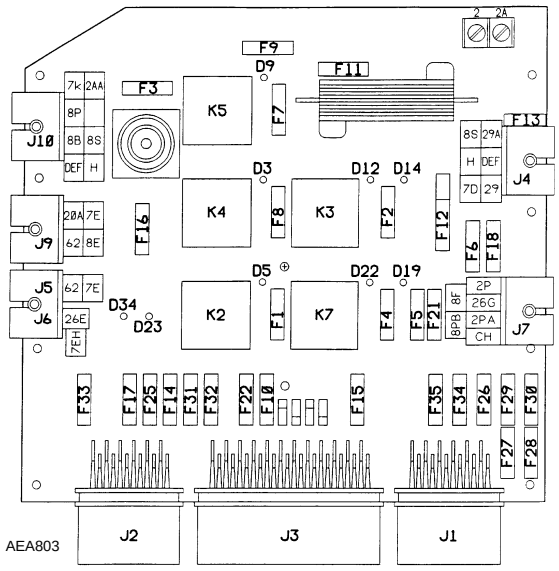
UNIT WIRING

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 THERMO-GUARD Microprocessor Controller Operation & Diagnosis Manual for a complete list of the size and function of the fuses.

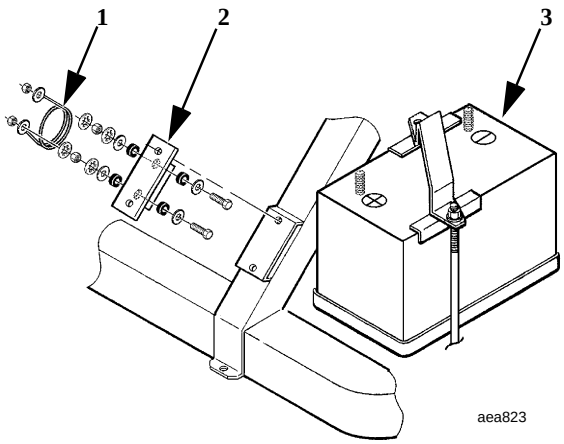
- A 40 amp fuse (F9—#2 Circuit) protects the 2AA circuit, which is the main power circuit.
- A 15 amp fuse (F3—Damper) protects the 29F circuit, which supplies power to the damper solenoid.
- A 15 amp fuse (F18—High Speed Solenoid) protects the 7D circuit, which supplies power to the high speed solenoid.
- A 15 amp fuse (F21—#8F Circuit) protects the 8F circuit, which supplies power to various control relays and components.
- A number of 2, 3, or 5 amp fuses protect microprocessor circuits, control relay circuits, remote status light circuits (optional), and various components.



Relay Board

FUSE LINK

The fuse link is located in the engine compartment near the battery. 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. The fuse link is located in the positive battery cable in late model units. Replace this fuse link by replacing the positive battery cable.



1.	Fuse Link
2.	Bracket
3.	Battery

Fuse Link Location (Early Models Only)

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 when the Preheat-Start switch is held in the PREHEAT or START position, or when the microprocessor initiates a unit start-up (CYCLE-SENTRY switch in the CYCLE position).

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. Hold the Preheat-Start switch in the PREHEAT position. The current draw should be approximately 89 amps at 12.5 volts and approximately 77 amps at 11 volts.

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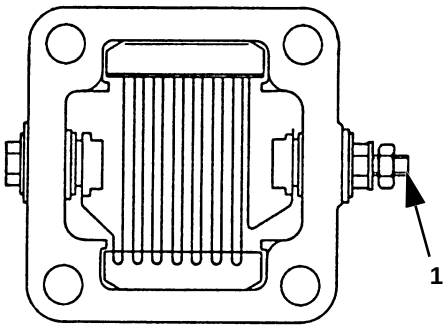


1.	M6 Terminal

Air Heater

THERMOGUARD µP V MICROPROCESSOR CONTROLLER

Refer to the THERMOGUARD µP-V Microprocessor Controller Diagnosis Manual (TK 50042) for complete service information about the Microprocessor Controller and the related components.

Engine Maintenance

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 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 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.

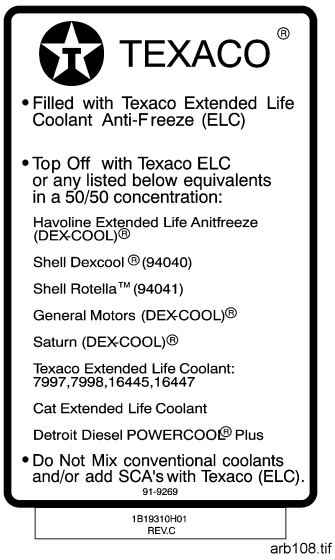
This provides the following:

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.



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).

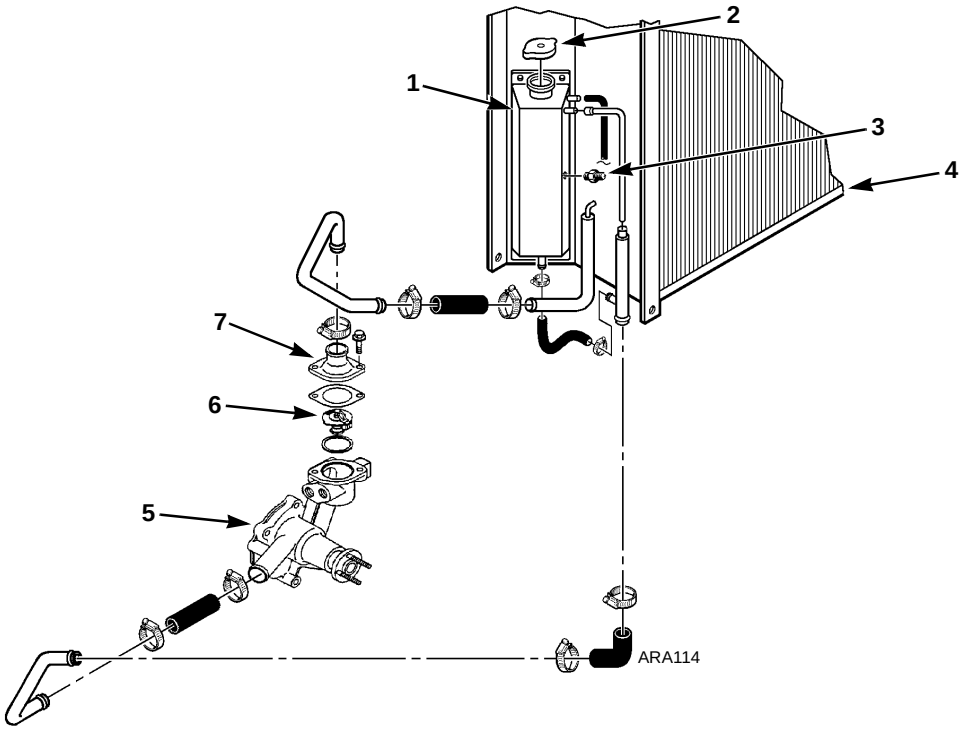
Units with engine serial numbers before L16553 must have the water pump replaced to change over to ELC coolant. Refer to Service Bulletin T&T 274 for information about retrofitting the new water pump.

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 32 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.



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

Engine Cooling System

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 32 to help determine which type of antifreeze to use.
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 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. REFER TO SERVICE BULLETIN T&T 029.

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, let it run for a minute, 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. 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.

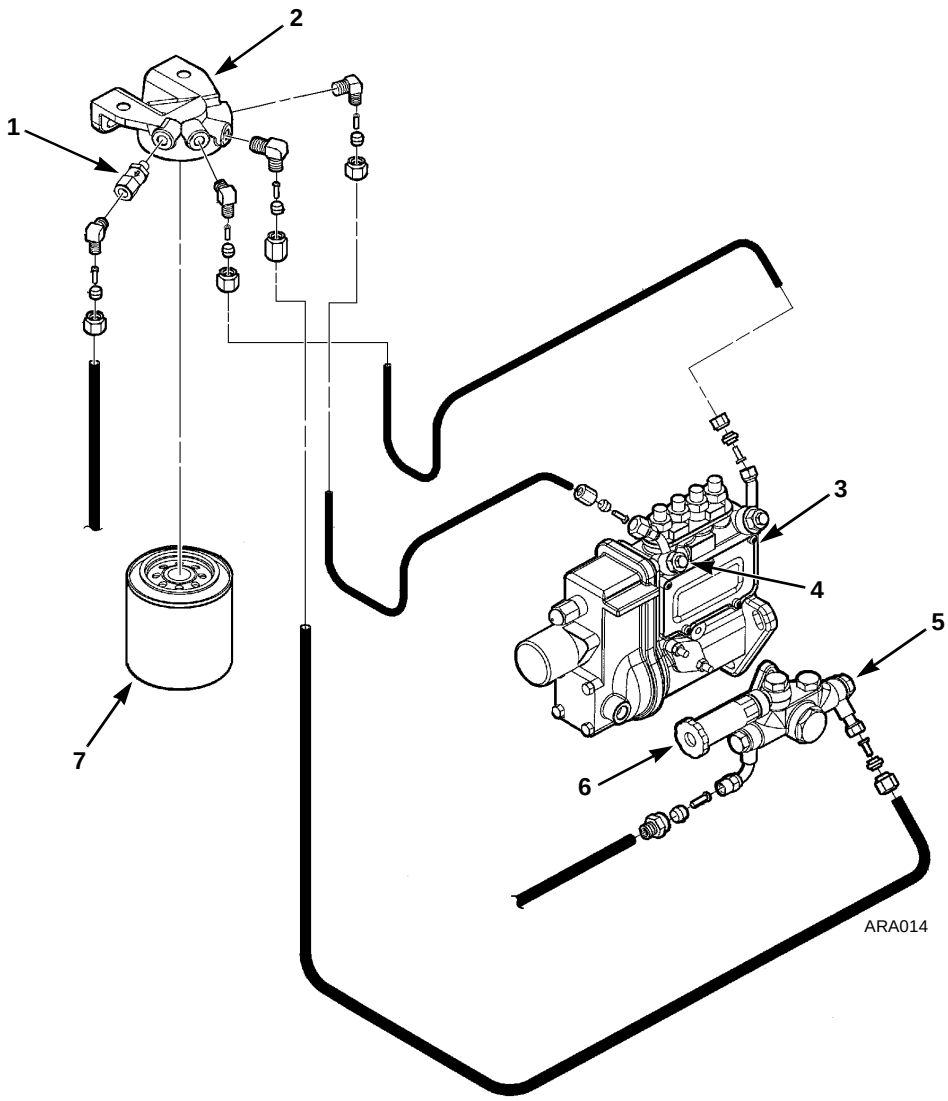
The injection pump plungers are activated by a gear driven injection pump camshaft. The governor sleeve and weight assembly is mounted on the end of the pump camshaft. The governor's speed requirements are relayed to the injection pump through a linkage arrangement located in the rear cover. The injection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

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.



1.	Check Valve	5.	Fuel Transfer Pump
2.	Filter Head	6.	Priming Pump
3.	Injection Pump	7.	Fuel Filter/Water Separator
4.	Bleed Screw		

Engine Fuel System

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.

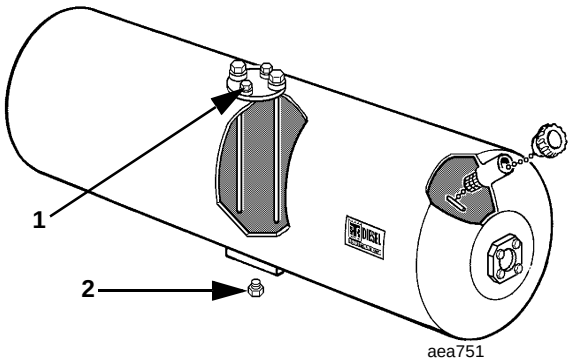
The following procedures can be done under field conditions:

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.

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.



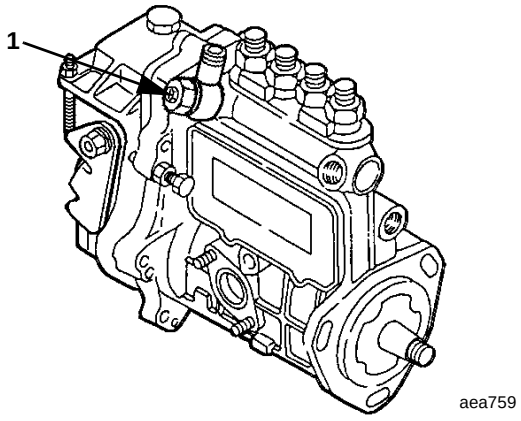
1.	Vent
2.	Drain Plug

Fuel Tank

To bleed air from the fuel system:

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



1.	Bleed Screw

Injection Pump

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.

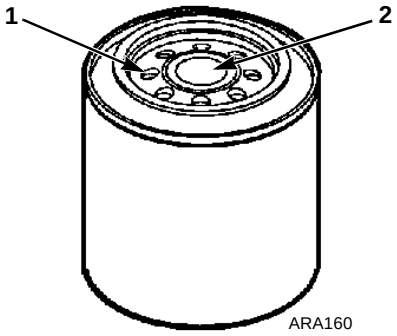
Fuel Filter/Water Separator

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. 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.
3. Clean the filter head seal surface.



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

Filling Fuel Filter/Water Separator

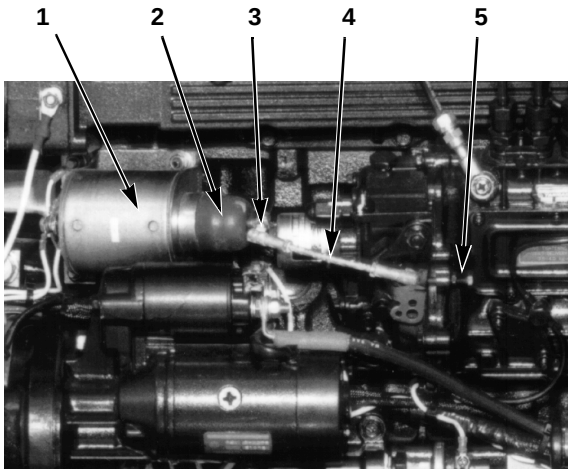
4. Lubricate the canister seal with clean fuel.
5. Screw the new canister on hand-tight. Using a strap wrench, tighten another 1/4 turn.

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.



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

Engine Speed Adjustments

High Speed

1. Use the Service Test Mode to run the unit in high speed and check the high speed rpm. It should be 2175 to 2225 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.

Low Speed

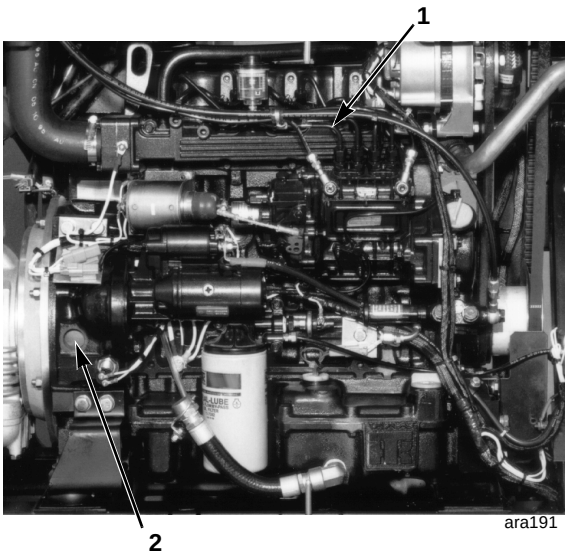
1. Loosen the jam nut on the low speed adjustment screw.
2. Use the Service Test Mode to run the unit in low speed. Adjust the screw to obtain the correct speed. It should be 1425 to 1475 rpm.
3. Tighten the jam nut and recheck the speed.

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

Component Location

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

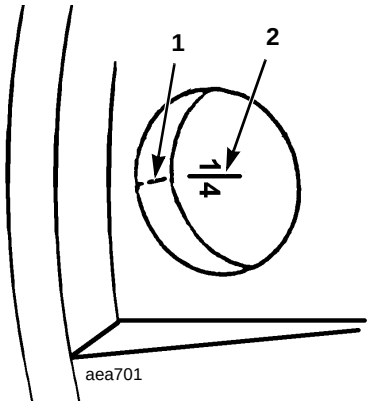
4. Remove the injection line for the number one cylinder from the delivery valve on the injection pump and from the injection nozzle.

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

5. Remove the rocker arm cover.

6. Place the engine at top dead center of the compression stroke for the number one cylinder.

   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

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.

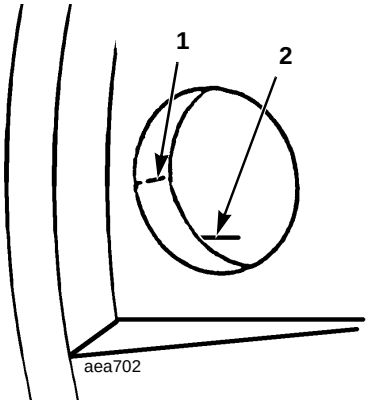
7. Disconnect the 8S wire from the starter solenoid to prevent the engine from cranking when the unit is turned ON.

8. Place the On-Off switch in the ON position.

9. Use the microprocessor keypad to enter the Relay Board Test Mode. Refer to the appropriate Microprocessor Operation and Diagnosis Manual for detailed information about the Relay Board Test Mode.

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

11. 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

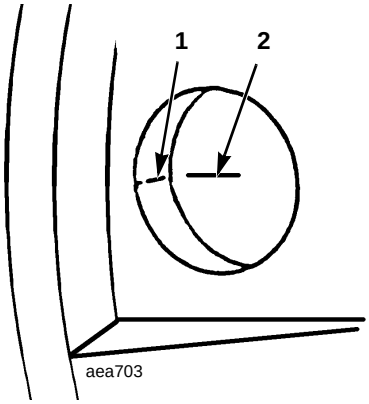
Timing Mark Alignment

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

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

14. 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.

15. 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 11 through 15 to recheck the timing.



1.	Index Mark
2.	Injection Mark

Correct Injection Timing Mark Alignment

16. 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.

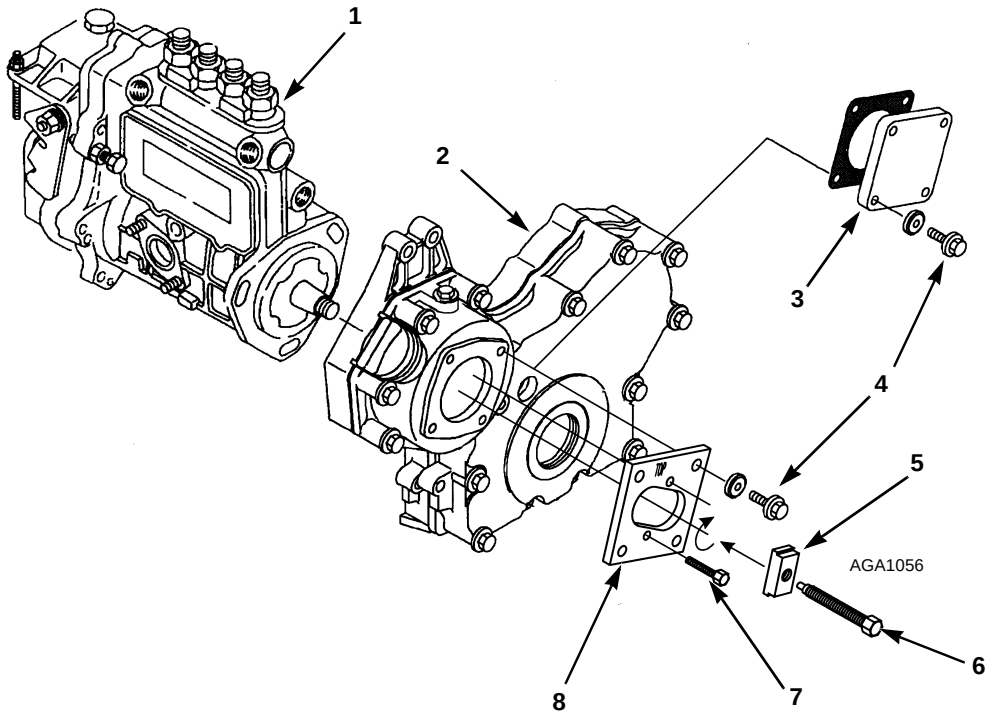
17. Tighten the injection pump mounting nuts and recheck the timing. Repeat steps 11 through 17 until the timing is correct.

18. Install the cover in the timing mark access hole, install the injection line for the number one cylinder, install the rocker arm cover, and tighten the other injection lines 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.

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 lockwasher which secure the gear to the injection pump shaft. Use a shop rag to prevent the lockwasher 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.



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

Injection Pump Gear Tool

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.

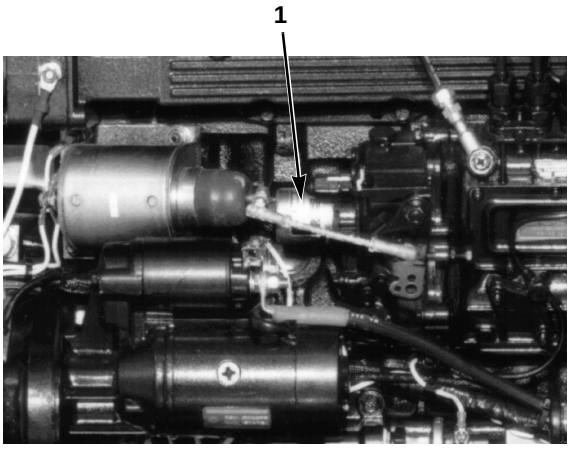
Injection Pump Reinstallation

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 lockwasher and nut, use a shop rag, as before, to prevent the lockwasher 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.

Fuel Solenoid System

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.



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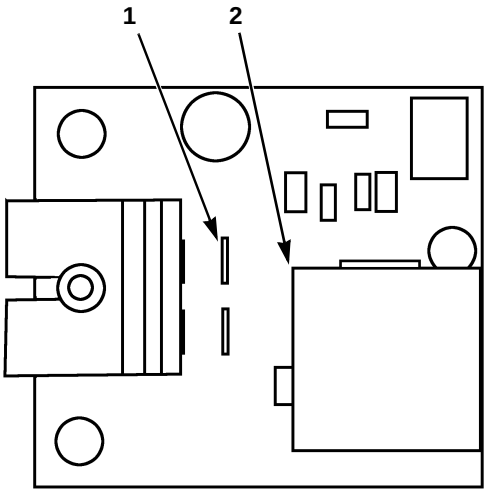
1.	Fuel Solenoid

Fuel Solenoid Location



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1.	Four Pin Connector
2.	Fuel Solenoid Relay (FSR)

Fuel Solenoid Timer

A fuel solenoid timer is used to control the fuel solenoid pull-in coil. The fuel solenoid timer consists of a small PC board that contains some electrical components, a four pin wire connector, and one removable relay. The relay is called the fuel solenoid relay. The fuel solenoid timer is mounted inside the control box.

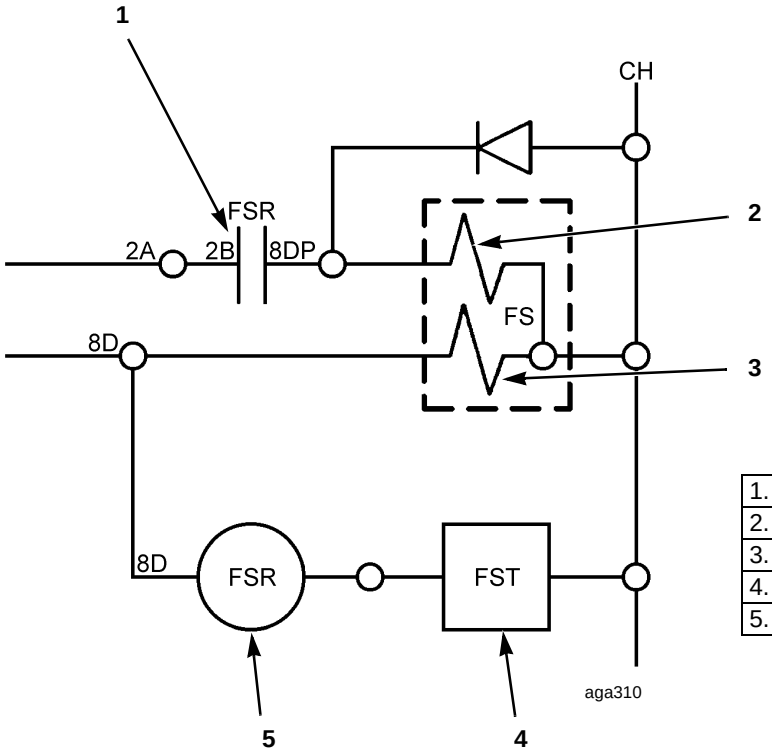
Fuel Solenoid Timer Operation

The fuel solenoid hold-in coil is connected to the 8D circuit. The fuel solenoid relay coil is also connected to the 8D circuit and it is grounded through the fuel solenoid timer. The fuel solenoid pull-in coil is connected to the 2A circuit through the normally open contacts of the fuel solenoid relay when the fuel solenoid relay is energized.

When the 8D circuit is energized, it supplies power to the fuel solenoid hold-in coil and to the fuel solenoid relay coil. The hold-in coil is energized and remains energized as long as there is power on 8D. The fuel solenoid relay is energized momentarily by the fuel solenoid timer when the 8D circuit is first energized. After approximately 2.5 seconds, the fuel solenoid timer de-energizes the fuel solenoid relay by opening the circuit to ground.

During the time the fuel solenoid relay is momentarily energized, the fuel solenoid pull-in coil is energized by the 2A circuit through the normally open contacts of the fuel solenoid relay and the 8DP circuit.

When power is removed from the 8D circuit the fuel solenoid hold-in coil is de-energized, and the fuel solenoid resets.



1.	Fuel Solenoid Relay Contacts
2.	Fuel Solenoid Pull-In Coil
3.	Fuel Solenoid Hold-In Coil
4.	Fuel Solenoid Timer
5.	Fuel Solenoid Relay Coil

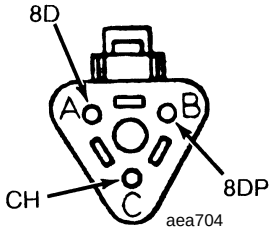
Simplified Schematic Diagram of Fuel Solenoid System

Troubleshooting the Fuel Solenoid System

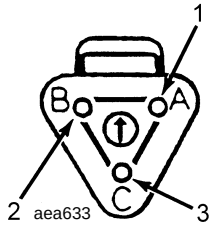
NOTE: The fuel solenoid pull-in coil will require 35 to 45 amps to turn on the fuel. The unit's battery must be in good condition. If the battery has enough power to crank the engine over, it has enough power to energize the fuel solenoid pull-in coil.

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

1. Disconnect the fuel solenoid wire connector from the main wire harness.
2. Use the microprocessor keypad to enter the Relay Board Test Mode. Refer to the appropriate Microprocessor Operation and Diagnosis Manual for detailed information about the Relay Board Test Mode.
3. Energize the fuel solenoid circuits by energizing the run relay [RUNR] with the Relay Board Test Mode.
4. Check the voltage on the 8D circuit (pin A) in the main wire harness connector for the fuel solenoid. Refer to the following illustrations to identify the pins in the wire connectors.
   a. If battery voltage is not present on the 8D circuit, check the 8D circuit and the related circuits and components for a fault.
   b. If battery voltage is present on the 8D circuit, go to step 5.



Main Wire Harness
Connector Pin Identification



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

Fuel Solenoid
Connector Pin Identification

5. Check the CH circuit (pin C) in the main wire harness connector for continuity to a good chassis ground.
   a. If there is no continuity between the CH circuit a good chassis ground, check the CH wire for an open circuit.
   b. If there is continuity between the CH circuit in the main wire harness at the fuel solenoid wire connector and a good chassis ground, go to step 6.
6. Place a jumper wire between the black wire (CH—pin C) in the fuel solenoid connector and a good chassis ground.
7. 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.

NOTE: If the pull-in coil fails, make sure to replace the fuel solenoid relay with a Potter-Brumfield relay P/N 44-9111. This particular relay is needed for the high current flow through the hold-in coil.

b. If the pull-in coil does energize, go to step 8.

8. 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 positive battery 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.

e. If the hold-in coil does function properly, go to step 9.

9. Reconnect the fuel solenoid connector and the main wire harness connector.

10. Remove the fuel solenoid relay from its socket and make sure the On-Off switch is in the ON position and the unit is in the Relay Board Test Mode [RUNR].

11. Check the voltage on the 8D circuit at the 85 terminal in the fuel solenoid relay socket. Refer to the following illustration to identify the terminals in the relay socket.

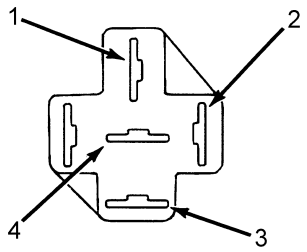
a. If battery voltage is not present on the 8D circuit, check the 8D circuit and the related circuits and components for a fault (minimum voltage is 10 volts).

b. If battery voltage is present on the 8D circuit, go to step 12.

12. Check the voltage on the 2A/2B circuit at the 30 terminal in the fuel solenoid relay socket.

a. If voltage is not present on the 2A/2B circuit, check the 2A circuit for an open or a short.

b. If battery voltage is present on the 2A/2B circuit, go to step 13.



1.	30 Terminal—2A/2B Circuit
2.	85 Terminal—8D Wire
3.	87 Terminal—8DP Wire
4.	86 Terminal to Timer

Relay Socket Terminal Identification

13. Test the relay.

    a. Use a jumper to connect the 85 terminal on the relay to the positive battery terminal.

    b. Use another jumper to connect the 86 terminal on the relay to a CH circuit.

    c. If the relay does not energize, it is defective. Replace the relay.

    d. If the relay does energize, the timer is defective. Replace the fuel solenoid timer PC board.

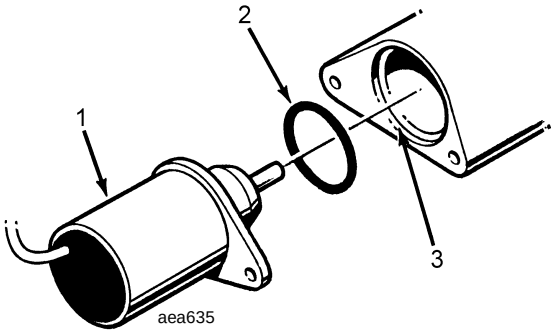
14. Turn the unit OFF after completing the test procedure.

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. Use the microprocessor keypad to enter the Relay Board Test Mode. Refer to the appropriate Microprocessor Operation and Diagnosis Manual for detailed information about the Relay Board Test Mode.
4. 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 being installed. If it is not, the plunger and the linkage may not line up correctly and the fuel solenoid will not function properly.

5. 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.
6. Install the new fuel solenoid.
7. Place the On-Off switch in the OFF position after installing the fuel solenoid.



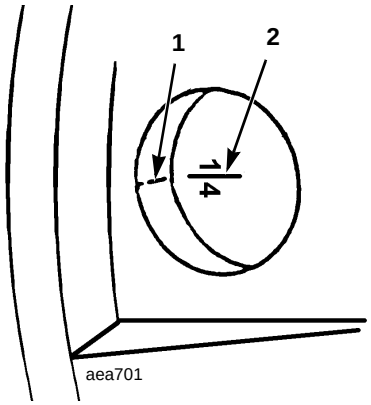
1.	Fuel Solenoid
2.	O-ring
3.	Groove in Fuel Injection Pump

Fuel Solenoid Components

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.
3. ***CAUTION: Loosen all of the injection lines at the injection nozzles to prevent the possibility of the engine firing while it is being rotated.***
4. Place the engine at top dead center of the compression stroke for the number one cylinder.

   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

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.

5. Check the valve clearance of both valves for the number one cylinder with a feeler gauge. 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).

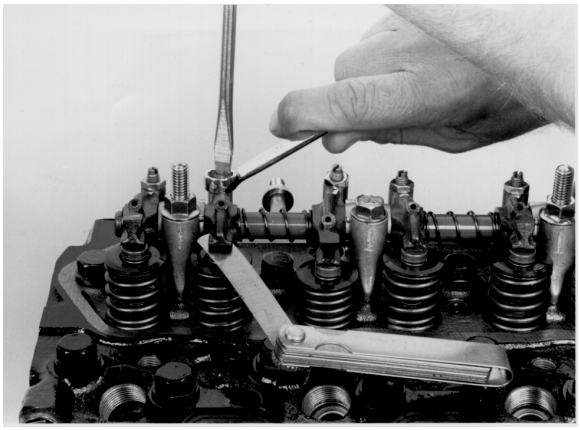
   NOTE: Check to make sure that the valve stem cap is in good condition and is positioned squarely on the top of the valve stem. Replace the valve stem cap if it shows significant wear.

6. Adjust the valves if necessary by loosening the lock nut and turning the adjustment screw until the valve clearance is correct.

	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			◎			◎	◎	◎

Valve Adjustments and Cylinder Configurations

7. Hold the adjustment screw in place and tighten the lock nut.



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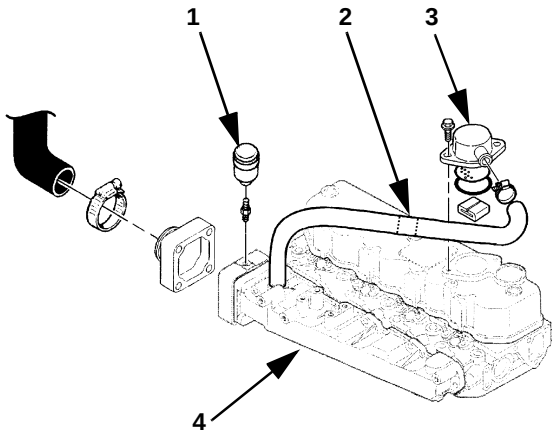
Adjusting the Valve Clearance

8. Recheck the valve clearance.
9. 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 fly-wheel with the index mark in the timing mark access hole. This is top dead center of the compression stroke for the number four cylinder.
10. 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.
11. 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.



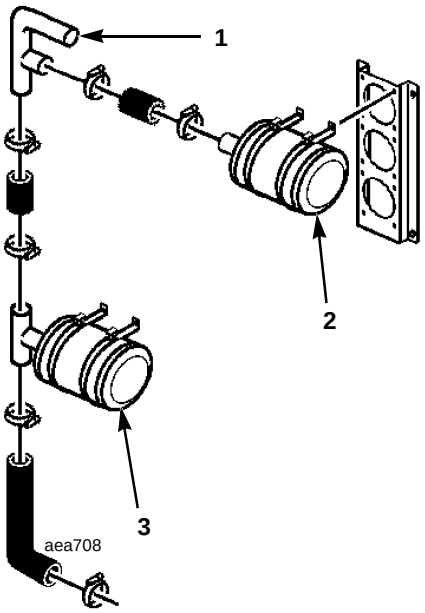
1.	Air Restriction Indicator
2.	Restrictor
3.	Crankcase Breather
4.	Intake Manifold

Crankcase Breather

Normal crankcase pressures with a new air cleaner are 0 to 1 in. (0 to 25 mm) H_2O of vacuum at 1450 rpm and 1 to 2 in. (25 to 51 mm) H_2O of vacuum at 2200 rpm. The vacuum will increase as the air cleaner gets dirty and becomes more restrictive. The crankcase breather and the breather hose should be inspected yearly to make sure they are not plugged or damaged.

ENGINE AIR CLEANER (Filter)

A heavy duty, dry air cleaner filters all of the air entering the engine. The resonator and the side branch resonator eliminate much of the air intake noise.

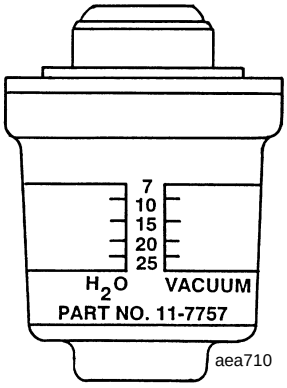


1.	Side Branch Resonator
2.	Air Cleaner
3.	Resonator

Sound Reduction Air Cleaner System

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

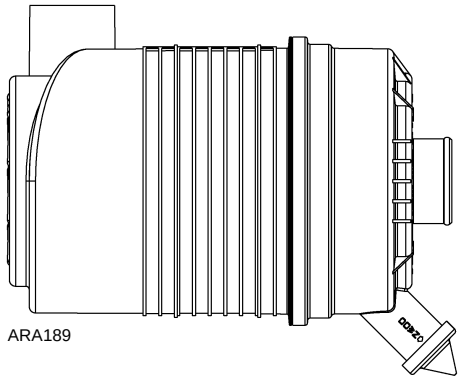
An air restriction indicator is installed in the air intake manifold. Visually inspect the restriction indicator periodically to assure the air filter is not restricted. Service the air filter when the yellow diaphragm indicates 22 in. of vacuum. Press the reset button on the bottom of the restriction indicator after servicing the air filter.



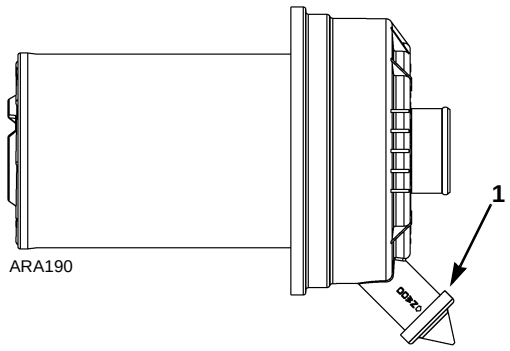
Air Restriction Indicator

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.



EMI 3000 Air Cleaner Assembly



1.	Dust Ejector Must Point Down When Installed

EMI 3000 Air Filter Element

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.

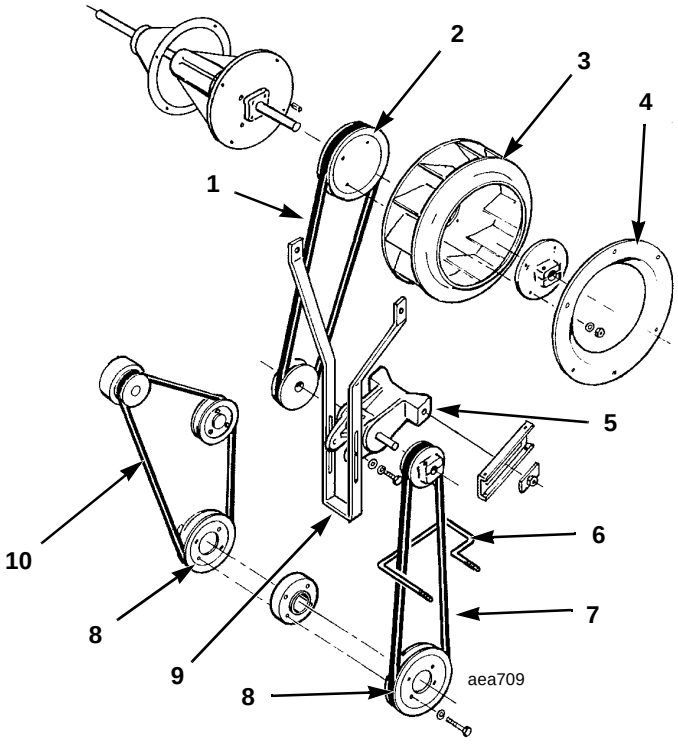
CAUTION: Do not attempt to adjust belts with the unit running.

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.

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.



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

Belt Arrangement

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.

Fan Belt Removal and Installation

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

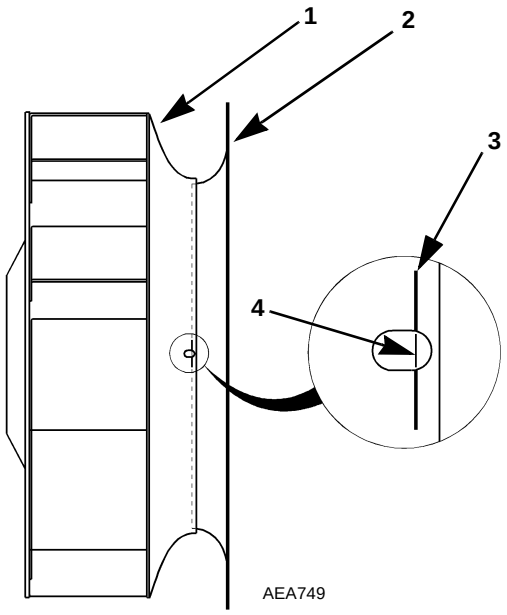
1. Loosen the idler adjusting arm bolts and remove the lower fan belt (see Lower Fan Belt Removal).
2. Push the idler adjusting arm in and the idler assembly up. The upper belt should become slack and slip down out of the idler pulley groove.
3. Pull the idler adjusting arm OUT. The upper fan belt should 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.
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.



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

Condenser Blower Alignment

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.

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 the Service Test Mode to run the unit in high speed cool. Refer to the appropriate Operation and Diagnosis 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). 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.
8. Under these conditions, the ball should be floating in the receiver tank sight glass.

Testing the Refrigerant Charge with a Loaded Trailer

1. Install a gauge manifold.
2. Use the Service Test Mode to run the unit in high speed cool. Refer to the appropriate Operation and Diagnosis 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, the ball should be floating in the receiver tank sight glass.

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 the Service Test Mode to run the unit in high speed cool. Refer to the appropriate Operation and Diagnosis 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 ball and 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 ball in the receiver tank sight glass should begin to move and the liquid level should drop.
   a. When the discharge pressure stabilizes, the ball and liquid level will rise.
   b. If the ball will not begin to move or 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 such as the COLLECTOR (P/N 204-884).
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.

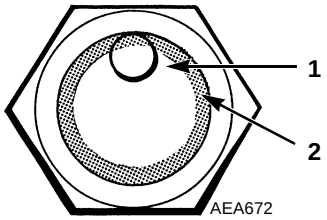
Moisture Indicating Sight Glass

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.	Floating Ball
2.	Colored Ring

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.

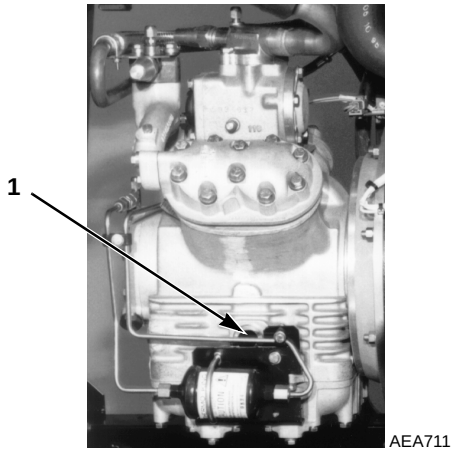
REFRIGERANT LEAKS

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

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.

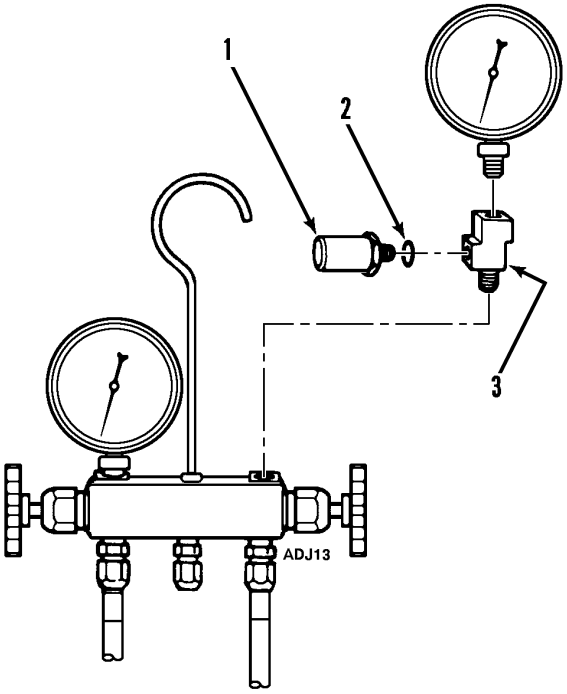
HIGH PRESSURE CUTOUT SWITCH (HPCO)

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

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 the Service Test Mode to run the unit in high speed cool.
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.



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

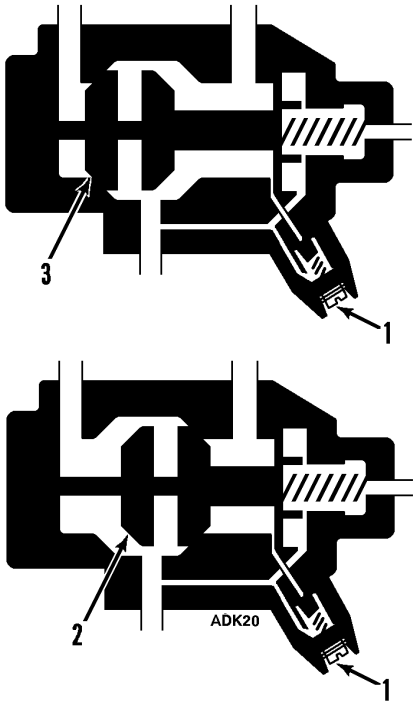
High Pressure Cutout Manifold

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.



1	Check Valve
2	Heating/Defrost Position
3	Cooling Position

Three-way Valve Condenser Pressure Bypass Check Valve

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.
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.

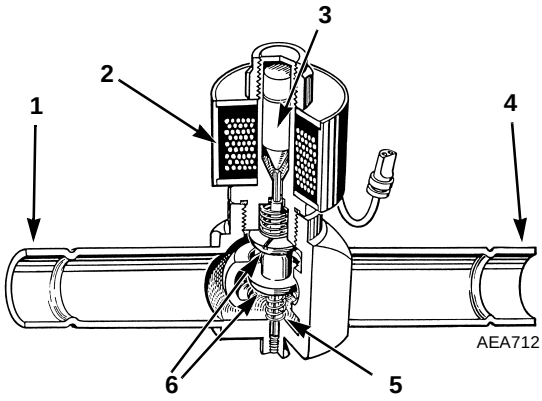
11. Open the receiver tank return outlet valve, remove the gauges and return the unit to normal operation.

MODULATION VALVE (Optional)

The modulation valve is normally open. As a controlled electrical signal is applied to the coil the armature overcomes spring pressure and the valve moves a precise amount in the closed direction. As the signal strength is increased, the valve closes more. This controls the flow of refrigerant to the compressor. The µPV Microprocessor controller monitors the return and discharge air temperature to control the signal and the position of the modulation valve.

Unlike other valves, the pressure from the flow of fluid going past the valve has no opening or closing force because of the valve and seat design. The forces cancel each other. The operation of this valve allows a very exact temperature to be maintained in the box by controlling the pumping ability of the compressor.

The modulation valve is not repairable but the electric coil can be replaced.



1.	Outlet
2.	Electric Coil
3.	Armature
4.	Inlet
5.	Opening Spring
6.	Seats

Modulation Valve

Refer to the appropriate Microprocessor Operation and Diagnosis Manual for information about testing the modulation valve. See the Refrigeration Service Operations section of this manual for removal and installation procedures.

HOT GAS SOLENOID (Optional)

The hot gas solenoid is used in conjunction with the modulation 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 the appropriate Microprocessor Operation and Diagnosis Manual 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. Front seat the discharge and suction service valves. Release the remaining refrigerant pressure from the compressor.
3. Unbolt the discharge and suction service valves from the compressor.
4. Disconnect the high pressure cutout switch and the pilot solenoid line.
5. Support the compressor and remove the compressor mounting bolts from the flywheel housing.
6. Lift the service valves out of the way.
7. Slide the compressor to the left until the coupling pins are clear.
8. 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 and install the mounting bolts.

   NOTE: The compressor drive coupling 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 and the pilot solenoid valve line.
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. Operate the unit at least 30 minutes and then inspect the oil level in the compressor. Add or remove oil if necessary.
8. Check the refrigerant charge and add refrigerant if needed.

Compressor Coupling Removal

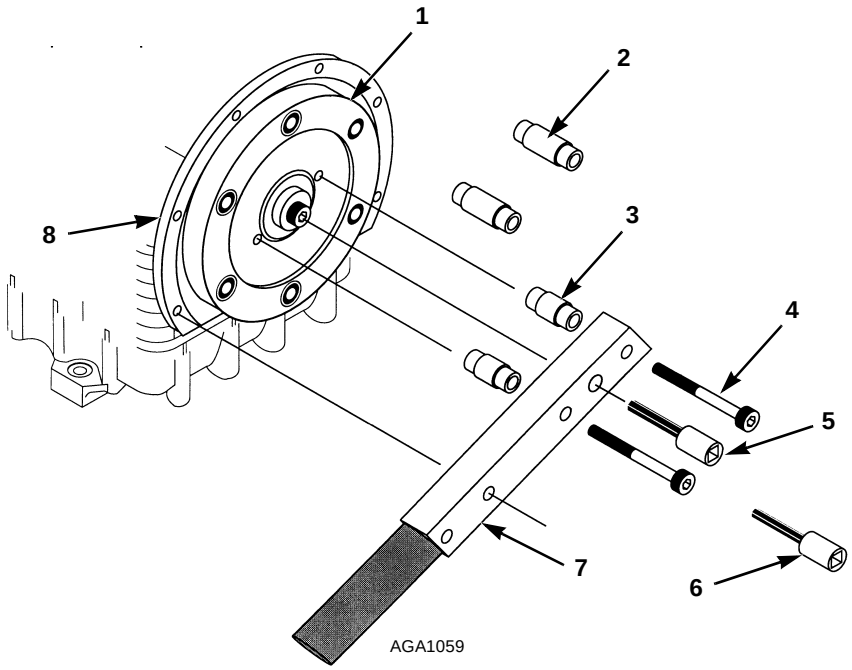
After the compressor has been removed from the unit use the appropriate Allen tool provided with removal tool P/N 204-991 to loosen the center bolt which holds the coupling to the compressor shaft.

1. Attach the tool to the coupling with the provided socket head screws and spacers. Two 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.

2. 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.
3. Use torque wrench and the appropriate Allen tool to unscrew the coupling mounting screw. Apply a maximum of 90 ft-lb (122 N•m) of torque to the screw.
4. 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

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.



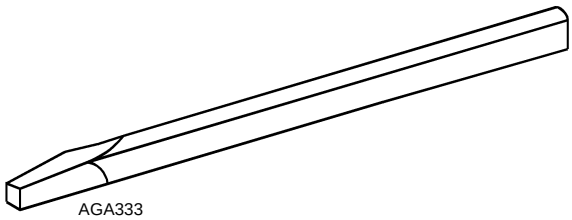
1.	Coupling	5.	10 mm Allen Tool (for large shaft compressor)
2.	Long Spacers (supplied with tool)	6.	5/16 Allen Tool (for small shaft compressors)
3.	Short Spacers (supplied with tool)	7.	Coupling Removal Tool (P/N 204-991)
4.	Socket Head Bolts (supplied with Tool)	8.	Engine Mounting Flange

Compressor Coupling Removal Tool

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

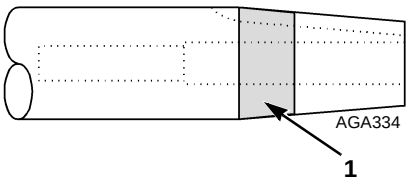
1. Clean the compressor shaft and taper and coupling bore and taper with a solvent that leaves no oily residue (such as naphtha, lacquer thinner, brake cleaner or the like).
2. Inspect both mating surfaces for burrs, oxidation and other surface imperfections. Dress with crocus cloth if necessary and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



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 from the crankshaft.
6. Small (1.0 in.) shaft only—apply a very thin even coating of blue Loctite™ 242 to the back one third of the crankshaft taper.

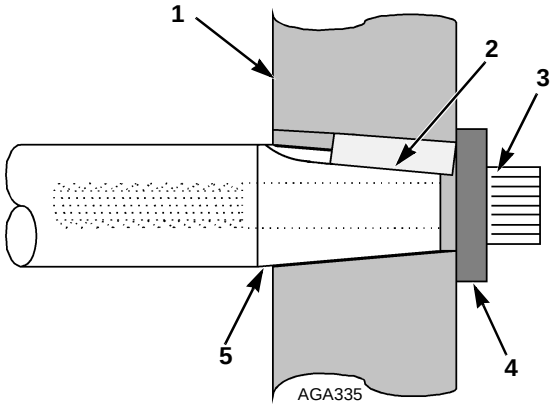


1.	Coat area shown with Blue Loctite 242.

Small Shaft Only

7. Re-install the coupling and align the keyways with the Keyway Tool.
8. **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.
9. 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 coupler.** If tapped in farther it may cause the coupler to move off center on the crankshaft.
10. Re-install the bolt and heavy flatwasher and snug the bolt down by hand. Torque the bolt in the 1.0 in. shaft to 54 ft-lb (73 N•m). Torque the bolt in the 1.187 in. shaft to 90 ft-lb (122 N•m).

11. Inspect the compressor side of the coupling to make sure some Loctite is present at the joint. If not, apply a light coating of Loctite to prevent moisture from wicking into the joint and causing corrosion. It may also be beneficial to cover the exposed part of the crankshaft with some type of corrosion protection such as paint.



1.	Compressor Coupling
2.	Key tapped flush with outside face of coupling. Do not tap key any farther into the keyway.
3.	1.0 in. Shaft—Torque bolt to 54 ft-lb (73 N•m) 1.187 in. Shaft—Torque bolt to 90 ft-lb (122 N•m)
4.	Heavy Washer
5.	Spray paint this area to prevent corrosion

Compressor Coupling Installation

CONDENSER COIL

Removal

1. Remove the refrigerant charge.
2. Open the roadside condenser fan grille.
3. Drain engine coolant from the expansion tank. Unbolt and remove the coolant expansion tank from the condenser coil frame. Unsolder the tank breather tube.
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. Remove 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

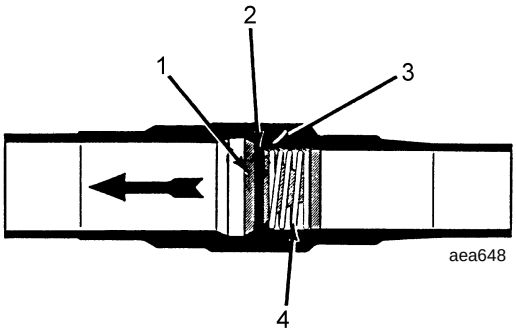
1. Prepare the vibrasorber and tubing fittings by cleaning thoroughly.
2. Solder the vibrasorber connections.

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

Cross Section of In-line Condenser Check Valve

CONDENSER CHECK VALVE REPLACEMENT

Removal

1. Remove 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. Remove the refrigerant charge.
2. Unsolder the condenser check valve line from the receiver tank. Disconnect the filter drier inlet and the bypass check valve lines. Remove the check valve from the receiver tank.
3. Unbolt the mounting brackets and remove the receiver tank from the unit.

Installation

1. Coat the bypass check valve fittings with compressor oil. Install the check valve on the receiver tank outlet tube. Tighten securely, holding the hex on the receiver tank outlet tube with a back-up wrench.
2. 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.
3. Solder the condenser check valve line to the receiver tank.
4. Connect the bypass check valve and filter drier inlet lines.
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 screws and nuts.
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

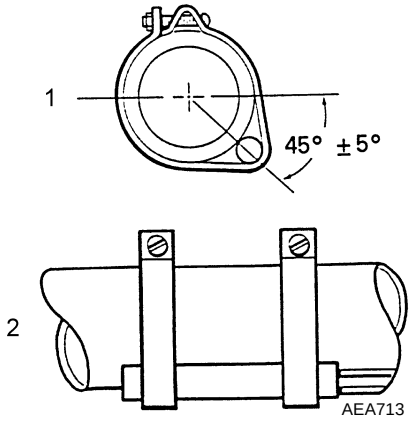
Removal

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

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. Remove 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.

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. Observe the slot in the piston and 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:

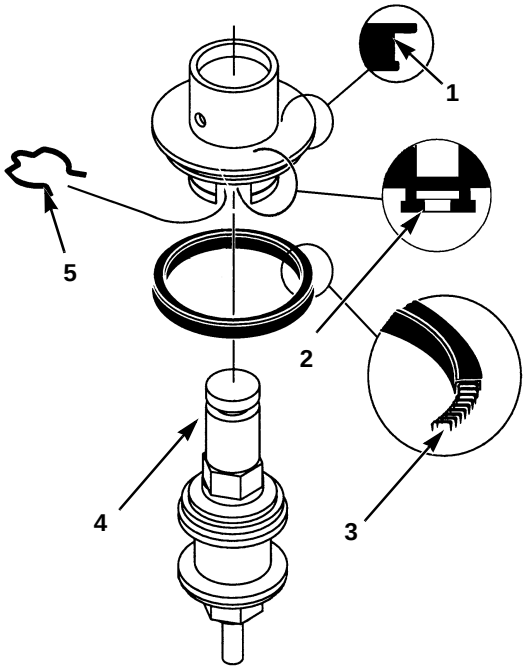
a. Stem assembly.

b. All gaskets.

c. Piston seal.

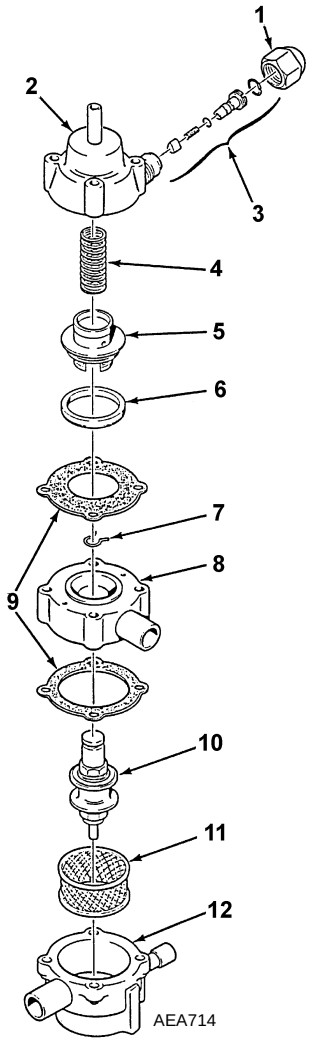
10. Remove the screen. If any particles drop from the screen into the discharge line, the discharge line must be removed at the compressor.

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

Piston & Stem Parts



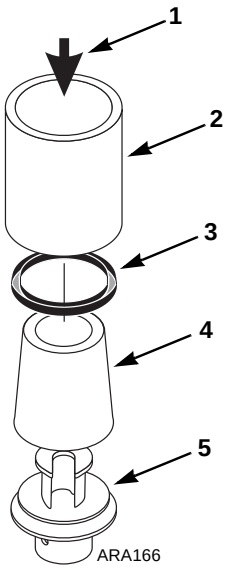
1.	Cap	7.	Clip
2.	Top Cap	8.	Seat
3.	Check Valve	9.	Gaskets
4.	Spring	10.	Stem Assembly
5.	Piston	11.	Screen
6.	Seal	12.	Bottom Cap

Three-Way Valve

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.
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.
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.



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

Seal Installation with Tool P/N 204-1008

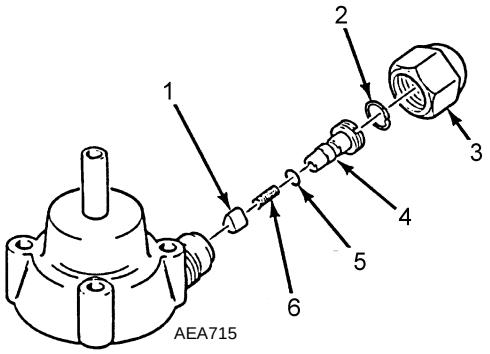
THREE-WAY VALVE CONDENSER PRESSURE BYPASS CHECK VALVE REPAIR

Removal

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



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

Teflon Check Valve Assembly

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. Remove 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. Release the remaining pressure.
3. Disconnect the wires and remove the high pressure cutout switch from the compressor discharge manifold.

Installation

1. Apply a refrigerant locktite 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 refrigeration system 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. Remove the refrigerant charge.
2. Unscrew and remove the high pressure relief valve.

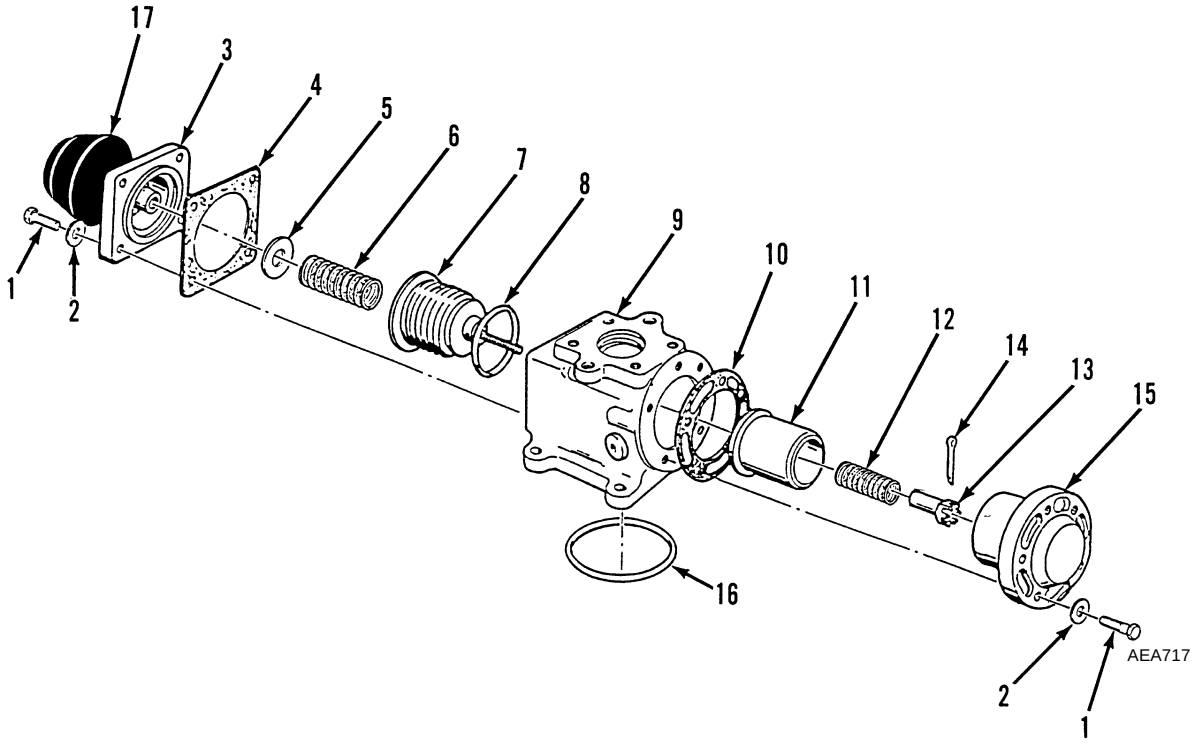
Installation

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 coil.

THROTTLING VALVE

Removal

1. Pump down the low side and equalize the pressure to slightly positive.
2. Front seat the discharge and suction service valves. Release the remaining pressure.
3. Remove the suction service valve and line from the compound gauge.
4. Unbolt and remove the throttling valve from the unit.



1.	SCREW - mtg plate	10.	GASKET - piston housing
2.	FLATWASHER	11.	PISTON
3.	PLATE - bellows end	12.	SPRING - piston
4.	GASKET - end plate	13.	NUT - adjusting
5.	WASHER - adjusting	14.	PIN - cotter
6.	SPRING - bellows	15.	HOUSING - piston
7.	BELLOWS & SHAFT - assy	16.	O-RING - valve to compressor
8.	O-RING	17.	CAP - rubber
9.	HOUSING		

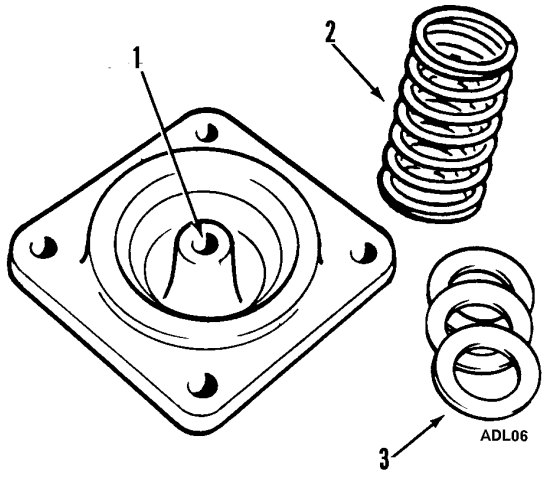
Throttling Valve Assembly

Disassembly

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

   CAUTION: This end cap is under slight spring pressure.

5. Break the gasket free and remove the end cap.
6. Note the number of shims next to the cap. These can be reused.

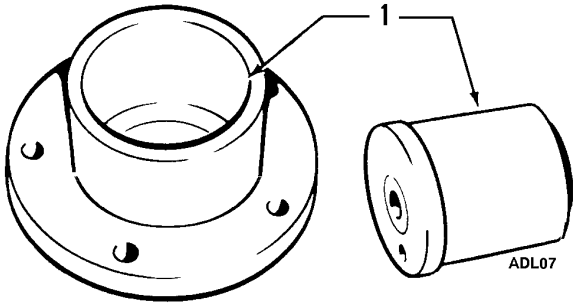


1.	Inspect Cap
2.	Inspect Spring
3.	Shims

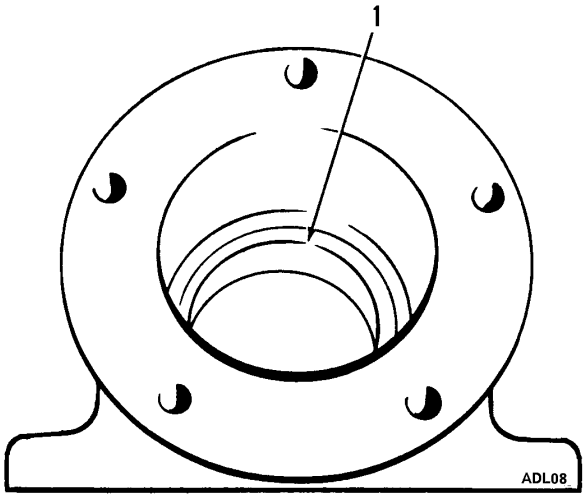
7. Remove the bellows.
8. Inspect all the parts.
   a. Piston and cap for wear (scuff marks).
   b. Body for stripped threads.
   c. Bellows end cap for damage in the pilot hole.

   NOTE: The bellows is normally replaced.

9. Clean the parts that will be reused.



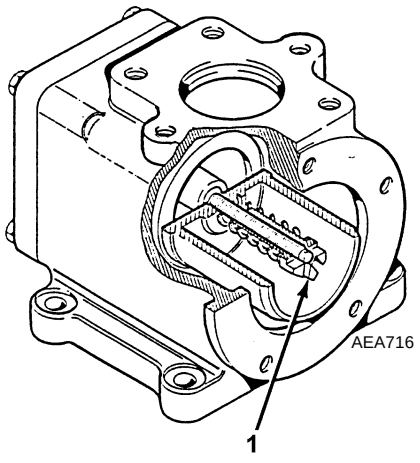
1.	Inspect for Wear



1.	Inspect for Damage

Reassembly

1. Install the bellows with the O-ring in the housing.
2. Center the spring on the bellows shoulder.
3. Oil the gasket, install it on the housing, and place the shims in the end cap (use same number as removed). Tighten the end cap in place with the vent hole closest to the outlet opening of the valve housing.
4. Install the piston, spring and tighten the castle nut until it is firmly seated against the bottom of the piston.
5. Back off the castle nut, one full turn only.
6. Insert the cotter pin.
7. Oil the gasket and install the end cap.
8. The throttling valve will have to be recalibrated on operating unit. (Refer to the Specification section for setting.)
9. Adjust by adding or removing shims under the spring.



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

Installation

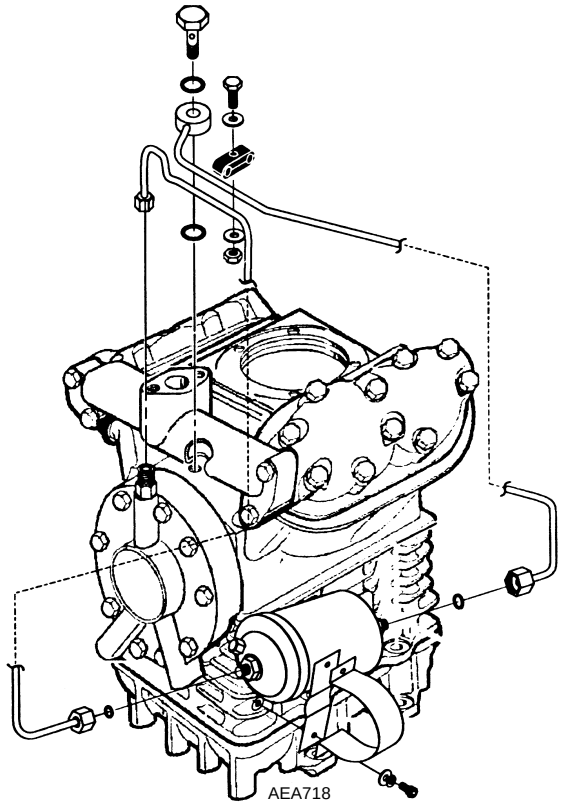
1. Install the throttling valve using a new O-ring soaked in compressor oil. Bolt the throttling valve to the compressor.
2. Install the suction valve and the line from the compound gauge.
3. Pressurize the low side and check for leaks. If no leaks are found, evacuate the low side.
4. Open the refrigeration valves and place the unit in operation.

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.



Compressor Oil Filter

MODULATION VALVE (Optional)

Removal

1. Pump down the low side and equalize pressure to slightly positive.
2. Remove the evaporator access panels.
3. Disconnect the modulation valve wire harness connector and remove the modulation valve coil.
4. Unsolder the elbow and tube that connect the modulation valve to the heat exchanger, and remove the modulation valve, the elbow and the tube.

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

Installation

1. Clean the tubes and elbow for soldering.
2. Properly position the modulation valve, the tube, and the elbow between the evaporator outlet and the heat exchanger inlet.
3. Solder the connections.

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

4. Pressurize the low side and test for leaks. If no leaks are found, evacuate the low side.
5. Install the coil on the modulation valve and connect the wires.
6. Install the evaporator access panels.
7. Open the refrigeration valves and place the unit in operation.

HOT GAS SOLENOID VALVE (Optional)

Removal

1. Remove 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 tube 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.

Structural Maintenance

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.

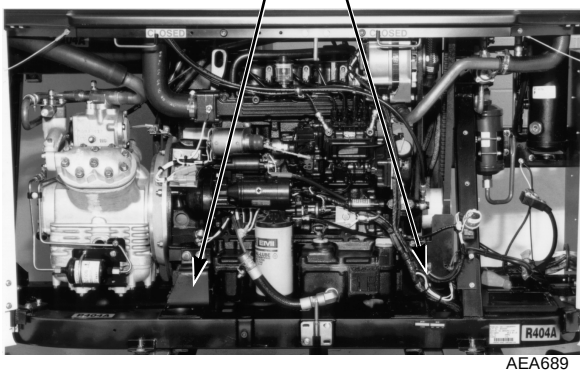
DEFROST DRAINS

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

Unit and Engine Mounting Bolts

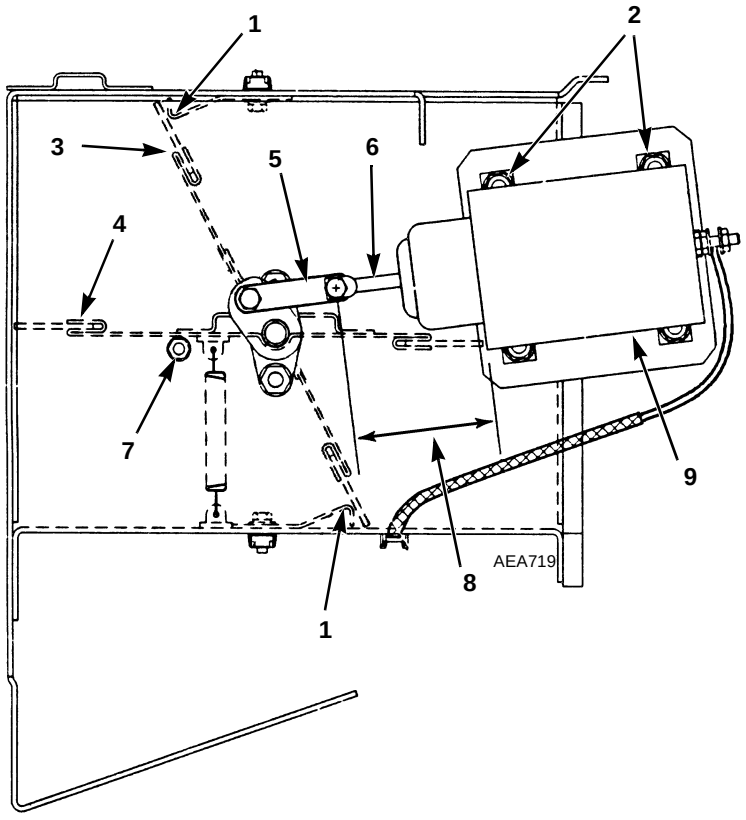
DEFROST DAMPER

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.



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		

Defrost Damper Adjustment

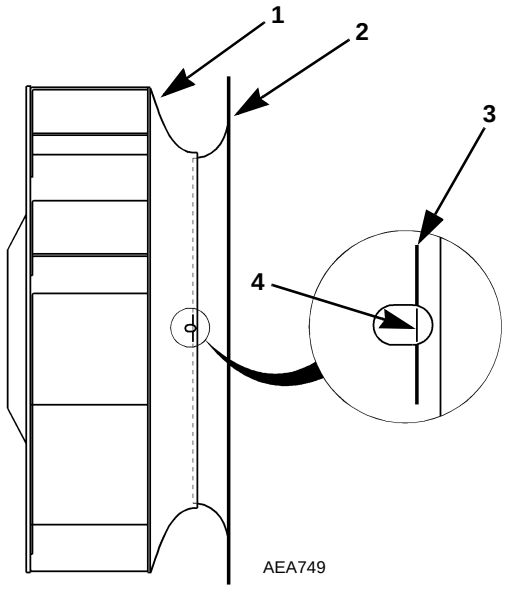
3. Check Distance A, the distance from the shoulder on the solenoid to the center of the hole in the eye bolt. Distance A should be 2.75 in. (69.85 mm) with the solenoid de-energized.
4. If necessary, adjust Distance A to the proper dimension by loosening the lock nut on the end of the solenoid plunger and turning the eye bolt. Tighten the lock nut 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.
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.
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).

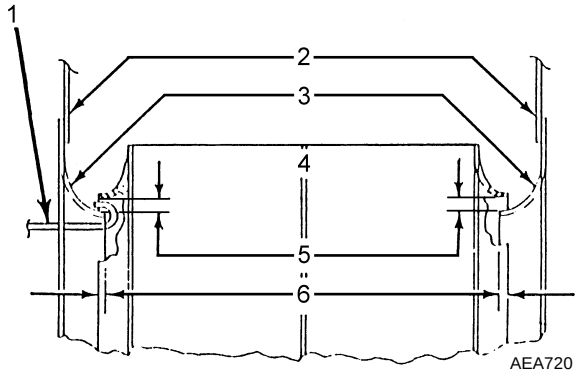


1.	Blower Wheel	3.	Alignment Mark
2.	Inlet Ring	4.	Edge of Inlet Ring

Condenser Blower Alignment

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

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.

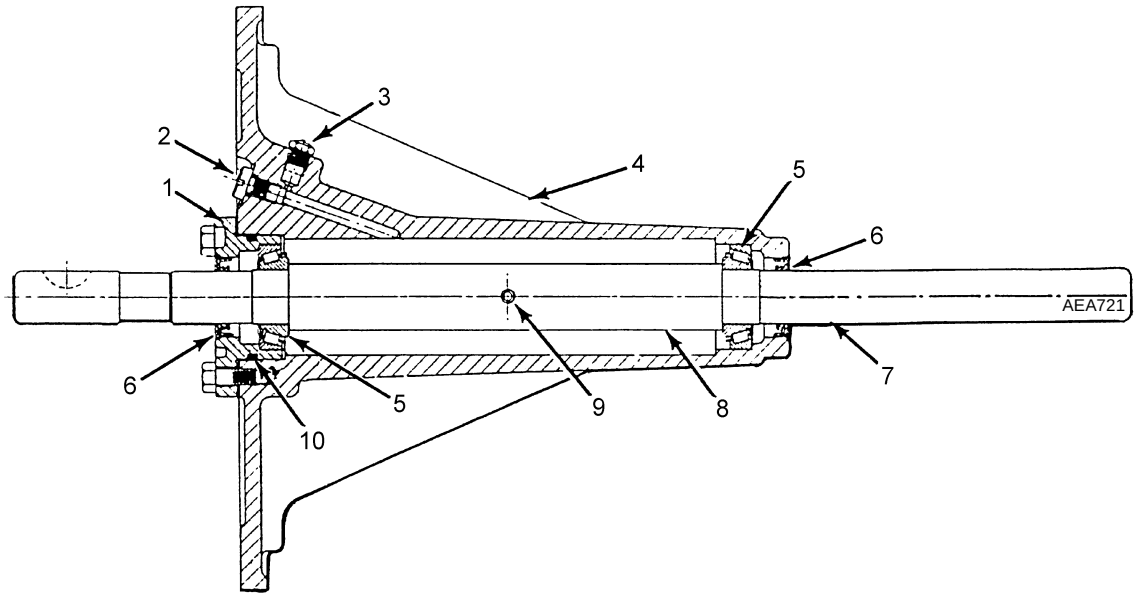
8. The bearing races can now be driven out with a punch and replaced in the same manner.

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



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

Fan Shaft Assembly

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 pretrip 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:

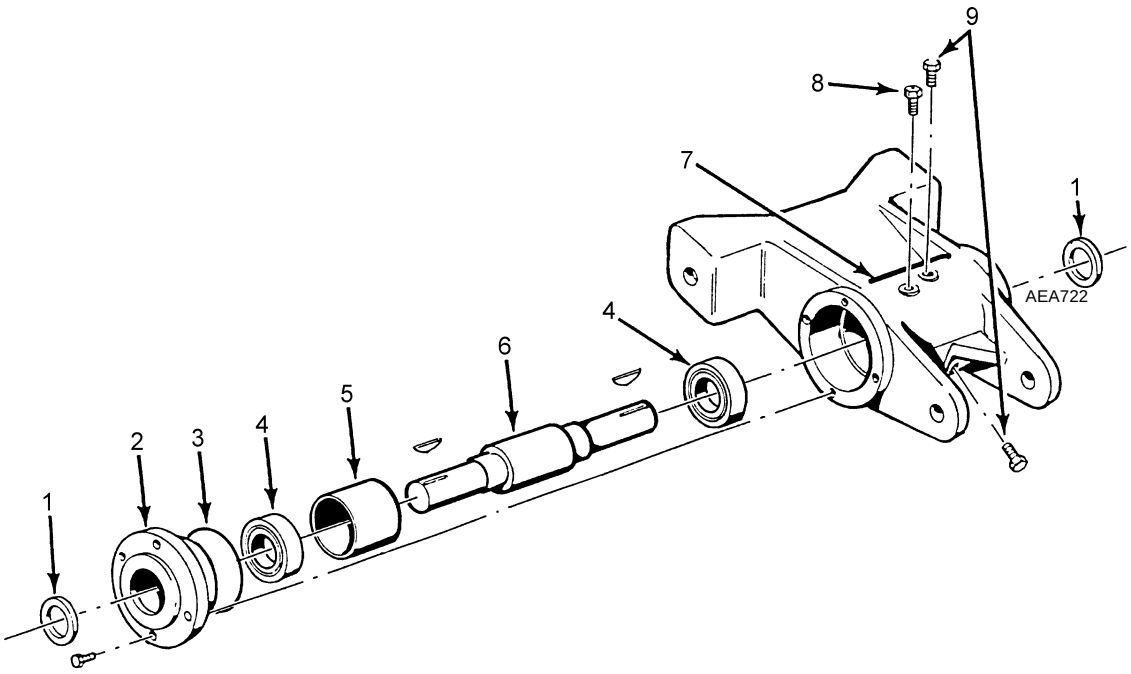
0.020 in. (0.500 mm)	Thermo King P/N 99-4231
0.007 in. (0.177 mm)	Thermo King P/N 99-2902
0.005 in. (0.127 mm)	Thermo King P/N 99-2901

7. After the correct end-play is obtained, add approximately 1.5 oz (44 ml) of oil for the bearings.

   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.

8. 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		

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 Operation and Diagnosis 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

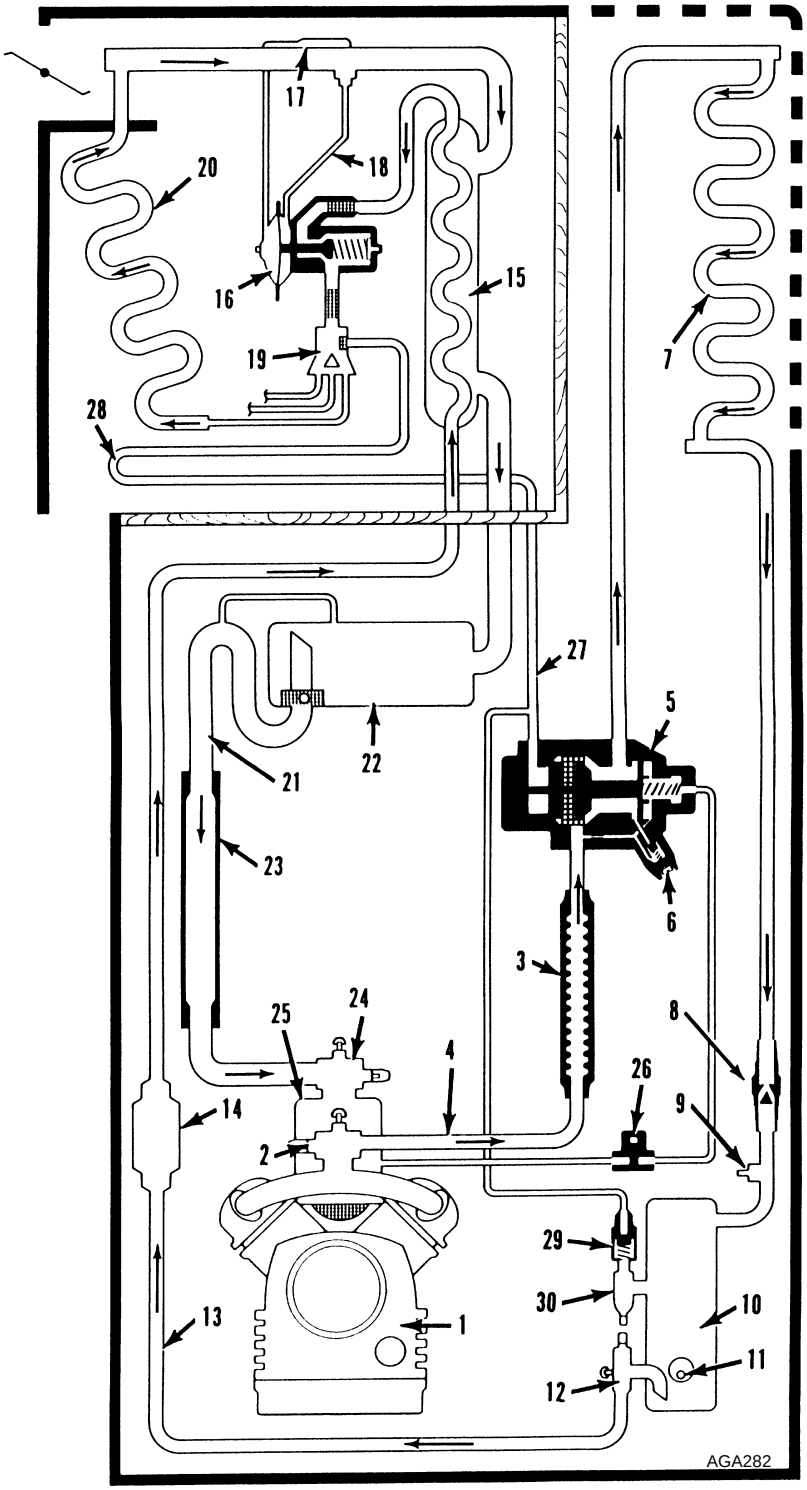
Refrigeration Diagnosis

Rapid cycling between cool and heat	Unit cools in heat and defrost cycle	Unit heats in refrigeration cycle	High head pressure	Low head pressure	No head pressure	High suction pressure	Low suction pressure	No suction pressure	Unit operating in a vacuum	Receiver sight glass empty	Suction line frosting back	Unable to pump down system	Unable to pull vacuum in low side	Unable to hold vacuum in low side	Noisy compressor	Unit not refrigerating	Unit not heating or defrosting	SYMPTOM / POSSIBLE CAUSES
			•			•									•	•		Overcharge of refrigerant
				•			•		•	•						•	•	Shortage of refrigerant
				•				•	•							•	•	No refrigerant
			•															Air through condenser too hot (ambient)
			•															Air flow through condenser restricted
				•			•			•								Air through condenser too cold (ambient)
			•												•	•		Air in refrigerant system
			•															Condenser fan blades bent or broken
•																		Air short cycling around evaporator coil
							•											Air through evaporator restricted
							•		•		•				•			Evaporator needs defrosting
				•									•					Compressor discharge valves leaking
						•						•						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

Rapid cycling between cool and heat	Unit cools in heat and defrost cycle	Unit heats in refrigeration cycle	High head pressure	Low head pressure	No head pressure	High suction pressure	Low suction pressure	No suction pressure	Unit operating in a vacuum	Receiver sight glass empty	Suction line frosting back	Unable to pump down system	Unable to pull vacuum in low side	Unable to hold vacuum in low side	Noisy compressor	Unit not refrigerating	Unit not heating or defrosting	**SYMPTOM** **POSSIBLE CAUSES**
							•									•		Expansion valve 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
					•													Discharge service valve back seated
								•										Suction service valve back seated
	•	•		•		•						•		•		•	•	Faulty three-way valve
	•	•										•				•	•	Faulty pilot solenoid
	•																•	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
							•	•	•							•	•	Modulation valve stuck closed
				•		•						•				•	•	Hot gas bypass valve stuck open or leaking

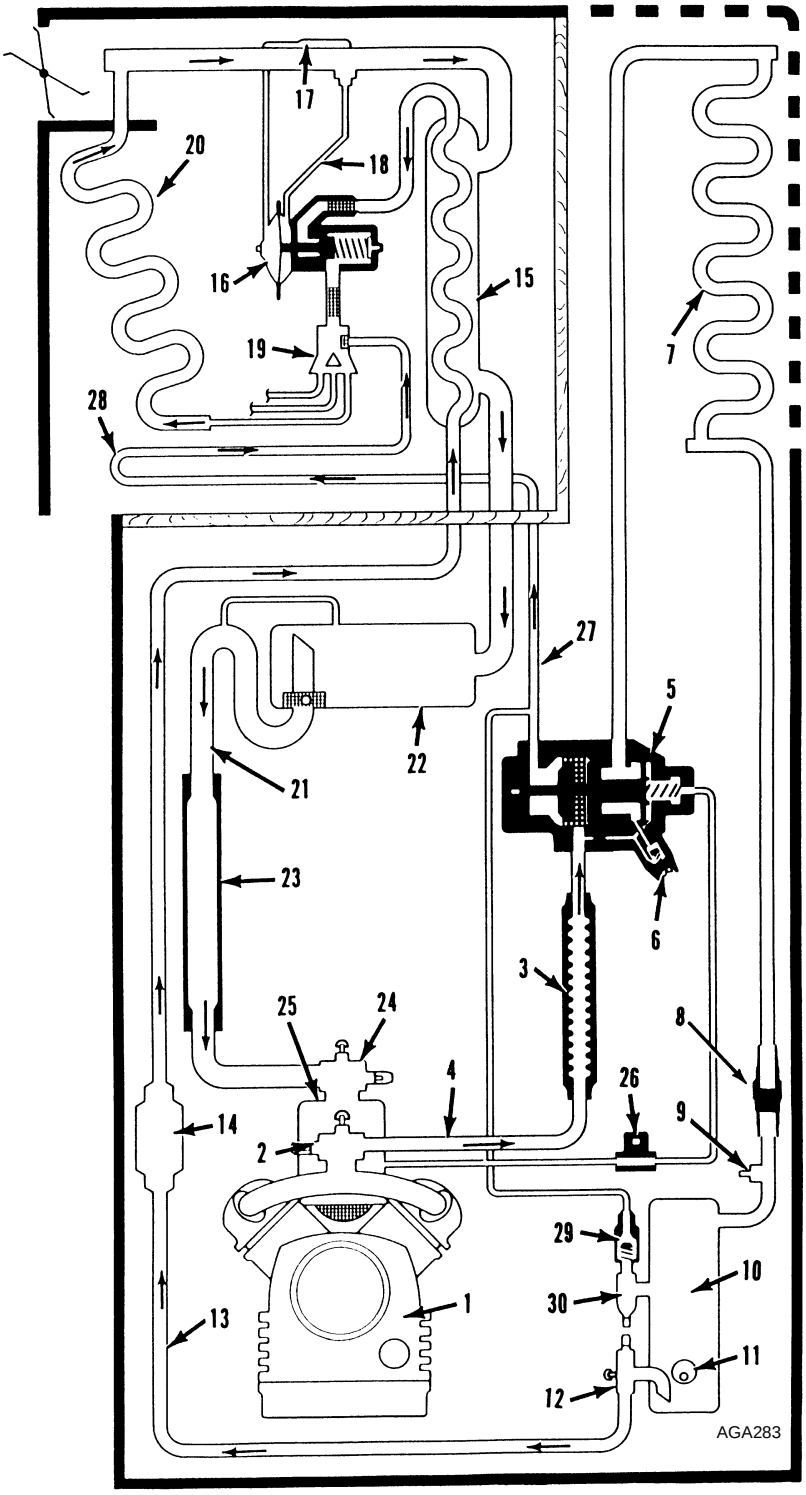
Cool Cycle

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.	Throttling Valve
26.	Pilot Solenoid
27.	Hot Gas Line
28.	Defrost Pan Heater
29.	Bypass Check Valve
30.	Bypass Service Valve



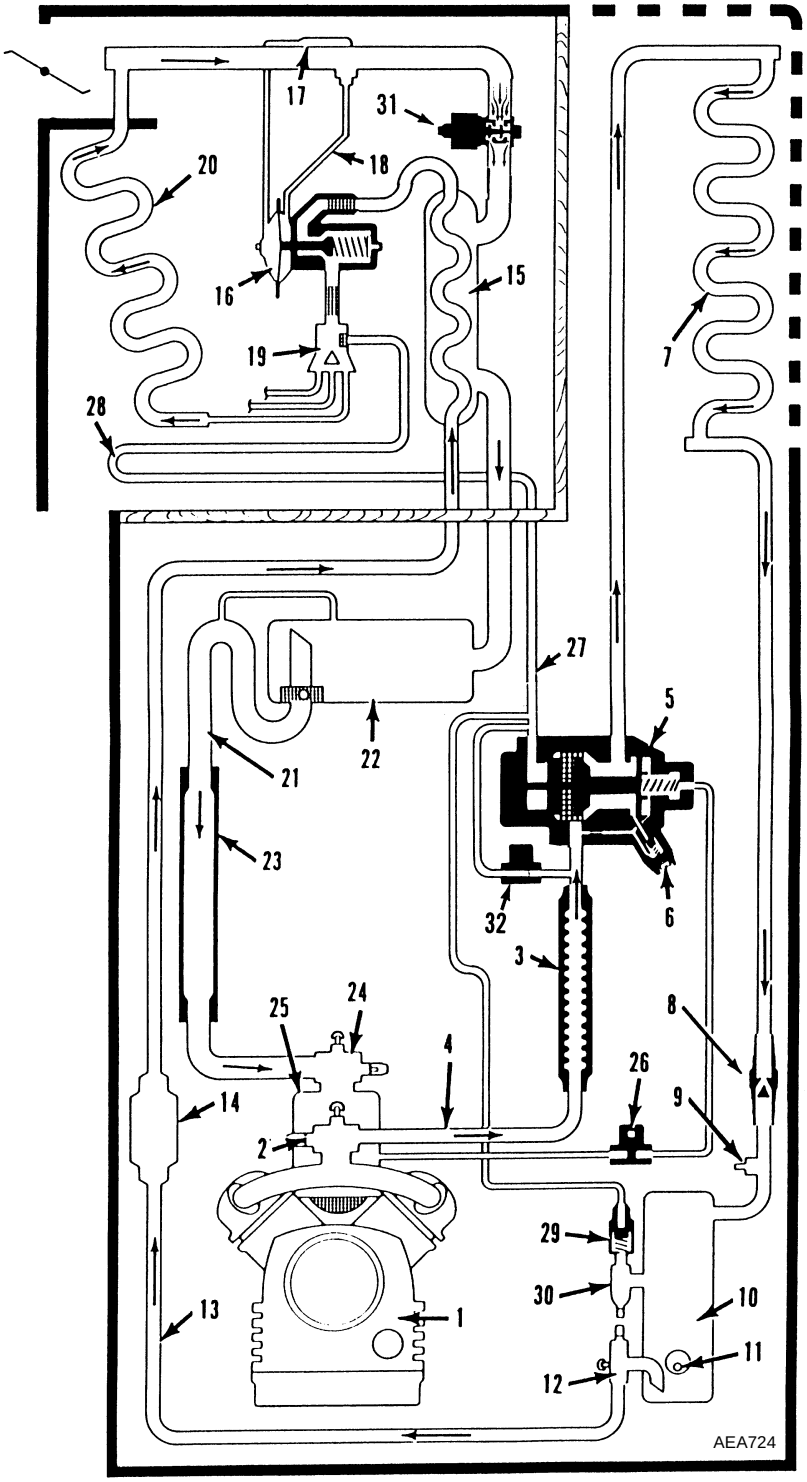
Defrost and Heating Cycle

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.	Throttling Valve
26.	Pilot Solenoid
27.	Hot Gas Line
28.	Defrost Pan Heater
29.	Bypass Check Valve
30.	Bypass Service Valve



Cool Cycle With Modulation

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.	Throttling Valve
26.	Pilot Solenoid
27.	Hot Gas Line
28.	Defrost Pan Heater
29.	Bypass Check Valve
30.	Bypass Service Valve
31.	Modulation Valve
32.	Hot Gas Bypass Valve



Defrost and Heating Cycle With Modulation

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
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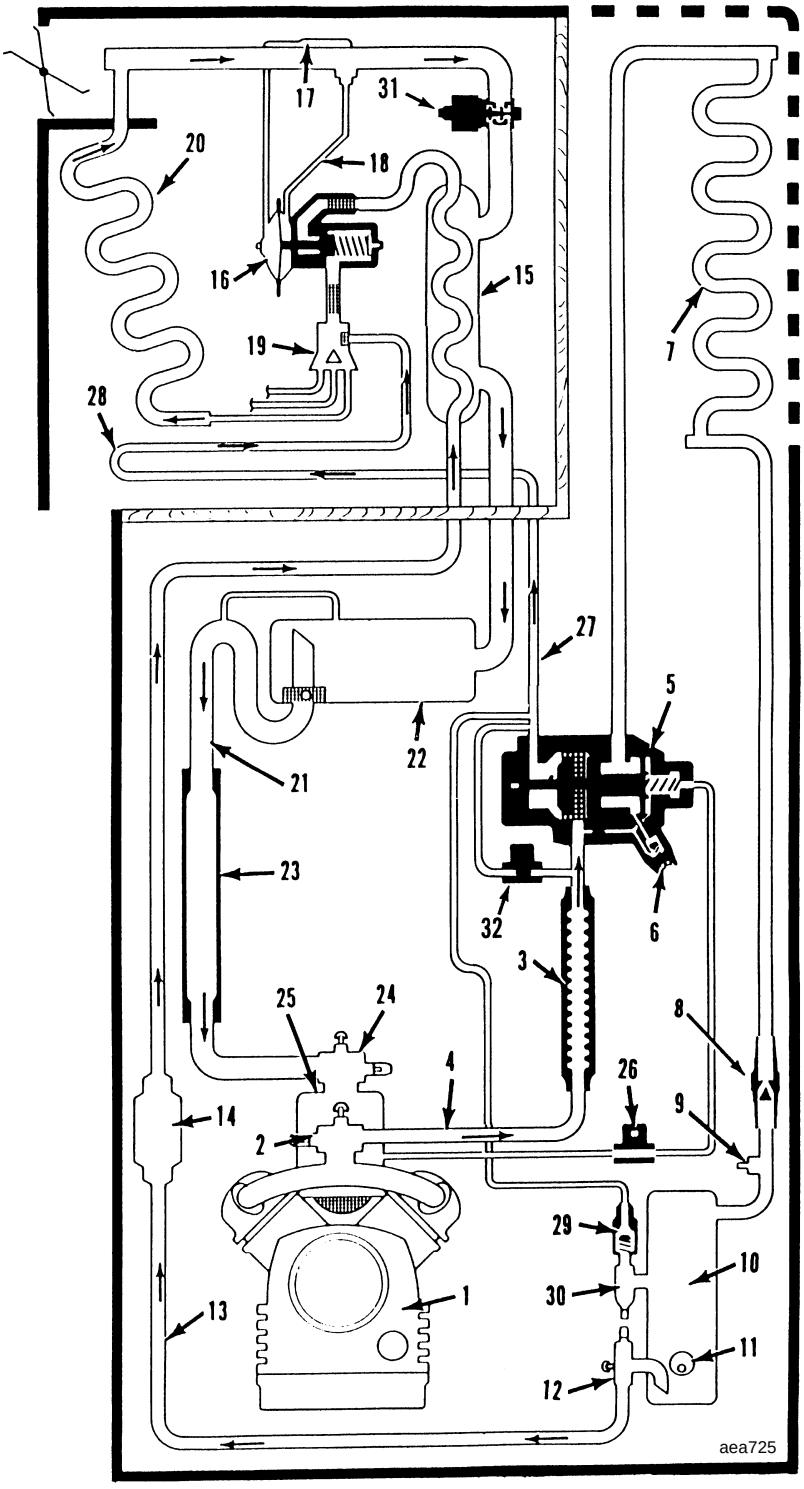
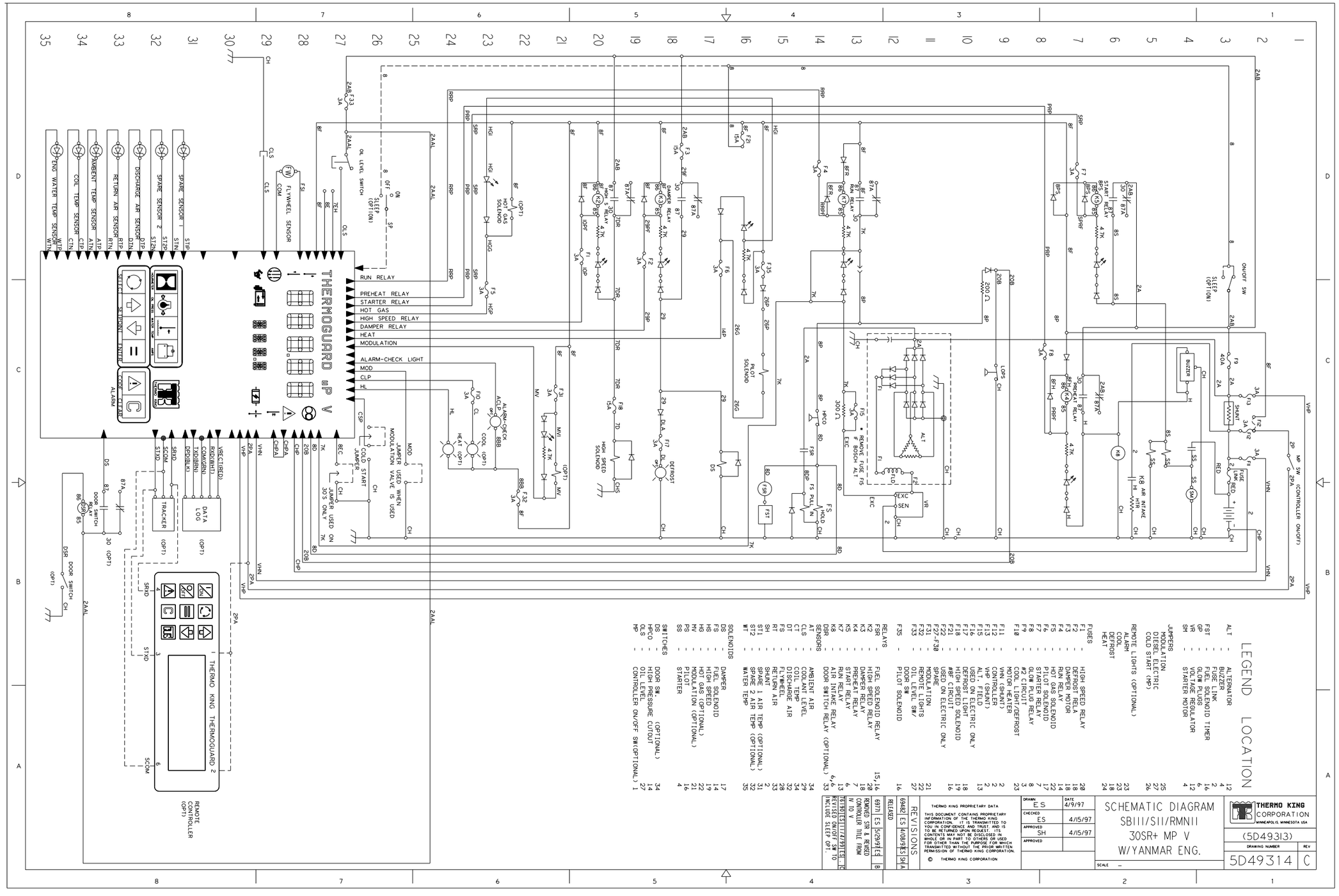
27.	Hot Gas Line
28.	Defrost Pan Heater
29.	Bypass Check Valve
30.	Bypass Service Valve
31.	Modulation Valve
32.	Hot Gas Bypass Valve

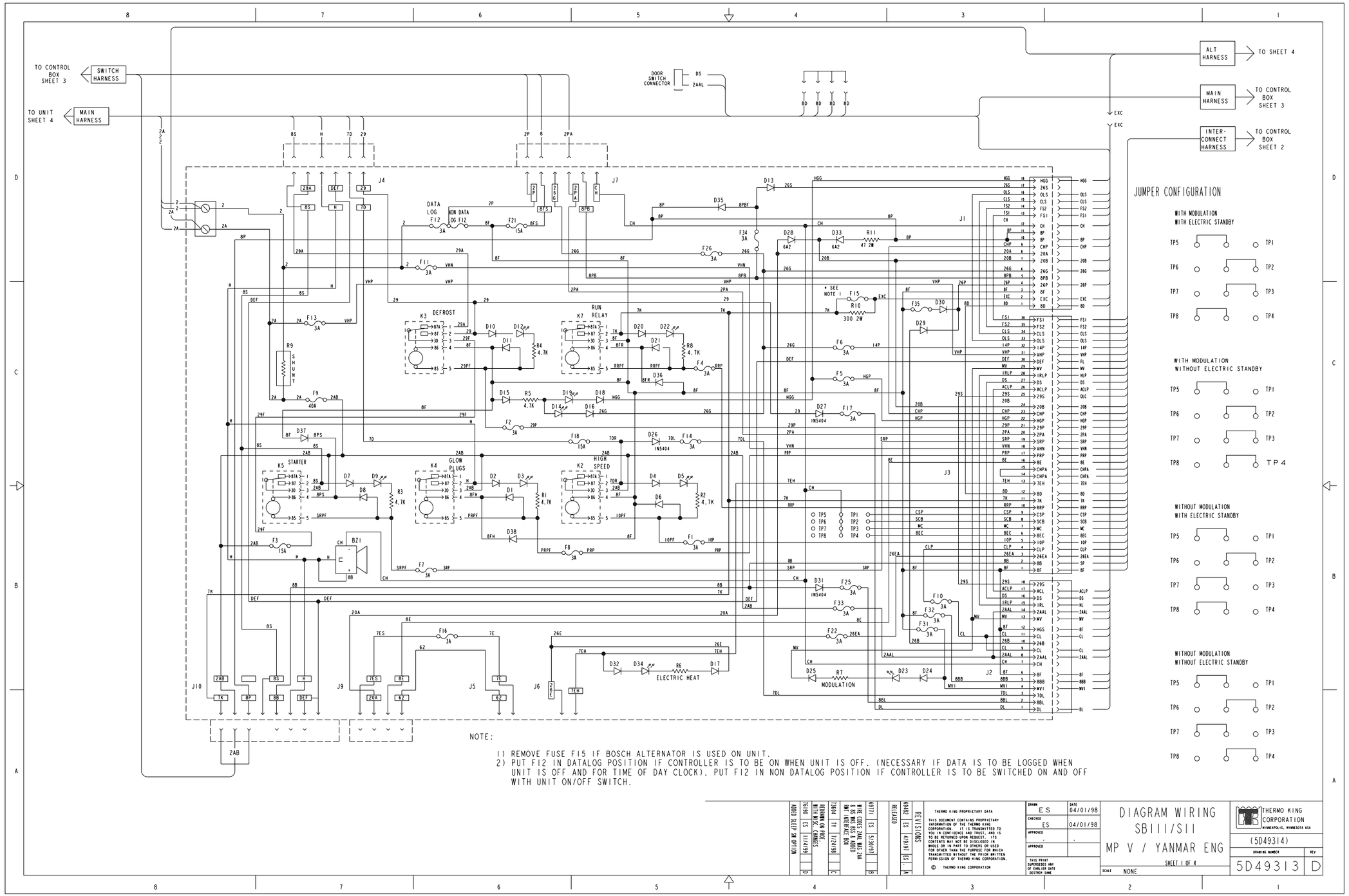


Wiring Diagram Index

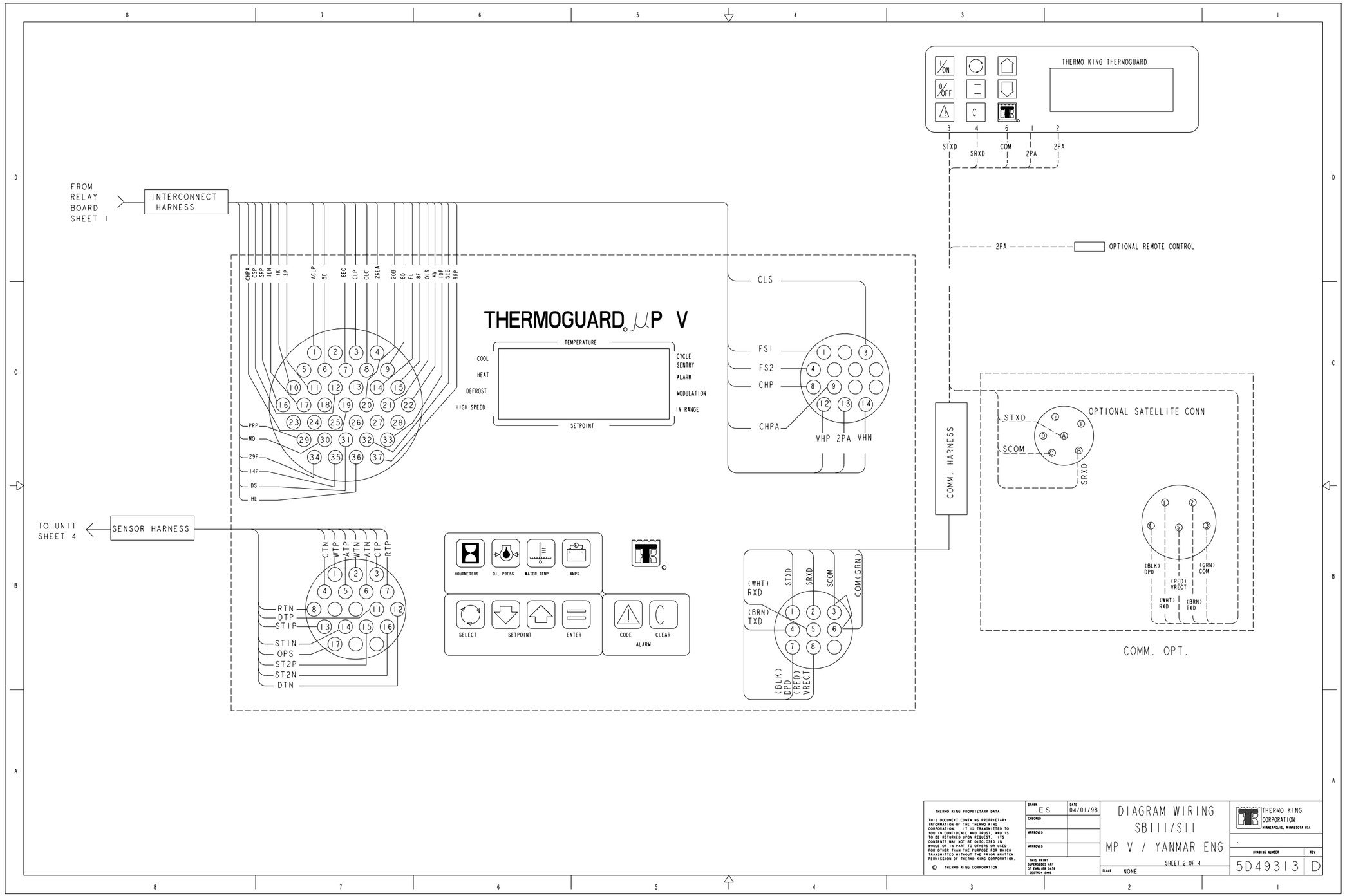
Early Model (Coiled Wire Fuse Link) Wiring Schematic



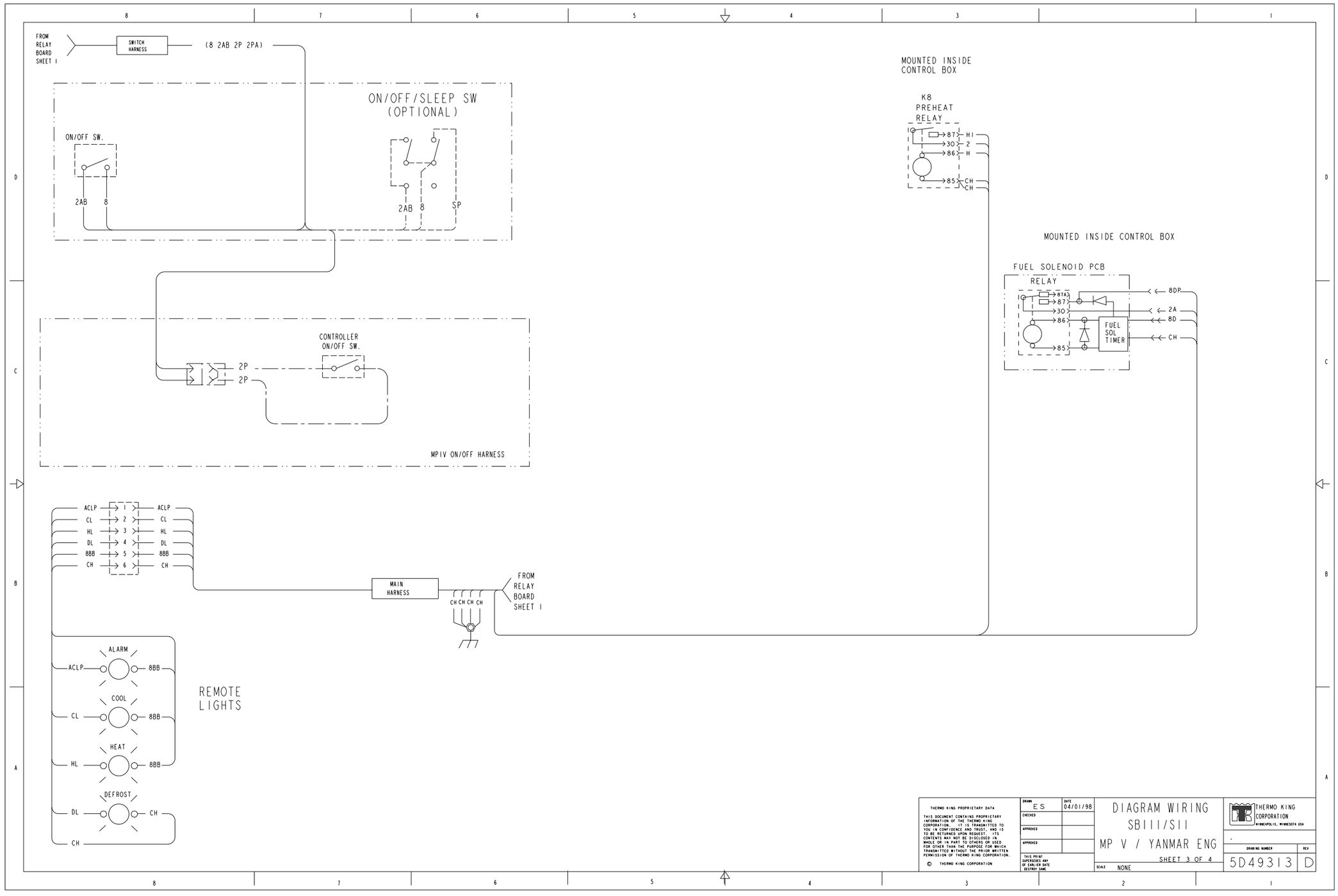
Early Model (Coiled Wire Fuse Link) Wiring Diagram—Page 1 of 4



Early Model (Coiled Wire Fuse Link) Wiring Diagram—Page 2 of 4



Early Model (Coiled Wire Fuse Link) Wiring Diagram—Page 3 of 4



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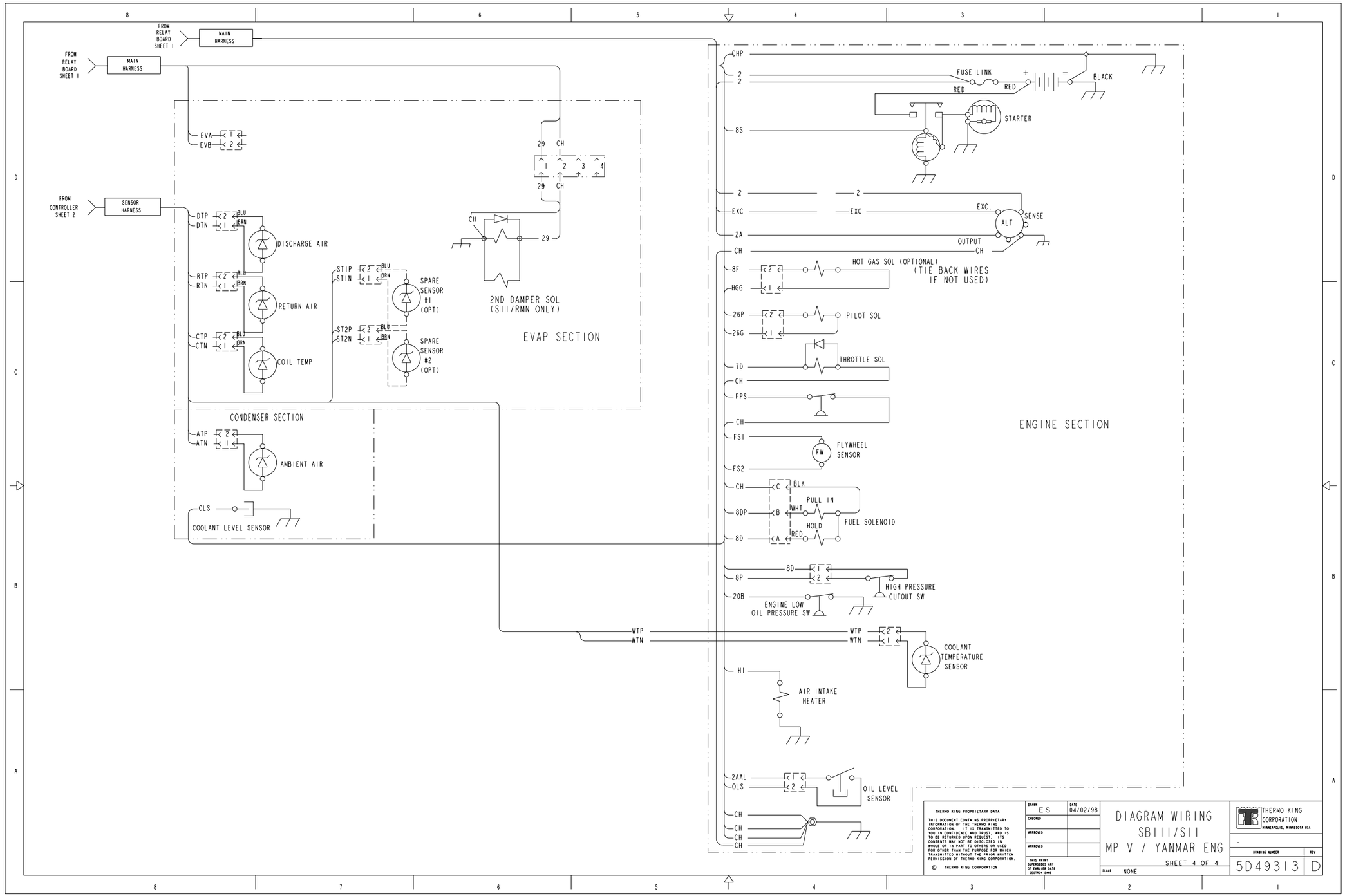
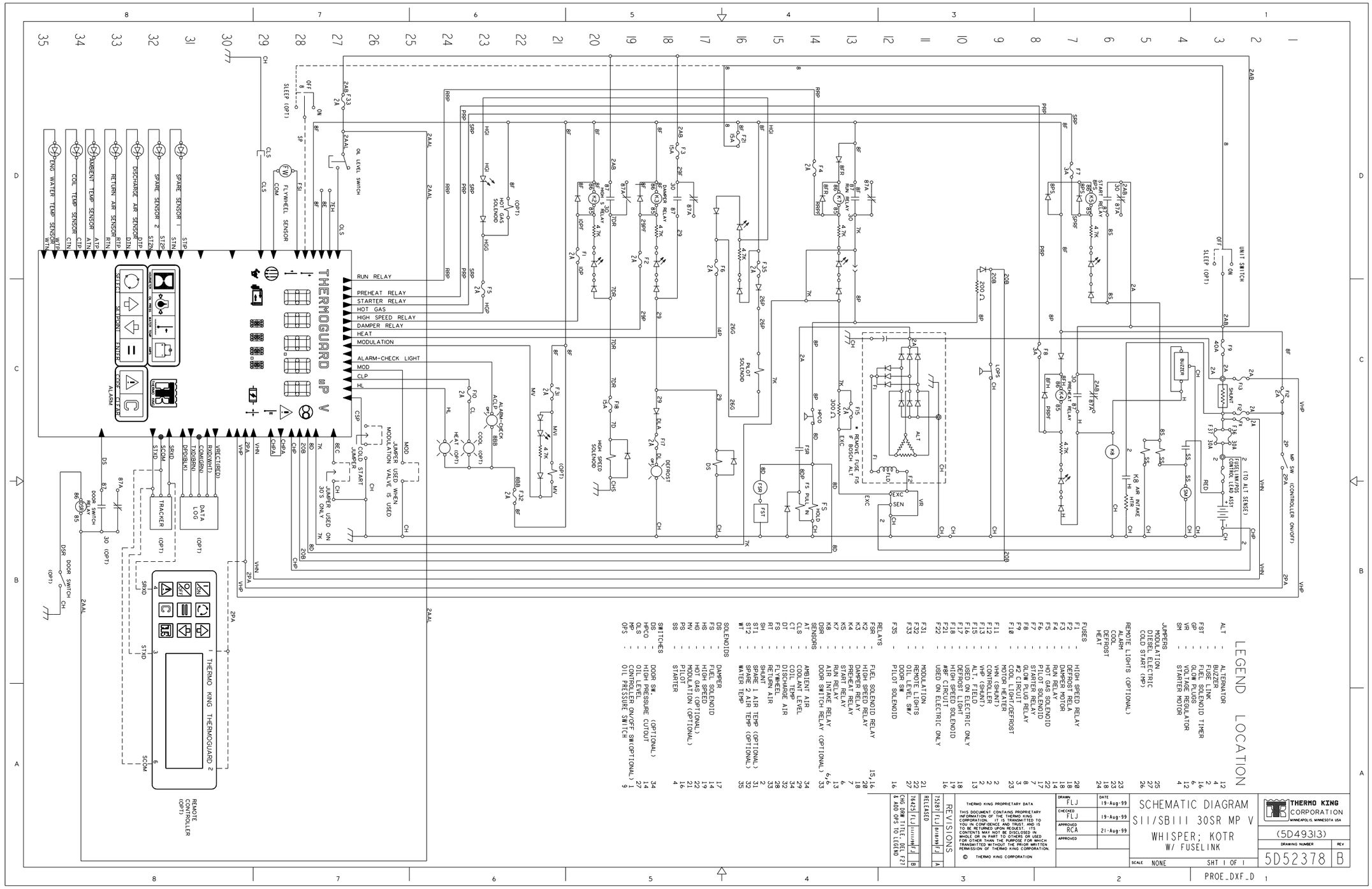
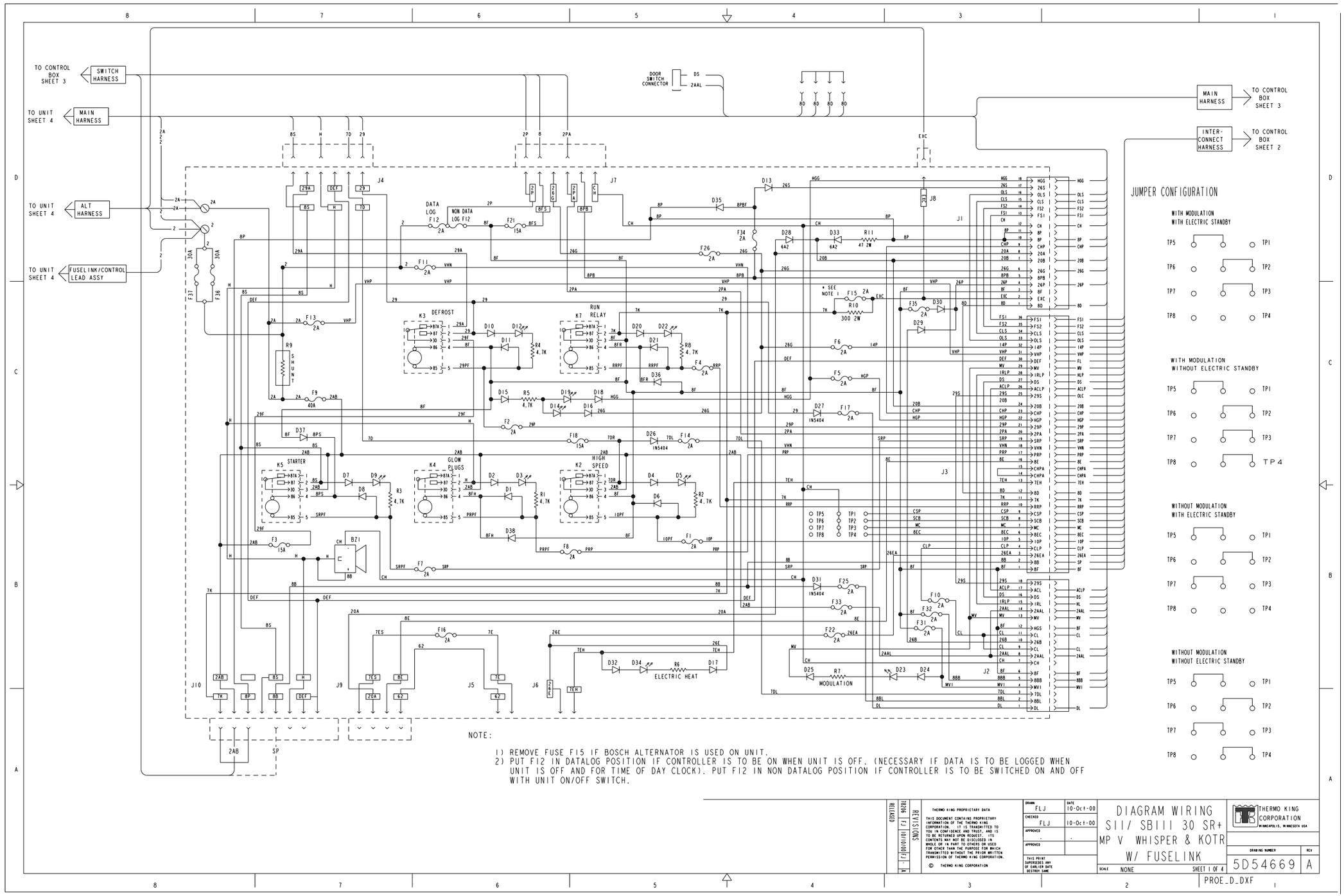
Early Model (Coiled Wire Fuse Link) Wiring Diagram—Page 4 of 4



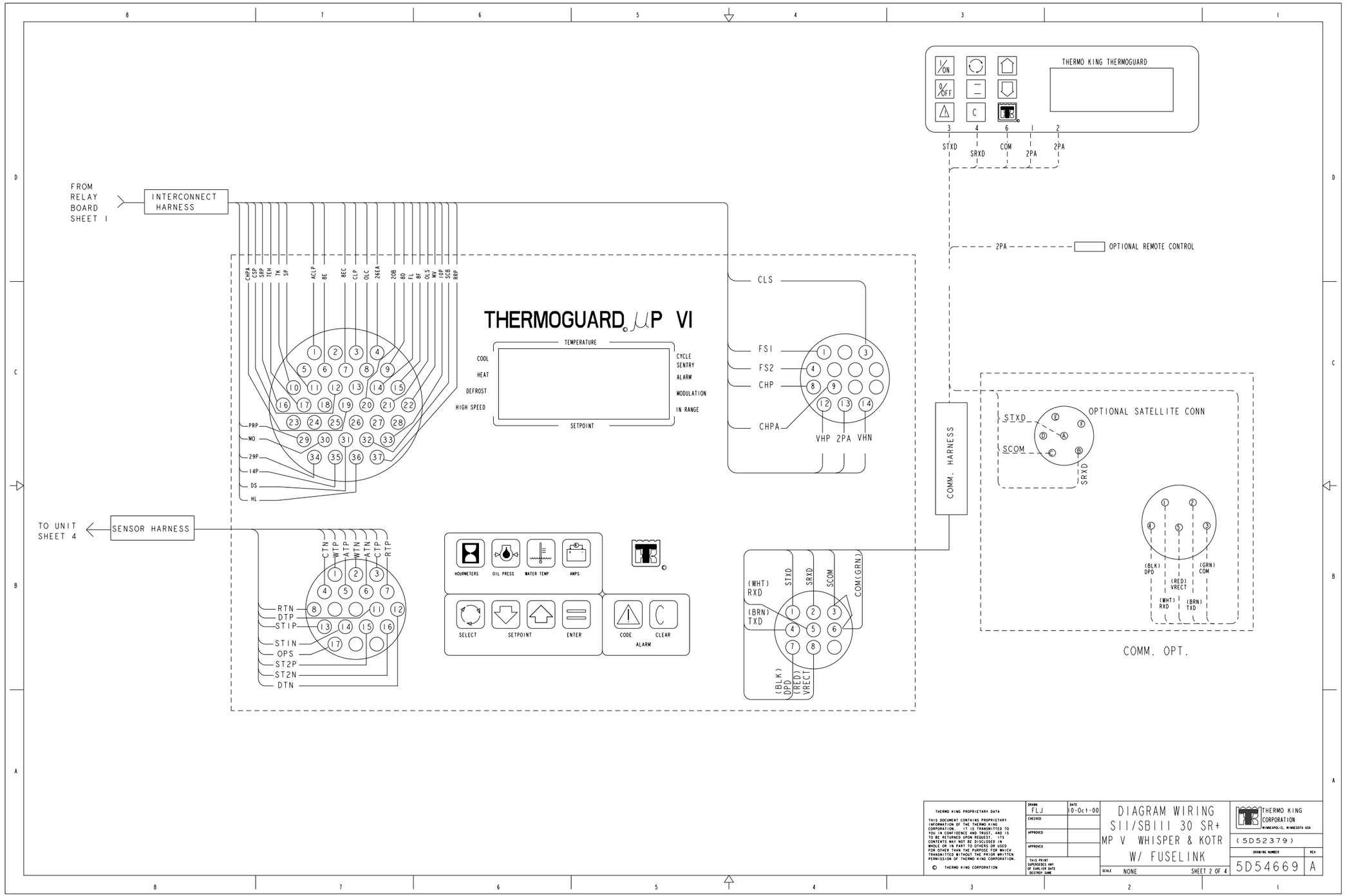
Late Model (Fuse Link in Battery Cable) Wiring Schematic



Late Model (Fuse Link in Battery Cable) Wiring Diagram—Page 1 of 4



Late Model (Fuse Link in Battery Cable) Wiring Diagram—Page 2 of 4



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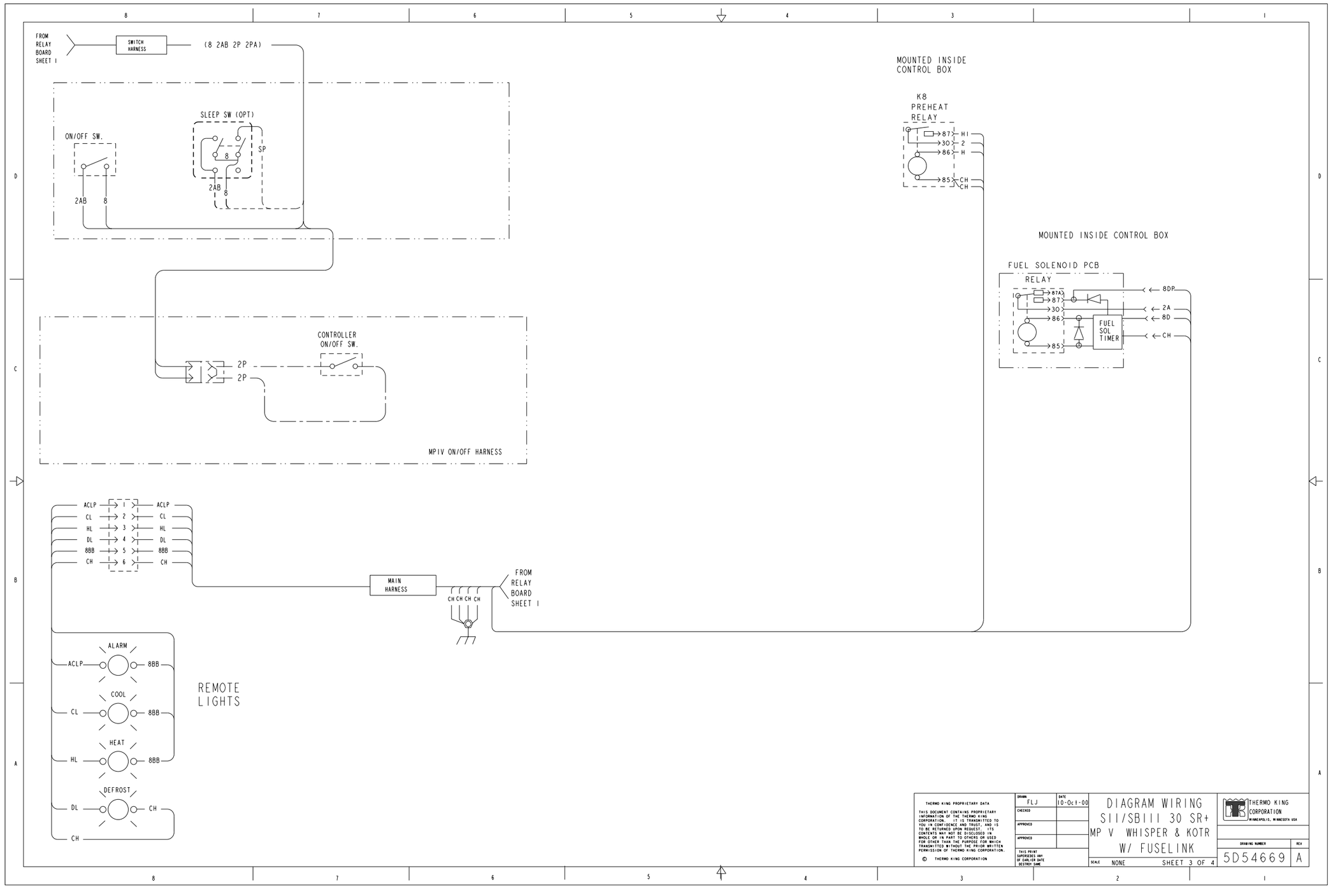
Late Model (Fuse Link in Battery Cable) Wiring Diagram—Page 3 of 4



Late Model (Fuse Link in Battery Cable) Wiring Diagram—Page 4 of 4