MD-200

w/TK 3.74

TK 51912-1-MM (Rev. 0, 07/03)

The maintenance information in this manual covers unit models:

MD-200 30	**MD-200 50 230/3/60 EEC**
MD-200 30 230/3/60	**MD-200 50 380/3/50 EEC**
MD-200 50 380-460/3/50-60	**MD-200 30 R-134a**
MD-200 30 EEC	**MD-200 50 R-134a**
MD-200 50 220/3/50 EEC	

For further information, refer to:

MD-200 Operator's Manual	**TK 51913**
MD-200 Parts Manual	**TK 51911**
2.44, 2.49, 3.66, 3.74, 3.88, and 3.95 Engine Overhaul Manual	**TK 8312**
Diagnosing Thermo King Refrigeration Systems	**TK 5984**
Tool Catalog	**TK 5955**
Thermoguard µP-T Microprocessor Controller	**TK41087**
The Collector Refrigeration Recovery Unit	**TK40956**
Principals of Evacuation for Field Application	**TK 40612**
Electrostatic Discharge Training Guide	**TK 40282**

The information in this manual is provided to assist owners, operators and service people in the proper upkeep and maintenance of Thermo King units.

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

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Recover Refrigerant

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

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

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

R-404A

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

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

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

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Safety Precautions

General Practices

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

Auto Start/Stop

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

Refrigerant

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

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

First Aid

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

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

Refrigeration Oil

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

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

First Aid

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

Electrical Hazards

Microprocessor Service

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

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

1. Disconnect all power to the unit.
2. Avoid wearing clothing that generates static electricity (wool, nylon, polyester, etc.).
3. Do wear a static discharge wrist strap (see Tool Catalog) with the lead end connected to the microprocessor's ground terminal. These straps are available at most electronic equipment distributors. Do not wear these straps with power applied to the unit.
4. Avoid contacting the electronic components on the circuit boards of the unit being serviced.
5. Leave the circuit boards in their static proof packing materials until ready for installation.
6. If a defective controller is to be returned for repair, it should be returned in the same static protective packing materials from which the replacement component was removed.
7. After servicing the controller or any other circuits, the wiring should be checked for possible errors before restoring power.
8. Never use testers consisting of a battery and a light bulb to test circuits on any microprocessor based equipment.
9. Before connecting or disconnecting the battery, the Microprocessor On/Off switch must be turned to the Off position.

Welding of Units or Truck Bodies

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

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

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

High Voltage

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

Precautions

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

First Aid

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

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

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

Low Voltage

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

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

Specifications

ENGINE SPECIFICATIONS

Engine	TK 3.74
Fuel Type	No. 2 Diesel fuel under normal conditions
Oil Capacity: Crankcase & Oil Filter	9 quarts (8.6 liters)
w/Bypass Oil Filter	10 quarts (9.6 liters)
	Fill to full mark on dipstick
Oil Type*	API Type CF-4 or CG-4 or better
	API Synthetic type CF-4, CG-4 or better after first 500 hours
Oil Viscosity*	**Multigrade Oil — Ambient Temperature**
	SAE 5W-30 — -22 to +86 F (-30 to +30 C)
	SAE 10W-30 — -4 to +86 F (-20 to +30 C)
	SAE 10W-40 — -4 to +104 F (-20 to +40 C)
	SAE 15W-40 — +5 to +104 F (-15 to +40 C)
Engine rpm: Low Speed Operation	1625 ± 25 rpm
High Speed Operation	2425 ± 25 rpm
Engine Oil Pressure	35 to 60 psig (241 to 414 kPa)
Intake Valve Clearance	0.0079 in. (0.20 mm)
Exhaust Valve Clearance	0.0079 in. (0.20 mm)
Valve Setting Temperature	Room temperature
Timing Injection Pump	14° BTDC
Injection Nozzle Pressure	1706 psig (11720 kPa)
Low Oil Pressure Sensor	10 ± 3 psig (69 ± 21 kPa)—shutdown
High Coolant Temperature Sensor	220 ± 5.0 F (104 ± 3 C)—shutdown
Engine Thermostat	180 to 190 F (82 to 88 C)
Coolant System Capacity	4 quarts (3.81 liters) with overflow tank
Radiator Cap Pressure	10 psig (69 kPa)
Drive	Belts to compressor, fans, 12 V alternator, water pump and electric motor (jackshaft)

Multi-viscosity weight oil with the recommended API classification may be used based on the ambient temperature. The above recommendations are written for mineral oil based lubricants.

R-134a REFRIGERATION SYSTEM

Compressor Model	X214
Refrigerant Charge	6.5 lb. (2.95 kg) R-134a
Compressor Oil Charge	102 oz. (3.0 liters)*
Compressor Oil Type: R-134a (Solest 35)	TK No. 203-413 (Ester base) required
Suction Pressure Regulator Setting	18 psig (124 kPa)
Heat/Defrost Method:Engine Operation	Hot gas
Electric Operation	Hot gas and electric heater strips (Model 50)
High Pressure Cutout	300 ± 25 psig (2068 ± 172 kPa)
	Automatically reset @ 200 ± 20 psig (1379 ± 138 kPa)

R-404A REFRIGERATION SYSTEM

Compressor Model	X214
Refrigerant Charge	6.5 lb. (2.95 kg) R-404A
Compressor Oil Charge	102 oz. (3.0 liters)*
Compressor Oil Type: R-404A (Solest 35)	TK No. 203-413 (Ester base) required
Suction Pressure Regulator Setting	20 psig (138 kPa)
Heat/Defrost Method: Engine Operation	Hot gas
Electric Operation	Hot gas and electric heater strips (Model 50)
High Pressure Cutout	470 ± 7 psig (3240 ± 48 kPa) Automatically reset @ 375 ± 38 psig (2585 ± 262 kPa)

NOTE: Compressors are equipped with an oil filter. Every 2 years of operation or whenever there is a major service procedure performed, both the compressor oil filter and filter-drier must be changed.

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

ENGINE CLUTCH—HILLIARD

Model	TK No. 107-272 (Dwg. No. 2C21375G01)
Engagement	600 ± 100 rpm
Dynamic Torque	66 ft-lb (89.5 N•m) minimum @ 1600 rpm

BELT TENSION

	Tension No. on TK Gauge 204-427	
	New Belt	Field Reset
Engine/Compressor	75 ± 3	70 ± 3
Compressor/Jackshaft (Electric Motor)	72 ± 3	67 ± 3
Compressor/Evaporator Fan/Alternator	55 ± 3	50 ± 3
Alternator/Evaporator Fan	55 ± 3	50 ± 3
Water Pump	1/2 in. (13 mm) deflection	

NOTE: These are the original factory settings. Because it is difficult to use the TK gauge 204-427 in the field, adjust each belt to allow 1/2 inch (13 mm) deflection at the center of the longest span.

NOTE: Belts should be tensioned cold and again tensioned cold after 10 hours of unit running.

ELECTRICAL CONTROL SYSTEM

Control System Voltage	12.5 Vdc
Battery Charging System	12 V 23 amp brush type integral alternator
Voltage Regulator Setting	14 V @ 70 F (21.1 C)
Alternator/Regulator Capacitor	4.7 µfd 50 Vdc
Alternator/Output Capacitor	0.5 µfd 100 Vdc

NOTE: Disconnect components from unit circuit to check resistance.

ELECTRICAL COMPONENTS

	Current Draw (Amps) at 12.5 Vdc	Resistance—(Ohms)
Glow Plug	8.3	1.5 ± 0.15
Fuel Solenoid: Pull In	18 to 25	0.5 to 0.7
Hold In	0.9 to 1.1	11 to 13
Pilot Solenoid	0.657	19
Starter Motor	90 to 105 (cranking)	
Damper Solenoid	5.68	2.2
DC Circuit Breakers	50 amp	
High Speed Solenoid	5 amp (approx.)	2.5 (approx.)
Electric Standby Reset Solenoid	8.5 amp (approx.)	1.5 (approx.)

Electrical Standby Compressor Motors (Model 50 Unit Only)

Voltage/Phase/Frequency	Horse-power	Kilowatts	rpm	Full Load (amps)	Locked Rotor Amps	Unit Full Load* Amps
230/1/60	5	3.7	1750	18	80	25
230/3/60	5	3.7	1750	14.4	58	21
460/3/60	5	3.7	1750	7.2	58	12
380/3/50	4.2	3.1	1450	7.3	55	12
220/3/50	4.2	3.1	1450	12.7	55	12.7

*w/Heater Strips

Electric Heater Strips (Optional):	Number	3
	Watts (each)	750

STANDBY POWER REQUIREMENTS

Supply Circuit Breaker	30 amp/230 V 20 amp/460 V
Extension Cord Size	Up to 50 ft—12 gauge 75 ft—10 gauge

AIR SWITCH

Air Switch Setting	0.7 ± 0.05 in. (17.78 ± 1.3 mm) H_2O

Maintenance Inspection Schedule

A closely followed maintenance program will help to keep your Thermo King unit in top operating condition. The following general schedule is provided to assist in monitoring that maintenance.

Pre trip	1,200 Hours	2,000 Hours	Annual/ 3,000 Hours	Inspect/Service These Items ***NOTE: The 1,200 hour maintenance interval may be extended to 2,000 hours or 1 year (whichever occurs first) when equipped with EMI fuel filter and EMI bypass oil filter.***
				Microprocessor
•				Run pretrip test (see “Pretrip Test” in the Operating Manual).
				Engine
•				Check fuel supply.
•	•	•		Check engine oil level.
•	•	•	•	Check engine coolant level. ***CAUTION: Do not remove radiator cap while coolant is hot.***
•	•	•		Inspect belts for condition and proper tension.
•	•	•		Check engine oil pressure hot, on high speed. Minimum 40 psig. (276 kPa. 2.8 bar). Record _____ psig.
•	•	•	•	Listen for unusual noises, vibrations, etc.
•		•		Dry air cleaner. Replace air cleaner element at 2,000 hours or 1 year (whichever occurs first).
	•	•		Clean and service crankcase breather and check air cleaner hose for damage.
		•		Change EMI 2000 (black) fuel filter.
	•	•		Inspect and clean fuel prefilter and electric fuel pump filter.
		•	•	Drain water from fuel tank and check vent.
		•	•	Check and adjust engine speeds (high and low speed).
			•	Check condition of engine mounts.
			•	Maintain year round antifreeze protection at –30 F (–34 C).
			—	Change ELC (red) engine coolant every 5 years or 12,000 hours. Units equipped with ELC have an ELC nameplate on the expansion tank. See “ELC (Extended Life Coolant)” on page 72.
				Engine Oil Change Intervals (see below) ***NOTE: Change engine oil and filter (hot).***
		•		Oil change interval with API classification CG-4 (or better) mineral oil or synthetic oil, and EMI 2000 bypass oil filter (see Tool Catalog).

Pre trip	1,200 Hours	2,000 Hours	Annual/ 3,000 Hours	Inspect/Service These Items ***NOTE: The 1,200 hour maintenance interval may be extended to 2,000 hours or 1 year (whichever occurs first) when equipped with EMI fuel filter and EMI bypass oil filter.***
				Electrical
•				Check controller for alarms.
•				Run Unit Self Check Test. See " μP-T Unit Self Check Test."
•	•	•		Check battery voltage screen.
	•	•		Inspect battery terminals and electrolyte level.
	•	•		Inspect electrical contacts for pitting or corrosion.
	•	•		Inspect wire harness for damaged wires or connections.
			•	Check calibration of return and discharge air sensors, and optional temperature sensors, in 32 F (0 C) ice water.
			•	Check air switch setting.
			•	Inspect alternator bearings* and brushes.
			•	Inspect electric motor bearings* (Model 50).
* With belt removed, spin bearings by hand. Listen for noise (bearings roll freely).				
				Refrigeration
•	•	•		Check refrigerant level.
•	•	•		Check compressor oil level.
	•	•	•	Check suction pressure regulator or throttling valve setting on defrost or heat.
		•	•	Check discharge and suction pressures.
			•	Check compressor efficiency.
			—	Replace dehydrator and compressor oil filter every two years.
				Structural
•	•	•		Visually inspect unit for fluid leaks (coolant, oil, refrigerant).
•	•	•		Visually inspect unit for damaged, loose or broken parts (includes air ducts and bulkheads, if so equipped).
	•	•	•	Inspect clutch for shoe and anchor bushing wear with a mirror. Check bearings.*
		•	•	Inspect idlers, fan shafts and jackshaft for leakage and bearing wear.*
			•	Clean entire unit including condenser and evaporator coils and defrost drains.
		•	•	Check defrost damper operation.
			•	Check all unit, fuel tank, engine and electric motor mounting bolts, brackets, lines, hoses, etc.

* With belt removed, spin bearings by hand. Listen for noise (bearings roll freely).

Unit Description

General Description

The MD-200 is a microprocessor based transport temperature control system, which utilizes the Thermoguard µP-T microcontroller to manage most of the system's functions.

The MD-200 is a one-piece, front-mount, medium capacity diesel powered cooling and heating system designed especially for straight trucks. The unit mounts on the front of a truck with the evaporator portion protruding into the box. Designed for use with totally chlorine free R-404A refrigerant. An optional R-134a unit is also available. There are two basic models:

MD-200 30: Cooling and heating on engine operation.

MD-200 50: Cooling and hot gas heating on engine operation and electric standby electric evaporator heaters are optional.

Power is provided by the TK 3.74 three-cylinder, special clean and silent diesel engine rated at 12.6 continuous horsepower at 2400 rpm. A belt drive system transfers energy to the compressor, unit fans and alternator.

Electric standby power (Model 50) is provided by a 5 horsepower electric motor. A clutch on the diesel engine isolates the engine during electric standby operation.

Belt driven, dual evaporator fans provide superior air throw. Exclusive space condenser provides maximum cab clearance and reduced truck body height on conventional chassis. Cube saver evaporator optimizes space below the evaporator for all types of cargo. Lightweight aluminum frame allows increased payload.

The continuous monitoring function of the µP-T microprocessor optimizes the Thermo King units' performance, thereby reducing fuel consumption and unit down time. The unit's self check can be run before the daily distribution route to identify any possible malfunctions. TherMax™ defrost/heating system increases unit heating capacity for faster defrost.

The built-in CYCLE-SENTRY, an exclusive Thermo King feature, automatically starts and stops the unit according to temperature demands.

In addition, a range of programmable modes, like high speed pull-down, allow you to tailor your unit's performance to the load you are distributing.

The MD-200's µP-T microprocessor continually monitors unit performance and makes adjustments to pre-programmed parameters automatically. Troubleshooting is simplified with built-in alarm codes to alert the driver to take corrective action before a problem develops. Diagnosis is fast and complete.

The clutch engages fully at 900 ± 100 rpm on engine operation, constantly turning the compressor and fans at both high and low speed.

Thermo King X214 Compressor

The MD-200 unit features a Thermo King X214, two-cylinder compressor with 13.92 $in.^3$ (228 cm^3) displacement.

MD-200 Standard features:

- Air Cleaner, Dry Type
- Air Switch
- Alarm Code Display
- Alternator, 23 amp
- Battery Voltage Display
- Continuous System Monitoring
- Coolant Expansion Tank
- Coolant Temperature Display
- Corrosion Resistant Protection
- CYCLE-SENTRY Start/Stop Controls
- Diesel/Electric Autoswitching
- Electric Hourmeter
- Engine Hourmeter
- Fahrenheit and Celsius Scales
- Fuel Filter, Spin On
- In-Cab Remote Display
- Microprocessor Controller µP-T
- Oil Filter, Full Flow

- Bypass Oil Filter, Spin-on
- Oil Pressure Display
- R-404A
- Smart Defrost
- Stainless Steel Condenser Hardware
- Stainless Steel Evaporator Hardware
- Tapered Roller Bearing Jackshaft (Model 30)
- TherMax™ System, Defrost/Heating
- TK 3.74 Engine
- Total Run Hourmeter
- Unit Self Check-pretripping
- X214 Compressor

MD-200 Options:

- Automatic Phase Correction (Model 50)
- Body Mount Control Box
- Condenser Top Screen
- Data Logging
- Door Sentry Switch
- Electric Heater Strips (Model 50)
- Electric Standby
- Engine Block Heater
- Evaporator Side Screens
- Fuel Heater
- Low Noise Kit
- R134a Refrigerant
- Remote Light Display
- Silicone Hoses

Unit Instruments

MICROPROCESSOR LCD DISPLAY: The LCD display normally shows the setpoint, the return air temperature, and any active icons, which are:

- Cool
- Heat
- Defrost
- Setpoint
- CYCLE-SENTRY
- Alarm
- Electric (Optional)

Pressing the SELECT key causes the display to show the other sensor readings.

ALARM ICON: The alarm icon comes on whenever there is an alarm code stored in the microprocessor memory.

RECEIVER TANK SIGHT GLASS: The receiver tank sight glass is used to check the amount of refrigerant in the system, and the moisture content of the refrigerant.

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

Unit Protection Devices

FUSES: A number of fuses are located on the relay board. The sizes and functions are shown in Table 1.

Table 1: Relay Board Fuse Size and Function

Fuse	Size	Function
F200	3A	2P Power to Microprocessor
F202	3A	Oil Level Switch
F300	3A	Pilot Solenoid
F301	3A	TherMax Solenoid
F302	3A	Alternator Relay
F303	3A	Damper Relay
F304	3A	Starter Relay
F305	3A	On/Run Relay
F306	3A	Preheat Relay
F307	3A	Not Used
F308	3A	Not Used
F309	15A	Alternator Excitation
F310	15A	Damper Solenoid
F311	10A	Motor Reset Solenoid
F400	3A	Motor Starter
F401	10A	Fuel Solenoid and Fuel Pump
F402	10A	Throttle Solenoid
F403	3A	Heater Contactor

FUSE LINK WIRE: The fuse link is located between the unit harness and the battery. At a current draw of approximately 50 to 55 amperes, the fusible link will melt and cut all power to the unit controls.

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 psig (3241 kPa) for R-404A systems or 325 psig (2088 kPa) for R-134a systems.

The HPCO switch opens the HPCO input to the microprocessor interface board. The controller stops the unit and then records an alarm.

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 psig (3447 kPa). The valve will reseat when the pressure drops to 400 psig (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.

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

PREHEAT BUZZER: The preheat buzzer sounds when the CYCLE-SENTRY system energizes the glow plugs.

OIL PRESSURE SENSOR: The oil pressure switch closes when oil pressure is too low.

On SR models an oil pressure sensor provides an OPS input to the microprocessor interface board. If the oil pressure remains too low, the controller stops the unit and records an alarm.

WATER TEMPERATURE SWITCH: The water temperature switch provides a WTS input to the microprocessor interface board. If the engine coolant temperature is too high, the controller stops the unit and records an alarm.

OVERLOAD RELAY: An overload relay protects the standby electric motor. The overload relay opens to stop the electric motor if the motor overloads (e.g., low line voltage or improper power supply) while the unit is on electric standby operation.

An auxiliary contact signals the µP-T controller that the overload relay has tripped. The controller then generates an alarm. When the alarm is cleared, the controller sends a 1 second pulse to the reset solenoid to reset the overload relay.

EVAPORATOR COIL SENSOR: Evaporator high temperature protection is provided by the µP-T controller using an evaporator coil sensor. If the evaporator temperature becomes excessive, the controller records an alarm and may stop the unit.

PREHEAT INDICATOR BUZZER: The preheat indicator buzzer is energized whenever the GLOW PLUGS are energized on units equipped with CYCLE-SENTRY.

WARNING: On CYCLE-SENTRY Auto Start-Stop operation, the glow plugs do not always preheat before the engine starts.

Unit Operation

Pre-trip Inspection (Before Starting Unit)

The following pre-trip inspection should be completed before starting the unit and loading the truck. While pre-trip 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.

FUEL: The diesel fuel supply must be adequate to guarantee engine operation to the next check point.

ENGINE OIL: The engine oil level should be at the FULL mark. Never overfill.

COOLANT: The engine coolant must have antifreeze protection to -30 F (-34 C). Check and add coolant in the expansion tank.

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

BATTERY: The terminals must be clean and tight.

BELTS: The belts must be in good condition and adjusted to the proper tensions.

ELECTRICAL: The electrical connections should be securely fastened. The wires and terminals should be free of corrosion, cracks or moisture.

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 be sure they are open. The damper in the evaporator outlet must move freely with no sticking or binding. Make sure all the doors are latched securely.

Starting Unit (Full Unit Self Check)

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

1. Perform a Pre-trip Inspection.
2. Adjust the setpoint to the desired load temperature (refer to the Operation Manual (TK 41087) 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 Unit Self Check (refer to the Operation Manual for detailed information about the Unit Self Check). This procedure is automatic and can be performed on the way to the loading area or while waiting to load.
   a. Press the ON button.
   b. Clear any alarms.
   c. Press and hold the T/K key for at least 3 seconds until the Unit Self Check [USC] prompt screen appears.
   d. Press the ENTER key. The display will briefly show Lod (load) and the unit will then start the Unit Self Check.
4. When the PRE TRIP test is complete, PASS, CHECK, or FAIL will appear on the display until any key on the controller is pressed. Continue as follows:

   PASS (Unit running, no alarms)

   - Unit has passed the PRE TRIP, go to step 5.

   CHECK (Unit running but Check Alarms have been recorded)

   or

   FAIL (Unit has shut down and recorded Shutdown Alarms)

a. View the Alarms with the SELECT key (refer to the appropriate Operation and Diagnosis Manual for detailed information about alarms).

b. Correct the alarm conditions.

c. Clear the alarms with the CLEAR key (refer to the appropriate Operation and Diagnosis Manual for detailed information about alarms).

d. Repeat the test until PASS appears (the unit passes the unit self check).

5. Recheck the setpoint.
6. Complete the After Start Inspection.

Selection of Operating Modes on CYCLE-SENTRY Equipped Units

The Thermo King CYCLE-SENTRY system is designed to save refrigeration fuel costs. The savings vary with the commodity, ambient temperatures and trailer insulation.

CYCLE-SENTRY is designed for use only with products which do not require tight temperature control or continuous airflow, such as all deep frozen products and non-perishable non-frozen products.

The start/stop nature of CYCLE-SENTRY does not satisfy the temperature control or airflow requirements for perishable or temperature sensitive products. Thermo King therefore does NOT recommend the use of CYCLE-SENTRY control for these products.

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

Products 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.

Products Acceptable for CYCLE-SENTRY Operation

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

NOTE: 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.

Continuous Run Operation

With the selector switch in the CONTINUOUS-RUN position, the unit will operate in its regular cooling and heating modes. Refer to starting instructions for Standard Units.

Auto Start-Stop Operation

With the selector switch in the CYCLE-SENTRY (AUTO START-STOP) position (or CYCLE-SENTRY icon visible in µP-T display), the CYCLE-SENTRY system shuts down the unit when the compartment temperature reaches the thermostat setpoint and restarts the unit on thermostat demand.

On CYCLE-SENTRY equipped units, unit start-ups may also be initiated by defrost cycle initiation or engine block temperature switch demand.

If defrost is initiated manually or automatically (defrost timer or air switch), the unit will start and operate on high speed. When the defrost cycle is complete, the unit will operate in whichever operating mode the thermostat is calling for until the compartment temperature reaches setpoint.

In cold ambients, the CYCLE-SENTRY system automatically maintains engine temperature by restarting the unit if the engine block temperature

drops to 35 F (18 C on units without Preheat). When the unit starts up because of low engine block temperature, the unit will operate in whichever operating mode the unit thermostat is calling for until the battery is fully charged (optional) and the engine block temperature rises to 120 F (49 C).

After the unit starts from thermostat demand, defrost initiation or engine block temperature thermostat demand, a battery sentry switch monitors the voltage across the field of the alternator and will keep the unit operating until the battery is recharged sufficiently. The unit operates in whichever mode the thermostat requires to properly maintain the load temperature. When the battery is sufficiently recharged, the unit will shut down on thermostat demand.

WARNING: With the ON/Off switch (or ON key) "ON" and the selector switch in CYCLE-SENTRY (Auto Start-Stop) position (or CYCLE-SENTRY icon visible in µP-T display), the unit may start at any time without proper warning.

NOTE: Fully charged batteries in good condition are essential for reliable unit operation. This is especially true on CYCLE-SENTRY equipped units in cold weather.

Restarting the Unit

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

Automatic Start

1. Push the ON key.
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 120 F (96 C), but the engine fails to start automatically:

- Push the OFF key.
- Check for and correct any alarm conditions and clear the alarm codes. View the alarms with the SELECT key, clear the alarms with the ENTER key, and the repeat the auto start procedure. Refer to the appropriate Operation and Diagnosis Manual (TK 41087) for detailed information about alarms.
- If the engine will still not start, push the OFF push button, 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.

OIL PRESSURE: Check the engine oil pressure in high speed by pressing the SELECT key to OIL PRESS. The oil pressure should be 30 to 80 psig (207 to 552 kPa).

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

COMPRESSOR OIL: The compressor oil level should be visible in the sight glass.

REFRIGERANT: Check the refrigerant charge. See Refrigerant Charge in the Refrigeration Maintenance chapter.

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 truck.

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

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

To manually initiate a defrost cycle, press the manual defrost key. Refer to the Operation Manual for detailed information about Manual Defrost.

The defrost cycle should end automatically.

NOTE: The unit will not defrost unless the evaporator coil temperature is below 45 F (7.2 C).

Loading Procedure

1. Make sure the unit is OFF before opening the doors to minimize frost accumulation on the evaporator coil and heat gain in the truck. (Unit may be running when loading the truck 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 units are designed to maintain loads at the temperature at which they were loaded. Transport refrigeration units are not designed to pull hot loads down to temperature.

Post Load Procedure

1. Make sure all the doors are closed and locked.
2. Start the unit. If it was shut off to load, see Restarting Unit.
3. Make sure the setpoint is at the desired setting.
4. One-half hour after loading, defrost the unit by momentarily pressing the manual defrost switch. If the evaporator coil sensor temperature is below 45 F (7.2 C), the unit will defrost. The microprocessor will terminate defrost automatically when the evaporator coil temperature reaches 57 F (13.9 C) or the unit has been in the defrost mode for 30 to 45 minutes (depending on setting).

Post Trip Checks

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

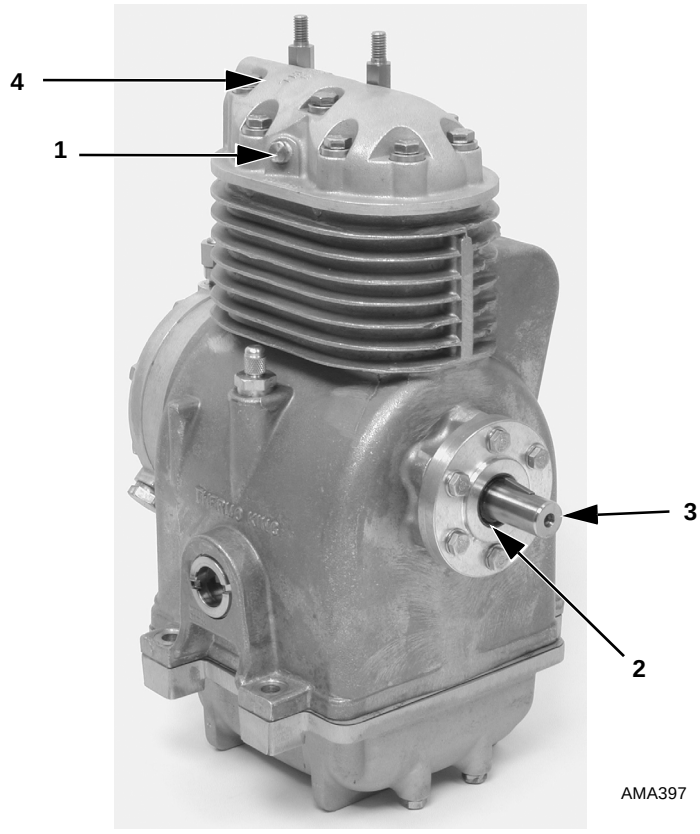
Unit Photographs

AMA412

Figure 1: Front Curbside view—MD-200

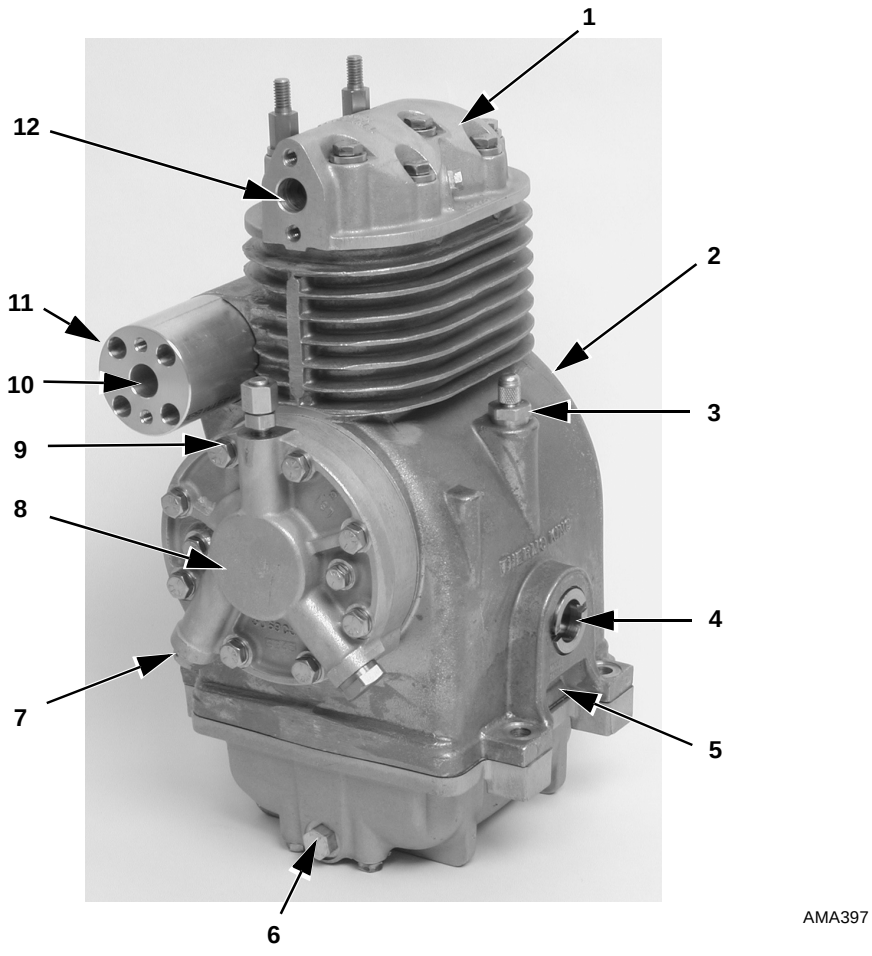
AMA401

Figure 2: Front Roadside View—MD-200



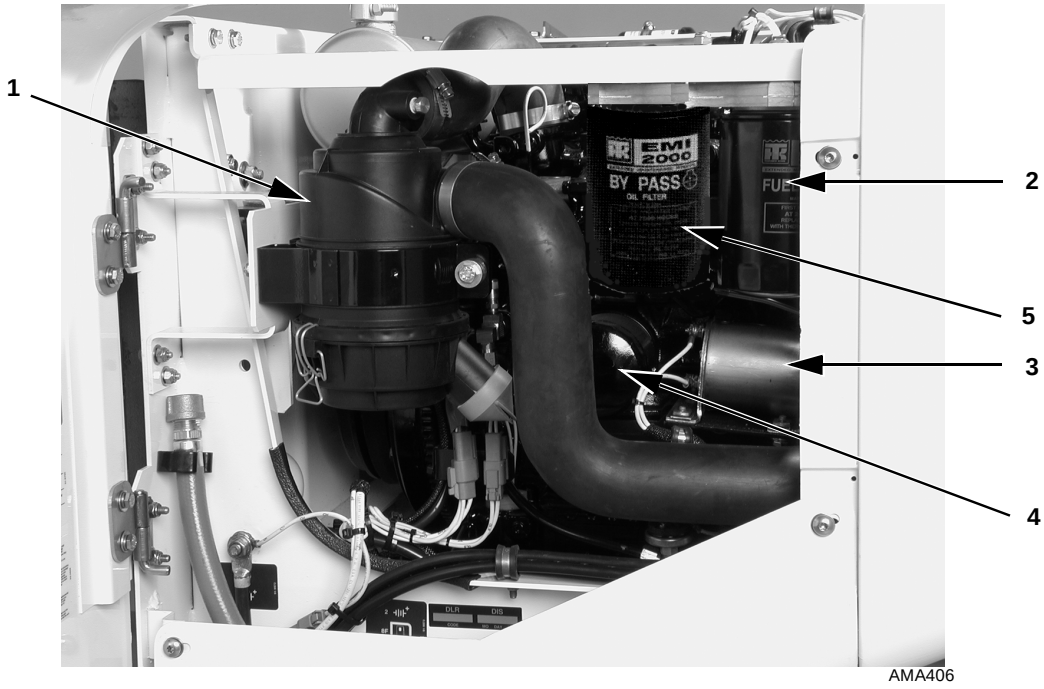
1.	Note: Apply Thread Sealant When Installing High Pressure Cutout
2.	Oil Seal (Location Not Shown)
3.	Crankshaft
4.	Cylinder Head

Figure 3: X214 Compressor



1.	Cylinder Head	7.	Oil Pump Cover
2.	Crankshaft	8.	Pressure Regulator Assembly
3.	Oil Fill Plug	9.	Oil Pump Gauge Access
4.	Sight Glass	10.	Suction Port
5.	Serial Number	11.	Suction Valve Adapter
6.	Oil Drain Plug	12.	Discharge Port

Figure 4: X214 Compressor

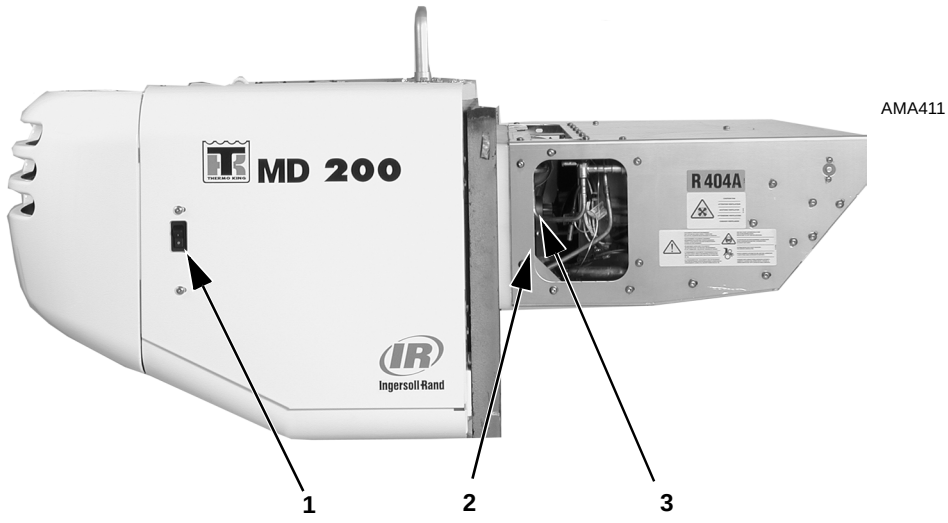


1.	Cyclonic Engine Air Filter	4.	Oil Filter
2.	Fuel Filter	5.	Bypass Oil Filter
3.	Throttle Solenoid		

Figure 5: Access Panel Open (Curbside)—MD-200

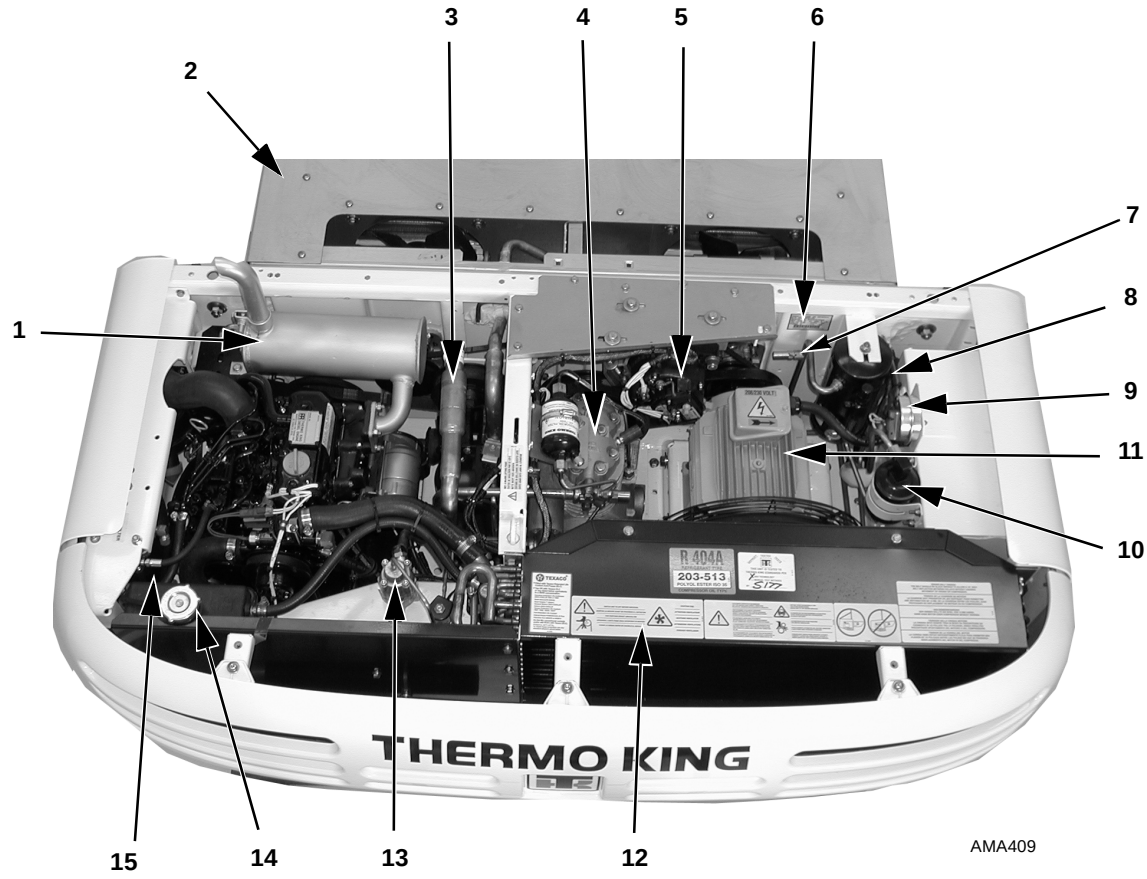
1.	Evaporator

Figure 6: Rear View (Curbside)—MD-200



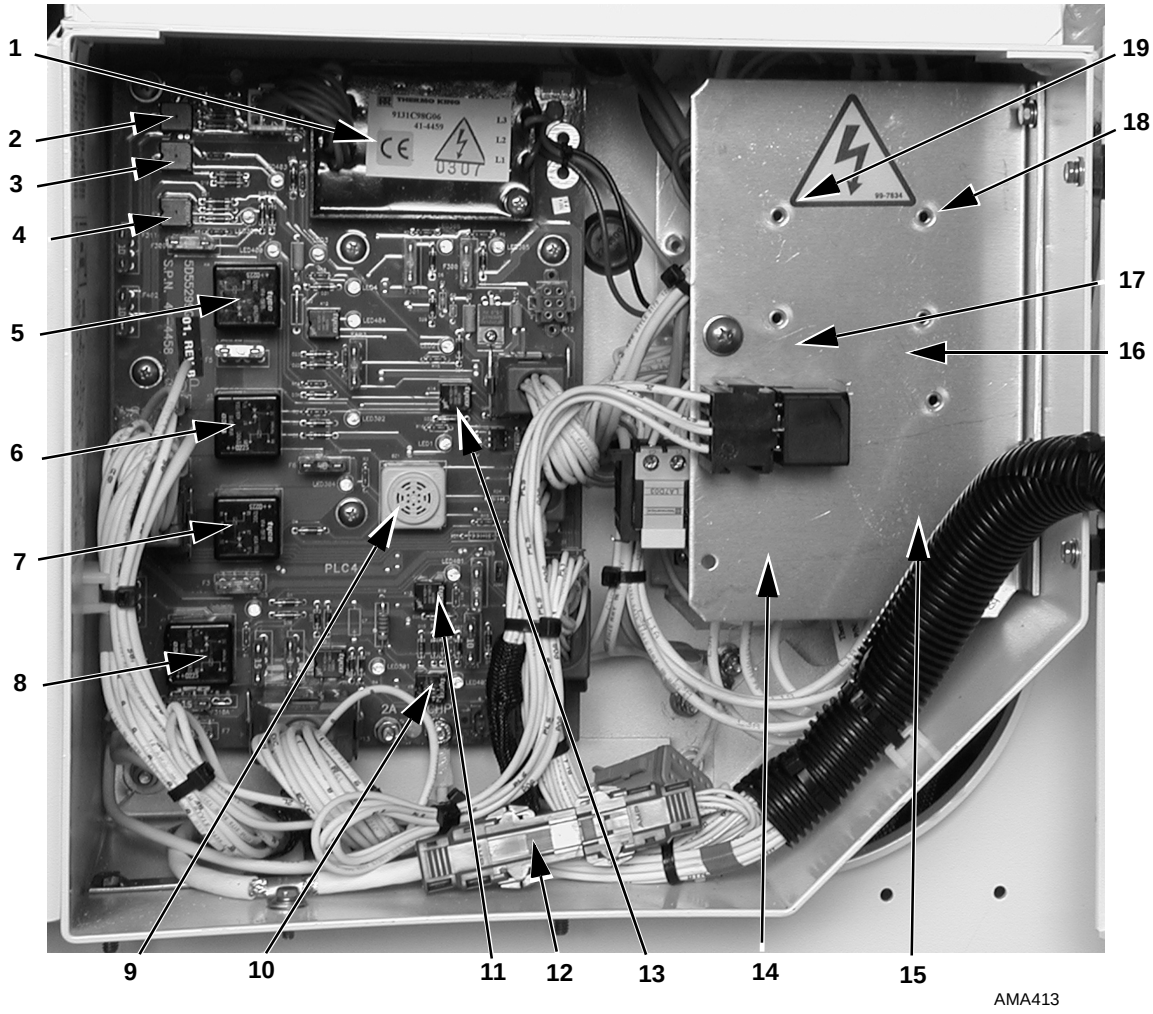
1.	Power Switch	2.	Coil Sensor Location	3.	Microprocessor Switch

Figure 7: Side View (Roadside)



1.	Muffler	9.	Air Defrost Switch
2.	Evaporator	10.	Drier
3.	Suction Pressure Regulator	11.	Electric Motor (Model 50)
4.	Compressor	12.	Condenser Coil
5.	Alternator	13.	Three-Way Valve
6.	Nameplate	14.	Expansion Tank
7.	High Pressure Relief Valve	15.	Fuel Filter
8.	Receiver Tank		

Figure 8: Top View

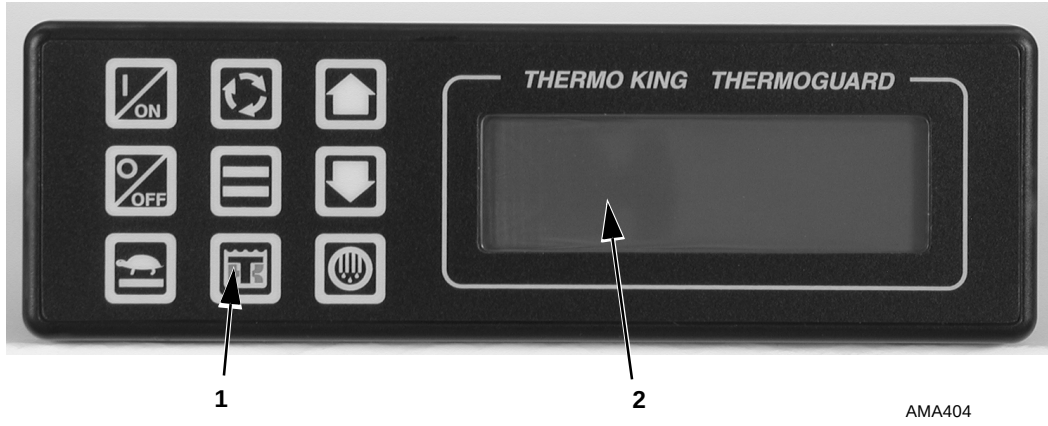


1.	High Voltage Module (Caution)	11.	K13 Electric Motor Relay
2.	K8 Motor Reset Relay	12.	Remote Control Cab Box Harness Connector
3.	K5 Throttle Relay	13.	K14 Electric/Diesel Relay
4.	K1 Alternator Relay	14.	Motor Contactor (under cover)
5.	K4 Fuel Solenoid Pull-In Coil Relay	15.	Motor Start Contactor (under cover)
6.	K3 Starter Relay	16.	Motor Start Relay (under cover)
7.	K6 Preheat Relay	17	Current Relay (under cover)
8.	K7 On/Run Relay	18.	Heater Contactor (under cover)
9.	Preheat Buzzer	19.	Overload Relay (under cover)
10.	K9 Fuel Solenoid/Pump Relay		

Figure 9: Control Box

AMA410

Figure 10: Power Receptacle Box—MD-200 50



1.	Keypad	2.	LED Display

Figure 11: THERMOGUARD Remote Control Panel

µP-T System Description

General Description

The µp-T microprocessor controllers are self contained temperature control units designed for MD-II Smart Reefer truck units.

Model 30 units are powered by a diesel engine and Model 50 units are powered by either a diesel engine or an external electric standby power source turning an induction motor. The unit mounts on the upper front of the truck box and the evaporator extends into the box. The compressor, condenser and evaporator fans are driven by belts. Defrost is accomplished by means of hot gas when operating in Diesel mode and hot gas and electric evaporator heaters when operating in optional Electric Heat mode.

CAUTION: Dangerous single phase or three phase AC power is present whenever the unit is operating in Electric mode or whenever the unit is connected to external standby power. Voltages of this magnitude can be lethal. Exercise extreme caution when working on the unit.

µP-T Control System

The µP-T Microprocessor Control System consists of the following main components:

- Microprocessor Power Switch
- Remote Control Panel
- µP-T Microprocessor
- Interface Board
- Sensors
- Refrigeration System Controls
- Engine Controls
- High Voltage Tray (Model 50 Units)

Microprocessor Power Switch

The microprocessor power switch applies 12 volts DC control power to the microprocessor. It is located just below the control box on the street side of the unit. Main power to the balance of the controls is supplied by the 50 amp circuit breaker CB1. Note that when the Microprocessor Power Switch is turned “off” that power is still applied to the Interface Board and control circuits via CB1. To completely remove power from the control system disconnect the unit battery.

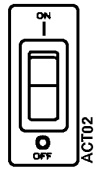


Figure 12: Microprocessor Power Switch

For additional information, see Operation and Diagnosis Manual TK 41087.

Optional Electric Standby (Model 50 Units Only)

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

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

CAUTION: The Electric Power Icon will not appear in the display if electric power is not present (the unit is not plugged in), or if there are electrical voltage or phase problems while the power cord is connected to a power outlet. Under these conditions, when the microprocessor power switch is turned on and the On key is pressed, the unit will start and run on diesel automatically.

CAUTION: Electric operation mode is not stored in the controller if the microprocessor power switch is turned OFF. Turning the switch back ON again, even with the power cord connected, will not assure start up in Electric Standby. If the voltage is low or an electric phase is missing, the Electric icon will not be present in the display and the unit will start in diesel.

Standard Model 50 Features

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

Automatic Diesel/Electric Selection: The unit will automatically switch to electric operation when a power cord is connected and the standby power is switched ON.

Phase Lockout (Three Phase Units Only): If the motor rotation is reversed as a result of incorrect phase rotation, the unit will shut down and generate an Alarm Code 38. The phase rotation must be manually corrected.

Hot Gas Heat: Hot gas heat is utilized on standard model 50 units.

Optional Model 50 Features

The following features are available as options on units equipped with Electric Standby.

Automatic Phase Correction Option (Three Phase Units Only): The control system features two motor contactors. This allows correct motor rotation regardless of phase rotation on the incoming power.

Electric Heat Option: The unit is equipped with a heater contactor and electric evaporator heaters. These heaters provide supplemental heat during electric mode heat and defrost operation.

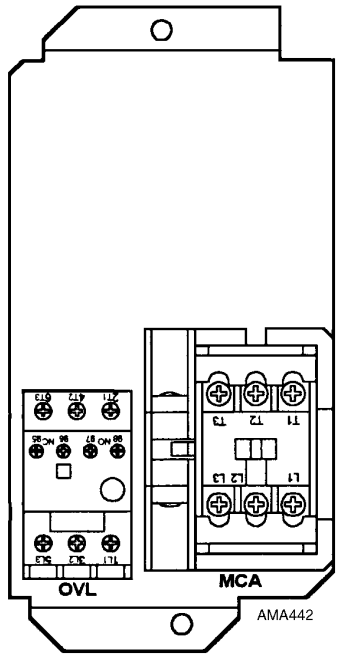


Figure 13: High Voltage Tray No Options

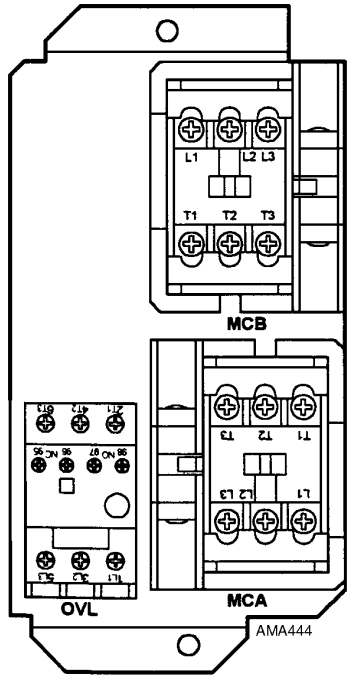


Figure 14: High Voltage Tray with Phase Correction

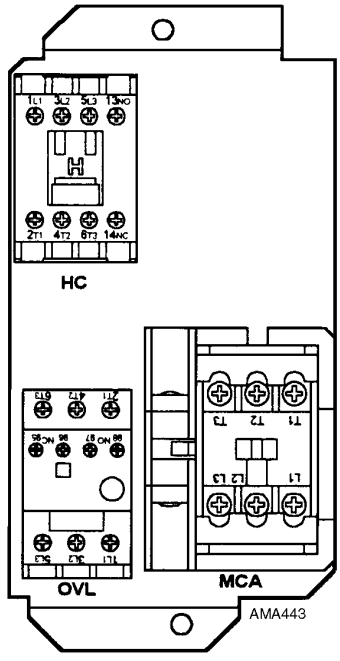


Figure 15: High Voltage Tray with Electric Heat

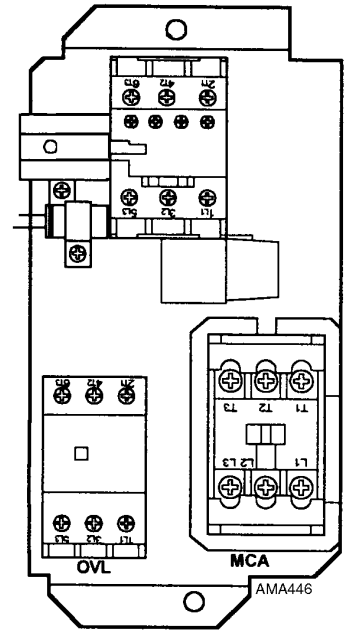


Figure 17: High Voltage Tray with Single Phase Power and Electric Heater

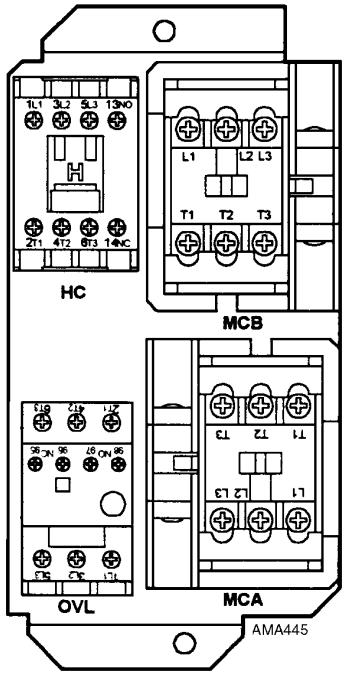
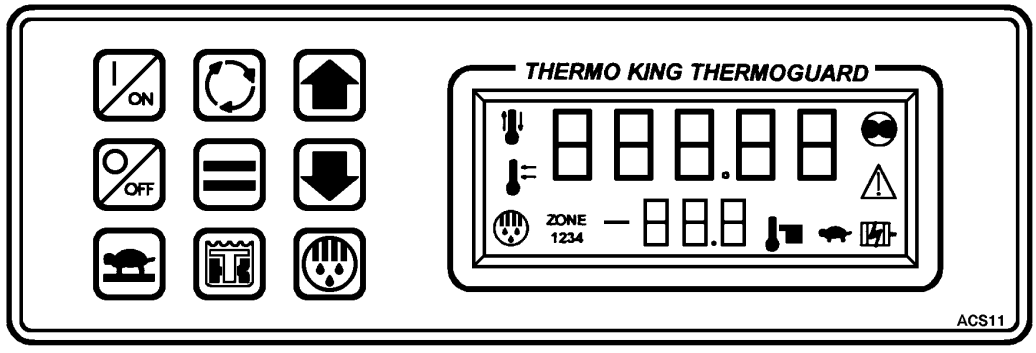


Figure 16: High Voltage Tray with Phase Correction and Electric Heat

Remote Control Panel Features

The remote panel is connected to the microprocessor and is used to operate the unit. It may be located in the truck dashboard using the supplied DIN mounting ring, under the dashboard using the supplied under dash mounting kit or on the dashboard using the supplied plastic mounting strips. An optional body mount enclosure kit is available to mount the remote control panel on the truck box.



KEYPAD **DISPLAY**

These nine touch sensitive keys are used to turn the unit ON and OFF, change the setpoint and control or change the units operation.

The display normally shows the Standard Display of return air temperature and setpoint. The display shown here has all possible segments lighted.

KEYPAD KEYS

ON KEY. Turns the unit ON.

OFF KEY. Turns the unit OFF

SELECT KEY. Scrolls through the prompt an display screens.

UP ARROW KEY. Chooses prompt screen actions or increases setpoint or other setting.

DOWN ARROW KEY. Chooses prompt screen actions or decreases setpoint or other setting.

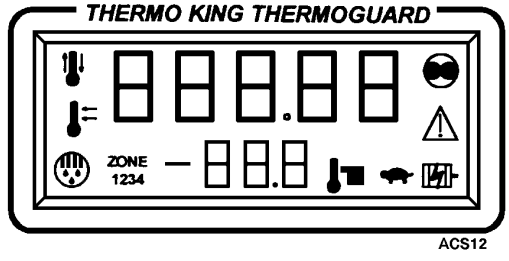
ENTER KEY. Executes prompts or loads set-points or other new settings.

DEFROST KEY. Initiates a manual defrost cycle.

WHISPER KEY. Disables high speed diesel mode operation.

LOGO KEY. Initiates the Unit Self Check test and displays software revision.

UNDERSTANDING THE DISPLAY



The display normally shows the Standard Display of return air temperature and setpoint. In addition, the icons located at the sides of the display indicate the operating mode of the unit and shows if any alarm codes are present. Pressing the SELECT key will show the prompt and display screens. The display shown here has all possible display features turned ON.

DISPLAY ICONS

COOL ICON. Appears when the unit is cooling.

HEAT ICON. Appears when the unit is heating.

This icon appears during a remote control panel test but is not used on truck units.

DEFROST ICON. Appears when the unit is defrosting.

CYCLE SENTRY ICON. Appears when CYCLE-SENTRY mode has been selected.

ALARM ICON. Appears when an alarm condition has been detected by the microprocessor.

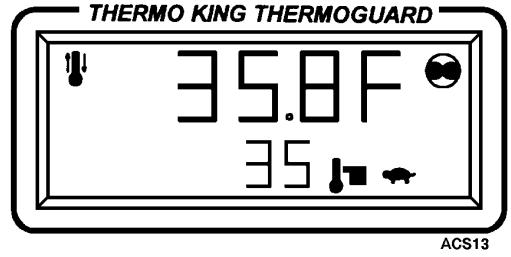
ELECTRIC ICON. Appears when AC power is connected and the phases are correct.

SETPOINT ICON. Appears when the setpoint is being shown in the lower display.

WHISPER ICON. Appears when Whisper mode has been selected.

ZONE 1234 These icons appear during a remote control panel test but are not used on truck units.

READING A TYPICAL DISPLAY

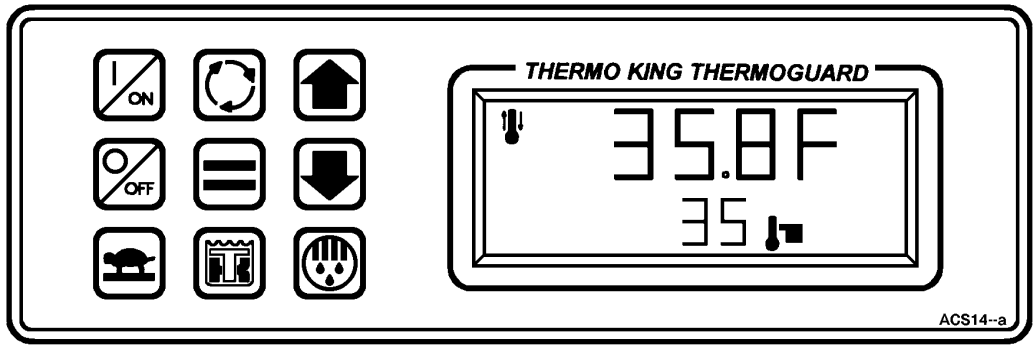


This display shows the following information:

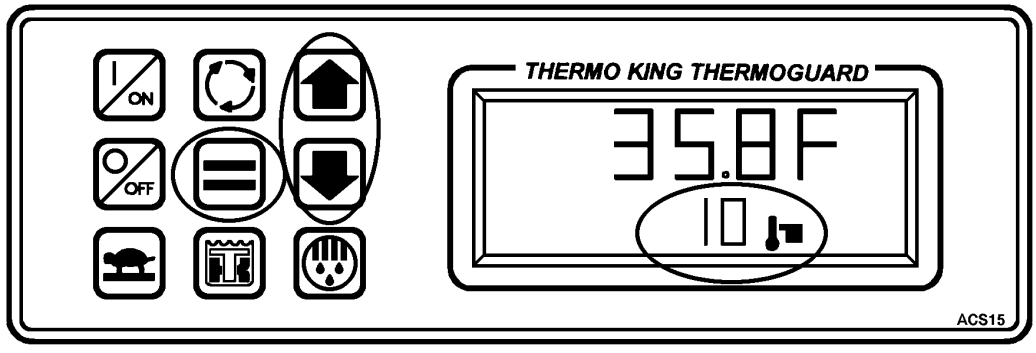
1. The unit is ON and is cooling.
2. CYCLE SENTRY mode and Whisper mode have been selected.
3. The Box temperature is 35.8 degrees Fahrenheit and the setpoint is 35 degrees Fahrenheit.

THE STANDARD DISPLAY

The Standard Display appears when the unit is turned ON and no other functions have been selected. The box temperature appears in the upper display and the setpoint appears in the lower display. This display shows a box temperature of 35.8 F and a setpoint of 35 F. The Standard Display is the starting point used to reach all other prompts and displays. To return to this display from any other prompts or display, wait 10 seconds and it will return automatically.



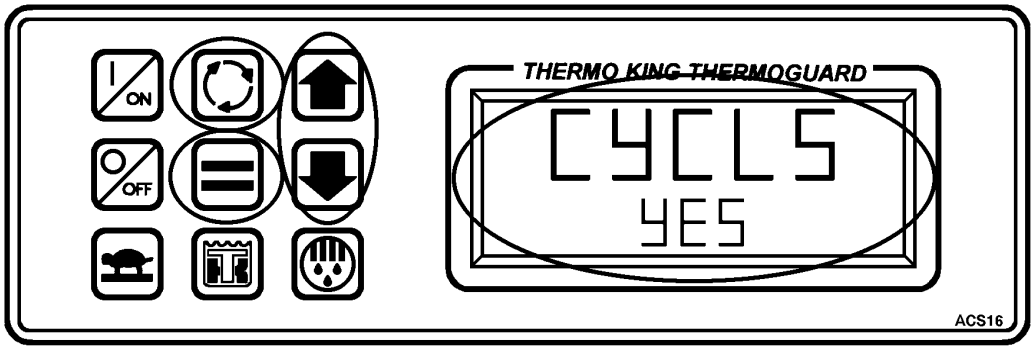
CHANGING THE SETPOINT



1. Press the ON key to turn the unit ON.
2. Press the or Arrow keys to select the desired setpoint.
3. Press the Enter key to load the new setpoint into the microprocessor. The display will briefly show [Lod] and then the new setpoint will reappear in the display.

IMPORTANT: The Enter key must be pressed or the setpoint will not be changed. The display will return to the Standard Display and the setpoint will return to the old setpoint in about 10 seconds if the Enter key is not pressed.

SELECTING CYCLE-SENTRY or CONTINUOUS MODE

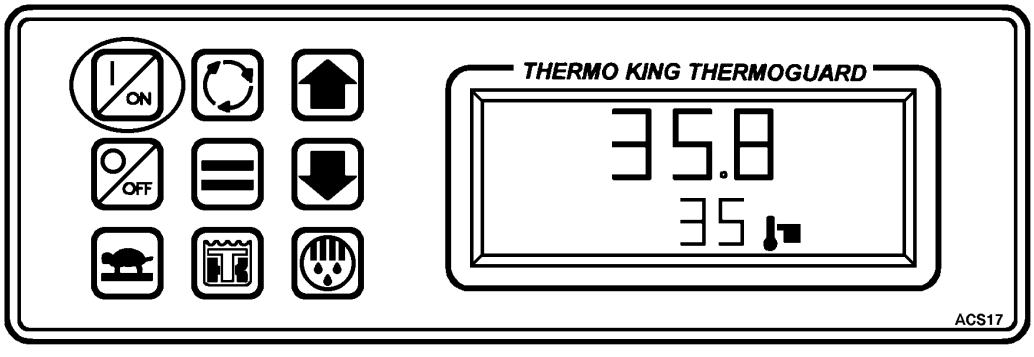


1. Press the ON key to turn the unit ON.
2. Press the Select key to display [CYCLS] and [YES] or [no].
3. Press the or Arrow keys to select the desired mode[YES] = CYCLE SENTRY mode

   [no] = Continuous mode.
4. Press the Enter key to load the new operating mode selection into the microprocessor.

IMPORTANT: The Enter key must be pressed or the setpoint will not be changed. The display will return to the Standard Display and the setpoint will return to the old setpoint in about 10 seconds if the Enter key is not pressed.

STARTING THE ENGINE

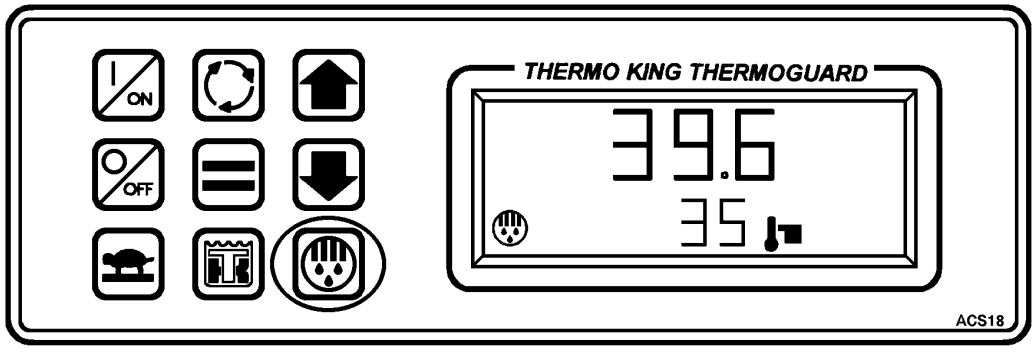


CAUTION: This unit will start automatically in either CYCLE SENTRY or CONTINUOUS mode after the ON key is pressed.

1. Press the ON key to turn the unit ON.

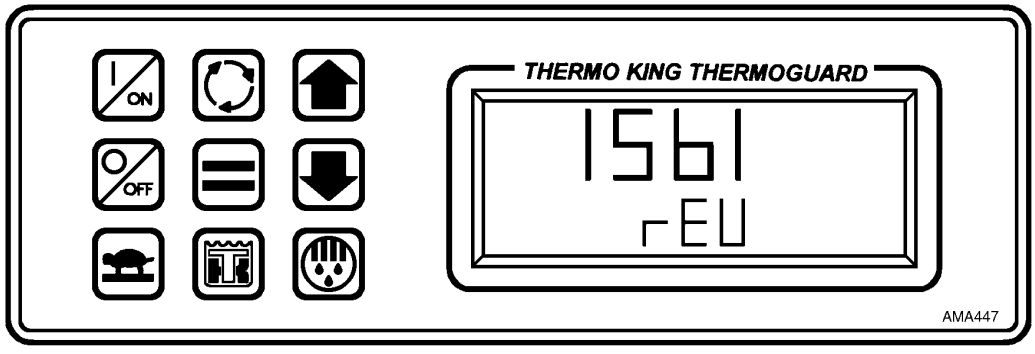
   If no other key is pressed, the engine will automatically preheat and start in about 10 seconds in either CYCLE SENTRY or CONTINUOUS mode. If other keys are pressed (for example: to change the setpoint or view display screens), the engine will automatically preheat and start about 10 seconds after the last key is pressed.

INITIATING A MANUAL DEFROST CYCLE



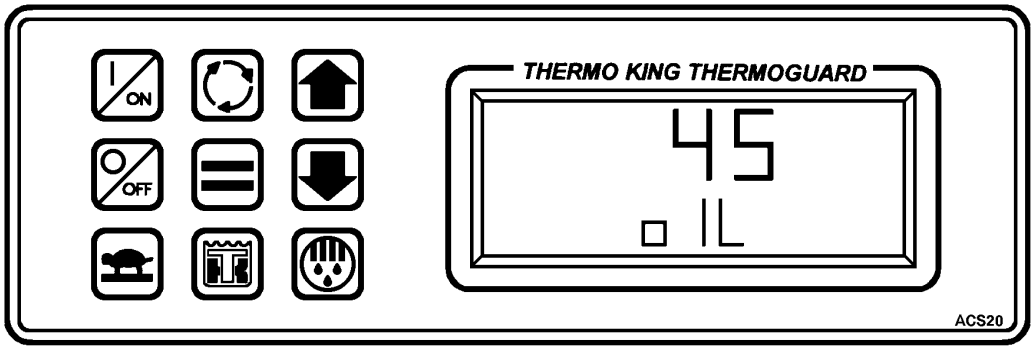
1. The unit must be running in either CYCLE SENTRY or CONTINUOUS mode and the coil temperature must be below 45 F. Press the Defrost key to start a manual defrost cycle. The defrost prompt will appear in the display when the unit starts a defrost cycle. The defrost cycle will terminate automatically. If the unit is not running or the coil temperature is not below 45 F, the request will be ignored.

CHECKING THE SOFTWARE REVISION



1. Press the ON key to turn the unit ON.
2. Press and hold the TK Logo key to display [USC].
3. Press the Select key to display [rEU] and the software revision.
4. The software revision shown here is Revision 1520.

VIEWING PROMPT and DISPLAY SCREENS



1. Press the ON key to turn the unit ON.

2. Press the Select key repeatedly to show the prompt and display screens.
   The prompt and display screens will appear in the order shown below:

[**ALr**]Alarm codes if present. If no codes exist this screen will not appear.

[**CYCLS**]CYCLE SENTRY or Continuous mode prompt screen. {YES] - CYCLE SENTRY; [no] = Continuous

[**dIS**]Discharge air temperature as measured by the discharge temperature sensor.

[**coL**]Evaporator coil temperate as measured by the evaporator coil temperature sensor.

[**tLH**]Total amount of time in hours the unit has been turned ON with the keypad On key.

[**EnH**]Total amount of time in hours the diesel engine has run.

[**ELH**]Total amount of time in hours the electric motor has run (on units equipped with Standby).

[**Hr4**]Total accumulated hours on hourmeter 4 (only appears if this hourmeter is set to Type 1, 2 or 3).

[**Hr5**]Total accumulated hours on hourmeter 5 (only appears if this hourmeter is set to Type 1, 2 or 3).

[**Hr6**]Total accumulated hours on hourmeter 6 (only appears if this hourmeter is set to Type 1, 2 or 3).

[**oIL**]Diesel engine oil pressure. OK or LO

[**Ent**]Diesel engine coolant temperature.

[**rPn**]Diesel engine RPM.

[**bAt**]Battery voltage of the unit battery.

[**bLIt**]Backlight select (allows the driver to select high or low backlight illumination level).

[**dFI**]Initial defrost interval.

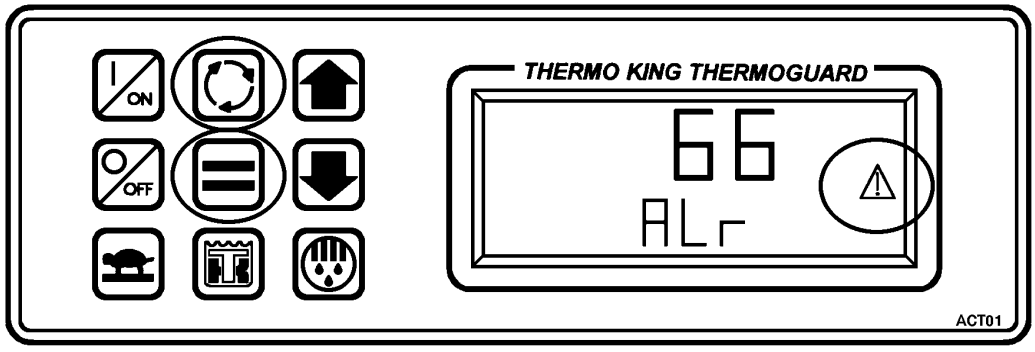
[**ddr**]Defrost duration.

Each prompt or display screen will remain on the display for about 10 seconds. If no other key is pressed, the display will then return to the Standard Display of box temperature and setpoint.

Locking a Display Screen on the Display

The display screens in the list above that are underlined can be locked on the display. Select the desired display screen by pressing the Select key and then press the Enter key. The display will now remain on the screen until any other key is pressed.

VIEWING and CLEARING ALARM CODES



1. Press the ON key to turn the unit ON.

2. If the ⚠ Alarm icon is present, one or more alarms have been detected.

To View Alarm Codes

1. Press the Select key to show the Alarm display screen.

If more than one alarm code exists, each will be displayed for several seconds.

The alarm code shown here is alarm code 66 — Low Engine Oil Level.

To Clear Alarm Codes

1. Correct the cause of the alarm code.

2. Press the Select key to display the alarm code.

3. Press the Enter key to clear the alarm code.

If more than one alarm code is present, the Enter key must be pressed to clear each alarm code individually.

µp-T Alarms

Alarms and Alarm Codes

If an abnormal condition is sensed by the microprocessor, an alarm code is generated and saved in memory. There can be more than one alarm present at one time. An alarm code will remain in memory until it is cleared.

The Alarm icon will appear in the display to indicate that an alarm has been sensed. If the alarm occurred during a Unit Self Check, it will be preceded by a dash (-).

These alarm codes will direct a service technician to the source of a problem. Always record any alarm codes present, they will be invaluable to the service technician.

Displaying Alarms

If the Alarm icon appears on the display, press the Select key to display the alarm. If more than one alarm is present, they will “cycle” through the display, with each alarm appearing for several seconds.

Clearing Alarms

To clear an alarm after the alarm condition is corrected, press the Select key to display the alarm and then press the Enter key to clear it. Repeat this process for any additional alarms.

Types of Alarms

There are three types of alarms. They may occur individually or along with other alarms. There can be more than one alarm present at one time. Alarms that occurred during a Unit Self Check will be preceded by a dash (-).

- **Stored Alarm**. Indicates that a condition exists that does not affect unit operation but that should be investigated. The Alarm icon will appear for 30 seconds when the unit On-Off switch is turned ON and then disappear.
- **Check Alarm**. Notice to take corrective action before an abnormal condition becomes severe. The Alarm icon will appear and remain ON.
- **Shutdown Alarm**. Indicates conditions that may damage the unit. The unit will automatically shut down, the Alarm icon will appear and the entire display will flash ON and OFF.

To view the complete list of possible alarm codes and their definitions, refer to Section 3 in the Operation and Diagnosis Manual (TK 41087). See “µP-T ALARM CODES” on page 49.

µP-T ALARM CODES

Stored	Check	Shutdown	Code	Description
			00	No Fault
	X		**02**	Evaporator Coil Sensor
	X		**03**	Return Air Sensor
	X		**04**	Discharge Air Sensor
	X		**06**	Engine Water Temperature Sensor
X		X	**07**	Engine RPM Sensor
	X	X	**09**	High Evaporator Temperature
		X	**10**	High Discharge Pressure or Compressor Temperature
	X		**11**	Unit Controlling on Discharge Air Sensor
		X	**12**	Sensor Shut Down
		X	**17**	Engine Failed to Crank (CYCLE SENTRY)
		X	**18**	High Engine Water Temperature
		X	**19**	Low Engine Oil Pressure
		X	**20**	Engine Failed to Start (CYCLE SENTRY)
	X		**21**	Cooling Cycle Check
	X		**22**	Heating Cycle Check
		X	**23**	Cooling Cycle Fault
		X	**24**	Heating Cycle Fault
		X	**25**	Alternator Check
		X	**28**	Unit Self Check Abort
X			**31**	Oil Pressure Sensor
	X	X	**32**	Refrigeration Capacity Low
	X		**33**	Check Engine RPM
		X	**35**	Run Relay Circuit; High Compressor Temperature Still Open
		X	**36**	Electric Motor Failed to Run
	X		**37**	Check Engine Water Level
		X	**38**	Electric Phase Reversed or Motor Overload Tripped
	X		**40**	High Speed Circuit
	X		**52**	Heat Circuit
		X	**54**	Test Mode Timeout
		X	**61**	Battery Check
		X	**63**	Engine Stopped—Reason Unknown
		X	**66**	Low Engine Oil Level
X			**70**	Hourmeters Exceed 99999 Hours
X			**71**	Hourmeter 4 Exceeds Set Limit
X			**72**	Hourmeter 5 Exceeds Set Limit
X			**73**	Hourmeter 6 Exceeds Set Limit
	X	X	**74**	Microprocessor Reverted to Default Settings
X			**77**	Internal Fault Code, Factory or Dealer Reset

µP-T Unit Self Check Test

The Unit Self Check is a functional test of the unit's operating capability. Once the test is started by the operator, it is fully automatic and requires no operator attendance.

Starting the Unit Self Check

The following steps are necessary to start a Unit Self Check:

- Disconnect power cord, if present.
- Turn the On-Off switch ON.
- Clear any alarms.
- Press and hold the TK Logo key for at least 3 seconds until the Unit Self Check [USC] prompt screen appears.
- Press the Enter key. The display will briefly show [Lod] and the unit will then start the Unit Self Check.

If any alarms were not cleared before starting the Unit Self Check, they will be displayed at this time. They can be cleared by pressing the Enter key.

The balance of the Unit Self Check is fully automatic and requires no operator attendance. The following tests are performed:

Preheat and Start

The controller will automatically preheat and start the diesel engine.

Display Check

All segments of the display will be lighted at the same time.

Show Programmable Settings

All programmable settings will be sequentially displayed. These settings may be verified by the operator if necessary.

Defrost Check

The operation of the damper door is checked.

RPM Check

The diesel engine RPM is checked in both high and low speed.

Cooling Check

The ability of the unit to cool is checked.

Heating Check

The ability of the unit to heat is checked.

Cooling Check

A second cooling test is performed to ensure the unit can switch from cool to heat and back to cool.

Unit Self Check Report

At the completion of the Unit Self Check, the check results will appear on the display. They will remain until any key on the controller is pressed. Check results are shown as either [PASS], [CHEC] or [FAIL].

[**PASS**] — The unit has passed the Unit Self Check.

[**CHEC**] — Stored or check alarm conditions were detected during the Unit Self Check. These alarms will be preceded by a dash (-) to indicate that they were detected during a Unit Self Check.

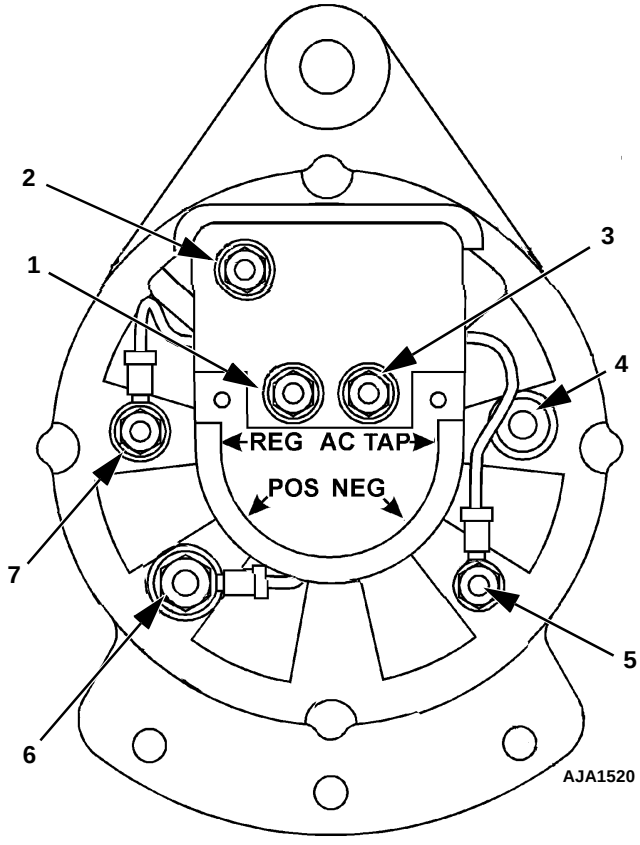
[**FAIL**] — Shutdown alarm conditions were detected during the Unit Self Check and the unit has been shut down to prevent possible damage. This will occur as soon as a shutdown condition is detected. The Unit Self Check will not be completed.

If check or shutdown alarms are detected during a Unit Self Check the condition(s) should be corrected and the check repeated before releasing the unit for service. See the Alarm Codes and Section 5 of the Operations and Diagnosis Manual (TK 41087) for details.

Alternator (Prestolite) Charging System Diagnostic Procedures

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

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



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

Figure 18: Prestolite Terminal Locations

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

- When testing alternators use accurate equipment such as a digital multimeter and an amp clamp or an equivalent. See the Tool Catalog.
- Make sure the drive belts and pulleys of the charging system are in good condition and are adjusted properly before testing the alternator. Worn belts and pulleys or loose belts will lower the output of the alternator.

- The battery must be well charged, the battery cable connections must be clean and tight, and the 2A and excitation circuits must be connected properly.

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

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

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

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

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

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

Excessive Voltage Output

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

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

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

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

Battery

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

Inspect/clean the battery terminals and check the electrolyte level during scheduled maintenance inspections. A dead or low battery can be the cause of an ammeter indicating discharge due to lack of initial excitation of the alternator even after the unit has been boosted for starting. The minimum specific gravity should be 1.235. Add distilled water as necessary to maintain the proper water level.

Unit Wiring

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

Electrical Contacts

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

Charging System (12 Vdc)

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

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

Preheat Buzzer

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

RPM Sensor

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

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

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

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

Testing the RPM Sensor:

The following equipment is required:

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

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

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

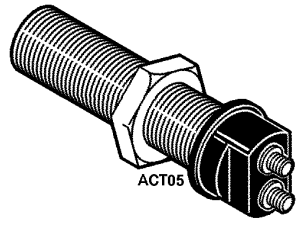


Figure 19: Flywheel (RPM) Sensor

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

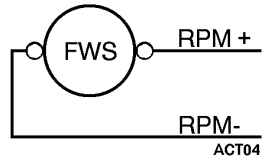


Figure 20: RPM+ and RPM- Wires

3. Place the unit in Continuous Run. Run the unit on low speed and high speed. Check the AC voltage output across the sensor terminals. Use a meter with a high ohms per volt internal resistance. A Simpson 260, Fluke digital or any good VOM will work. However, an automotive type meter may not give an accurate reading because the meter may load the circuit heavily and cause the voltage level to appear lower than it actually is.

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

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

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

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

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

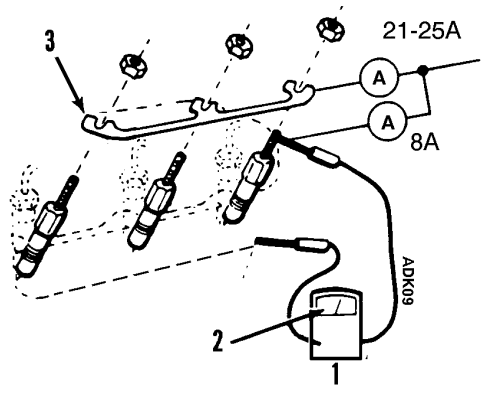
If the unit is not available, an alternate less reliable test may be performed as follows:

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

Glow Plugs

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

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



1.	Ohmmeter
2.	1.5 Ohms
3.	Remove Bar

Figure 21: Glow Plug Test

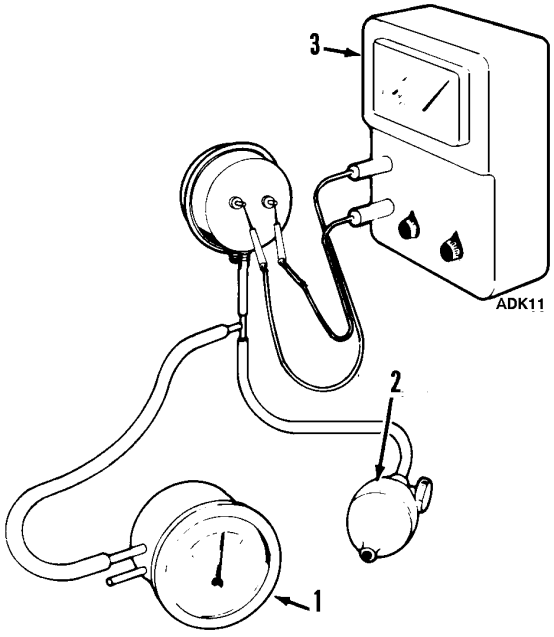
With an external ammeter connected in series, a shorted glow plug will show excessive current flow (more than 12 amps) when the Preheat is initiated. When fuse F6 is blown, check each plug.

Defrost Air Switch Checkout and Adjustment

Before testing or adjusting the air switch, check the clear plastic tubing and black plastic tubing to the evaporator coil. Make sure they are not obstructed or crushed. Check the probes in the evaporator housing to be sure they are in proper position, and make sure they are not obstructed.

1. Remove plastic sensing tubing from both sides of the defrost air switch.
2. Disconnect one wire at switch terminal. Connect test light or continuity tester to the two terminals used on the switch.
3. Install test equipment (see Tool Catalog) onto the hose fitting on the side of the air switch stamped BLACK.
4. Pressurize the hose until the continuity tester indicates a completed circuit. Now read the dial of the test gauge. This is the setpoint of

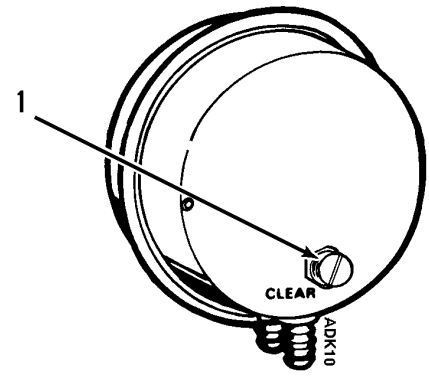
the air switch (correct reading is 0.70 ± 0.05 in. [17.8 ± 1.3 mm] H_2O). Release the pressure.



1.	Magnetic Pressure Gauge
2.	Squeeze Bulb Tool
3.	Continuity Tester

Figure 22: Testing Air Switch

5. If the switch is out of calibration, pressurize the hose again until the tester indicates 0.70 in. (17.8 mm) H_2O. Adjust the screw clockwise or counterclockwise until the switch closes and the continuity tester indicates a completed circuit with the gauge reading 0.70 in. (17.8 mm) H_2O. Release the pressure.



1.	Adjustment Screw

Figure 23: Air Switch

6. Repeat test procedure several times to be sure the setting is correct.
7. Remove the test equipment. Install wire on switch terminal and air sensing tubes on air switch. The BLACK hose from the high pressure or air inlet side of the evaporator coil goes on the hose fitting on the side of the air switch stamped BLACK. The CLEAR hose from the low pressure or air outlet side of the evaporator coil goes on the hose fitting on the side of the air switch stamped CLEAR.

NOTE: Route hoses for continuous slope to avoid condensate traps.

If too much frost continues to accumulate before defrost, decrease the pressure setting. Turn the adjustment screw counterclockwise.

If defrost action occurs with too little frost accumulation, increase the pressure setting. Turn the adjustment screw clockwise.

High Capacity TherMax™ Heating System

The high capacity heating system increases the capacity of the Heat mode by making more refrigerant available for use in the Heat mode. This is accomplished by adding an additional solenoid (TherMax™ solenoid) to the refrigeration system which opens during the beginning of the Heat mode to move the liquid refrigerant from the condenser to the accumulator where it can be used in the Heat mode. The sequence of operation for the improved heating system is from the Cool mode to the Heat mode with Refrigerant Transfer mode to the Heat mode. The Heat mode to Cool mode operation is the same as in the past. The bypass check valve, and the condenser check valve have been eliminated from the TherMax™ heating system.

The components that have been added to the system are:

- the TherMax™ solenoid
- the TherMax™ solenoid line
- the receiver outlet check valve

The TherMax™ solenoid controls the flow of refrigerant through the TherMax™ solenoid line. The TherMax™ solenoid line goes from the liquid line just past the receiver outlet check valve to the accumulator inlet. The receiver outlet check valve is located in the liquid line near the drier/receiver outlet. This check valve prevents refrigerant from migrating back into the receiver tank and condenser during the Heat mode.

Cool Mode

The Cool mode has not been changed in the TherMax™ heating system. The TherMax™ solenoid, which is normally closed, is de-energized during the Cool mode. The TherMax™ solenoid separates the high side from the low side. When the TherMax™ solenoid is closed, it does not allow liquid refrigerant to flow from the liquid line, through the TherMax™ solenoid line, to the accumulator.

Heat/Condenser Evacuation Mode

The unit will run in the Condenser Evacuation mode for two minutes before entering the Heat mode. This is accomplished by opening (energizing) the TherMax™ solenoid while the unit is running in cool. The pressure difference between the high pressure in the condenser and the low pressure in the accumulator drives much of the refrigerant out of the condenser and receiver into the accumulator. The refrigerant is then available for improved heating capacity. The unit is placed in the Heat mode by opening (energizing) the hot gas solenoid and closing (energizing) the condenser inlet solenoid. The TherMax™ solenoid remains open while the unit is in the Heat mode. The receiver outlet check valve prevents the migration of refrigerant back into the receiver tank and condenser.

Defrost Mode

The Condenser Evacuation mode is not used before the Defrost mode. The TherMax™ solenoid, the hot gas solenoid, and the condenser inlet solenoid are all energized at the same time. The TherMax™ solenoid remains open while the unit is in the Defrost mode.

Start Up Mode

For the first 20 seconds when the unit is started it runs in the Cool mode with the TherMax™ solenoid open and the alternator excitation circuit (7K) de-energized. This reduces the load. The Start Up mode is used for both diesel and electric operation.

MD-200 Units Equipped with a Three-Phase Electric Motor and a Phase Converter That Operates on Single-Phase Power

NOTE: Refer to drawings 1E19109 and 1E04148 diagrams in the back of this manual.

MD-200 units are equipped with a three-phase electric motor. Automatic Phase Conversion is availabel as an option. The phase conversion system enables the three-phase electric motor to operate using power from a single-phase power source.

NOTE: The suction pressure regulator must be set at a maximum of 19 psig (131 kPa) when single-phase power is used. A higher setting will overload the electric motor. To check the suction pressure regulator setting, run the unit on defrost and observe the suction pressure.

The overload relay is set at 18 amps. A higher setting may not provide adequate protection.

Voltage taps (230 volt or 208 volt) for the transformer are located on the test strip in the control panel. To make sure the unit operates properly, wire L1A should be connected to the voltage tap that matches the voltage of the power source. Wire L1A is normally connected to the 208 volt tap.

Conversion System

The optional automatic phase conversion system consists of a start system and a run system. The start system is energized by the high current draw that is present while the motor is starting under a load. Once the motor is running at normal speed and the current draw has dropped, the start system is de-energized and the run system is solely responsible for the phase shift. The run system is always connected to the motor circuit, but it does not affect the circuit while the start system is energized because the start capacitors have much larger capacitance and dominate the run capacitors.

Start System

The components of the start system are:

- a current relay
- a motor start relay
- a motor start contactor
- a filter capacitor
- two start capacitors (400 to 480 µF each)
- two start bleed down resistors (180 k ohms each)

Single-phase power is available at L1 and L2. L1 and L2 pass through the motor contactor and become L1A and L2A. L1A passes through the overload relay to become T1. L2A passes through the overload relay to become L2B. L2B passes through the overload relay to become T2.

The three-phase motor has two separate sets of windings with three windings in each set. Branches of T1 are connected directly to the first winding in each set. A branch of T2 is connected directly to the second winding in one set. Another branch of T2 passes through the control coil of the current relay and becomes T2A, which is connected to the second winding in the other set.

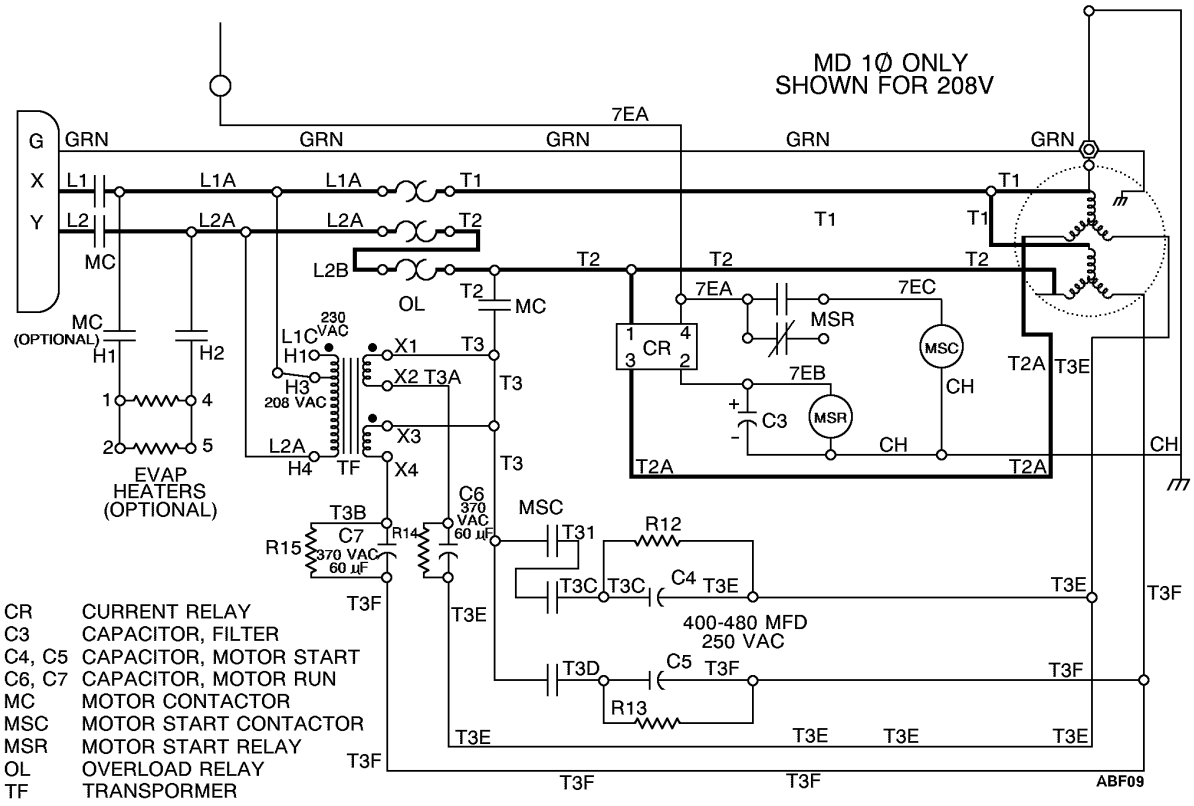


Figure 24: First and Second-Phase Connections

L1 and L2 supply power directly to the first and second windings in both sets of windings in the motor.

A branch of T2 passes through the motor contactor to become T3. A branch of T3 passes through the motor start contactor and a start capacitor to become T3E, which is connected to the third winding in one set. Another branch of T3 passes through the motor start contactor and a start capacitor to become T3F, which is connected to the third winding in the other set.

When the motor is starting under a load, the current in T1 and T2 climbs to a fairly high rate. When the current in T2-T2A passes through the control coil of the current relay exceeds 27 amps, the current relay is energized and its contacts close.

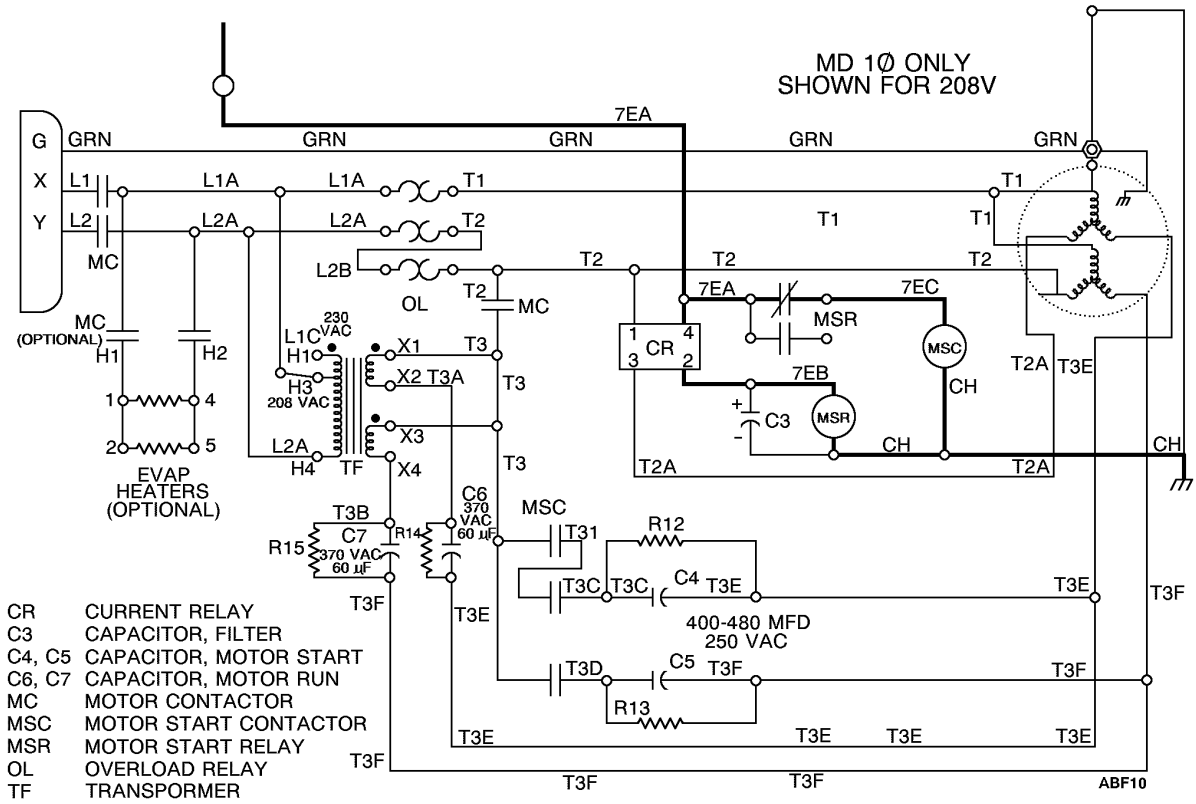


Figure 25: Motor Start Contactor Control Coil Circuit

7EA energizes the motor start contactor through the start relay when the current in T2-T2A exceeds 27 amps.

Wire 7EA supplies control voltage from the unit to the current relay at terminal 4. When the current relay is energized, control voltage passes through the contacts to terminal 2 and wire 7EB to energize the motor start relay. The C3 capacitor, which is connected in parallel with the control coil of the motor start relay, works with the motor start relay to act as a smoothing device to reduce chatter in the motor start contactor.

A branch of wire 7EA also supplies control voltage to one side of the motor start relay contacts. When the motor start relay is energized, control voltage passes through the closed contacts and wire 7EB to energize the motor start contactor.

The contacts in the motor start contactor close when it is energized through the motor start relay. T3E and T3F are energized and the start capacitors provide the phase shift and boost in power necessary to start the motor under a load.

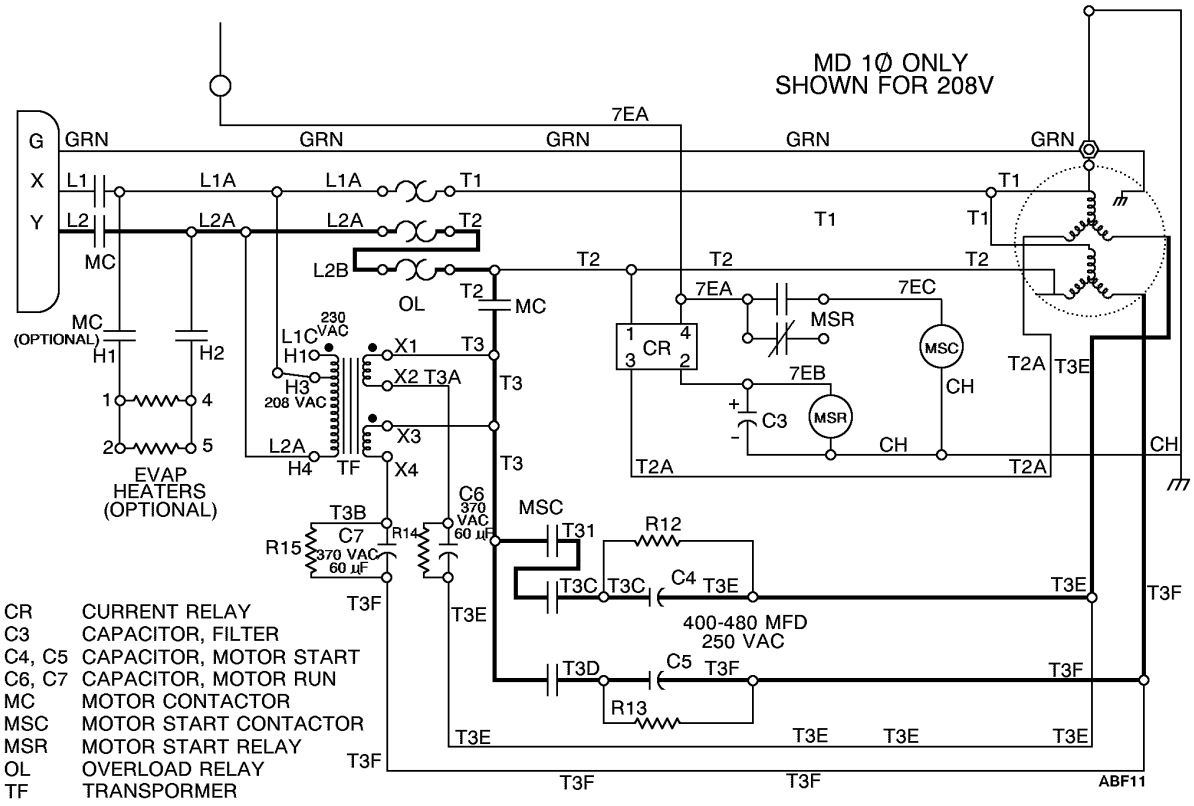


Figure 26: Third Phase Connection During a Start

L2 supplies power to the third windings in both sets of motor windings through the start

As the motor approaches normal running speed, the current through T2-T2A drops. When this current drops below 22 amps, the current relay is de-energized. This de-energizes the motor start relay, the motor start contactor and the start capacitors. The start system is now disconnected from the motor circuit and the run system provides the phase shift necessary to operate the motor at normal running speed.

Run System

The components of the run system are:

- a run transformer
- two run capacitors (60 µF each)
- two run bleed down resistors (560 k ohms each)

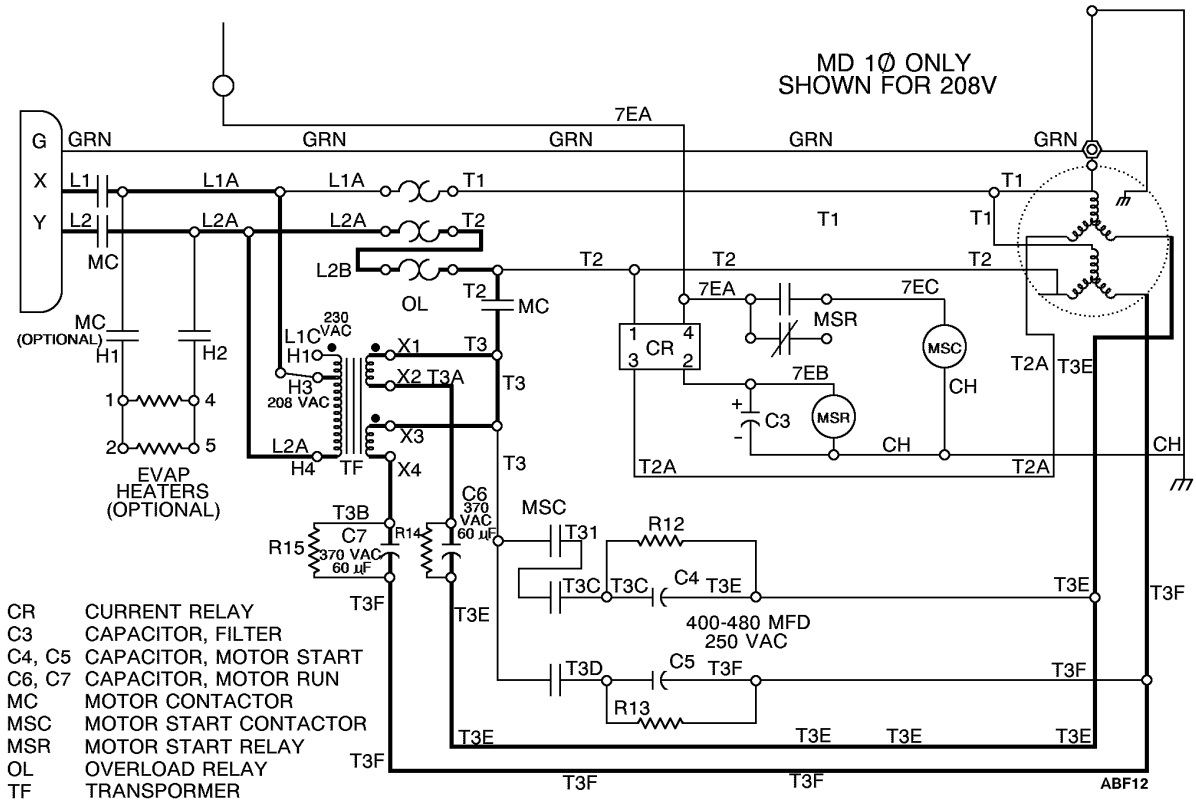


Figure 27: Third Phase Connection During a Start

L2 supplies power to the third windings in both sets of motor windings through the start second windings in both sets of windings in the motor.

The primary winding of the run transformer is connected to L1A on one side and to L2A on the other side. A branch of T3 passes through one of the secondary windings on the run transformer and one of the run capacitors to become T3E, which is connected to the third winding in one set of the motor windings. Another branch of T3 passes through the other secondary winding of the run transformer and the run capacitor to become T3F, which is connected to the third winding in the other set of motor windings. The run transformer and the run capacitors combine to provide the phase shift and power needed to operate the motor at its normal running speed.

The run transformer, run capacitors, and start capacitors are located in a control box under the motor pedestal. These components can be accessed by removing the motor and pedestal assembly from the unit's condenser frame. The wiring harness connected to the motor is long enough to allow the motor and pedestal assembly to be set beside the unit and test run if necessary.

The current relay, motor start relay, motor start contactor, and a test point strip are located in the unit's main control box. The test point strip is used to diagnose problems associated with the run transformer, the run capacitors, and the start capacitors.

Troubleshooting the Phase Conversion System

If the electric motor does not run properly, first check the line voltage, the motor contactor, and the motor overload relay. if these are all acceptable, test the electric motor to narrow down the possible causes for the problem. See the Troubleshooting Chart for the individual component tests.

Electric Motor Tests

Test 1. Run the motor with three-phase power.

Disconnect the T1, T2, T2A, T3E, and T3F wires from the motor and connect three-phase power directly to the motor. Connect L1 to leads 1 and 7, connect L2 to leads 2 and 8, and connect L3 to leads 3 and 9. Start and run the unit. Check and record the voltage and current readings in the following chart.

Wires	Voltage	Wire	Start Current	Run Current
L1-L2		L1		
L2-L3		L2		
L3-L1		L3		

The ideal voltage is 208 to 235 volts ac and the voltage should not vary more than 10% between the sets of wires. If the voltages are out of these ranges, check the power source.

The start current should be approximately 75 amps.

The run current should not exceed 14.5 amps.

The current should not vary more than 10% between wires.

If the run current is higher than 14.5 amps in all three wires, check the suction pressure regulator setting before replacing the motor. Check the setting of the suction pressure regulator by observing the suction pressure while the unit is running in defrost. If the suction pressure is higher than 19 psig (131 kPa), the suction pressure regulator must be adjusted or replaced.

Replace the motor if currents are out of these ranges.

Test 2. Run the motor with single-phase power and the phase conversion system connected to the motor.

Remove the electrical connection box cover on the motor, and check and record the current readings in the following chart.

Wire	(Motor Lead)	Start Current	Run Current
• T1	• (1)	•	• •
• T1	• (7)	•	• •
• T2	• (3)	•	• •
• T2A	• (9)	•	• •
• T3E	• (2)	•	• •
• T3F	• (8)	•	• •

The electric motor has two sets of windings. This test separates the sets.

The start current should begin at 40 to 45 amps, and then drop off to approximately 20 amps in 1 to 3 seconds (in wires T2 and T2A). After 3 seconds, the run current should stabilize at 4 to 8 amps (in each of the six wires).

Circuit T2A contains the current relay, which controls the motor start contactor. If the start current is in the proper range but the motor does not shift to run after 3 seconds, go to Test 3. If the start or run currents are very uneven, go to the start or run capacitor checks in the Troubleshooting Chart.

NOTE: Wire L1A should be connected to the transformer voltage tap that matches the line voltage of the power source. High voltage on the 208 volt tap will cause high run currents.

Test 3. The unit Starts but does not shift to the run system.

If the motor starts correctly but the current remains at approximately 20 amps after 3 seconds, the start system is not being de-energized. Use the following procedure.

1. Locate the current relay in the main control panel.
2. Disconnect the 7EA and 7EB wires.
3. Install a switch between the 7EA and 7EB wires.
4. Close the switch between the 7EA and 7EB wires and start the motor.
5. Wait 3 seconds and then open the switch between the 7EA and 7EB wires.
    a. If the motor does not shift to run, check for a faulty motor start relay or a faulty motor start contactor.
    b. If the motor shifts to run, check for a faulty current relay or an overload on the motor.
    c. If the motor shifts to run but then slows down or stops, check for a faulty transformer or faulty run capacitors.

See the Troubleshooting Chart for the individual component tests.

Troubleshooting Chart

NOTE: All amperage and voltage measurements should be taken with the unit turned ON and the motor running or attempting to start. Most of the voltage measurements can be taken inside the unit control box, from the components in the high voltage tray and from the test point strip. The voltage measurements associated with the components under the motor pedestal should be taken at the test point strip before checking the components and connections under the pedestal. The overload relay will trip if the motor does not start shortly after the motor contactor is energized.

Problem/Probable Cause	Test/Solution
Motor Does Not Start/Low Line Voltage	Check the power supply voltage at L1 and L2. The voltage should be between 195 and 230 volts. If not, check the power cord, the plug, and the main building power supply. / Repair as necessary.
Motor Contactor	Check to see that the motor contactor closes when energized. If not, check the control circuit and control coil. If the contactor closes, check the voltage between L1A and L2A and between L1A and T3. If either voltage is low, inspect the contactor for burned or pitted points. / Replace the contactor or points as necessary.
Motor Overload Relay	Check the overload relay to see if it is tripped. / Reset the relay. (The correct setting for the overload relay is 18 amps.) Check the current if the relay continues to trip. / Repair the cause of the overload. Check the voltage between T1 and L2B and between T1 and T2. If either voltage is low, check the overload relay for burned or pitted points. / Replace the overload relay or points as necessary.
Motor Faulty	Test the motor by disconnecting the T1, T2, T2A, T3E, and T3F wires from the motor and connecting three-phase power directly to the motor. Connect L1 to leads 1 and 7, connect L2 to leads 2 and 8, and connect L3 to leads 3 and 9. If the motor starts and runs under a load, the current should not exceed 14.5 amps per leg. / Replace the motor if it does not run or if the current is too high. NOTE: With the phase converter connected to the motor, the current per leg will vary with the line voltage and, in general, will not be the same in all legs.

Problem/Probable Cause	Test/Solution
Current Relay	Check the voltage between T1 and T2 at terminal 1 of the current relay and between T1 and T2A at terminal 3 of the current relay. If there is voltage between T1 and T2, but not T1 and T2A, the control coil is open. / Replace the current relay. Check the voltage on 7EB at terminal 2 of the current relay with unit control voltage (12 to 14 volts dc) present at 7EA on terminal 4 of the current relay and the current relay energized (current in T2A above 30 amps). If there is no control voltage or low control voltage on 7EB when the current relay is energized, the current relay is defective. / Replace the current relay.
Motor Start Relay	Check the voltage on 7EC at the motor start relay with unit control voltage (12 to 14 volts dc) present on 7EA and 7EB at the motor start relay. If there is no control voltage or low control voltage on 7EC, the motor start relay is defective. / Replace the motor start relay.
Motor Start Contactor	Line voltage must be present between T1 and T3 and T1 and T31 at the motor start contactor. If not, check T3 from the motor contactor to the start contactor. / Repair T3 as necessary. Check the voltage between T1 and T3C and T1 and T3D with control voltage present on 7EC at the motor start contactor. Line voltage should be present. If no voltage is present, the control coil of the start contactor is defective. If low voltage is present, the points are defective. / Repair or replace the contactor or points as necessary.

Problem/Probable Cause	Test/Solution
Start Capacitors	Voltage Test With line voltage present between T1 and T3C and T1 and T3D at the start capacitors, check the voltage between T1 and T3 and T1 and T3F. Both voltages should be within 10% of line voltage. If one of the voltages is low, the start capacitor in that circuit is defective. / Replace as necessary. **Current Test *(NOTE: Only one of the two T3E and one of the two T3F wires connected to the motor will carry a current while starting.)*** Check the current through T3E and T3F at the motor with an inductive ammeter during a start attempt. The current in each wire should be 30 to 45 amps. If one of the currents is low, the start capacitor in that circuit is faulty. If both the currents are low, the motor start contactor did not close. / Replace as necessary.
Motor Starts But Runs Poorly Or Slows Down and Restarts	
Run Transformer	With line voltage present between L1A and L2A at the primary winding of the run transformer, check the voltage between T3 and T3A and between T3 and T3B at the secondary windings of the run transformer. The voltages should be 122 (+ 13/-8) volts. If either voltage is less than 110 volts, the line voltage is low or the run transformer is defective. / Replace as necessary. NOTE: The transformer has a 208 volt tap and a 230 volt tap. These taps are accessible on the test strip as L1B (208 volts) and L1C (230 volts). Wire L1A should be connected to the tap that matches the line voltage of the power source.

Problem/Probable Cause	Test/Solution
Run Capacitors	**Voltage Test** (This test is valid only if the motor is running at normal speed and the motor start contactor is de-energized.) Check the voltage between T3A and T3E and between T3B and T3F at the test point strip. The voltages should be within 10% of the sum of the line voltage and the secondary transformer voltage. If the voltage is low, the run capacitor in that circuit is defective. / Replace as necessary. **Current Test** (This test is valid only if the motor is running at normal speed and the motor start contactor is de-energized.) ***NOTE: Only one of the two T3E and one of the two T3F wires connected to the motor will carry a current while running.*** ***NOTE: Check the current in T3E and T3F at the motor with an inductive ammeter. Both currents should be 4 to 8 amps. If a current is below 4 amps, the run capacitor in that circuit is defective. / Replace as necessary.***
Electric Motor Runs Hot or Loads the Diesel Engine During Diesel Operation	
Electric Motor Acting As An Induction Alternator	Check the voltage at the overload relay, T1 to T2, T2 to T3, and T3 to T1. Check the voltage between T3E and T3F. The voltage on any of the above pairs of wires should not exceed 15 volts ac while the unit is running on diesel operation. If the voltage on any of the above pairs of wires is between 500 and 700 volts ac, the electric motor is acting as an induction alternator. To repair the unit, check the following: 1.Check the T2 and T3 circuits through the motor contactor to make sure they are open during diesel operation. / Replace or repair the motor contactor as necessary. 2.Check the connections between the electric motor leads and the Thermo King wiring in the connection box on the electric motor. Compare these connections to those indicated in the wiring diagrams and schematics. / Repair the wiring connections as necessary. 3.Disconnect the electric motor leads from the Thermo King wiring at the connection box on the electric motor. Check the wiring in the electric motor with an ohmmeter to make sure the wires have continuity and are labeled correctly according to the wiring diagrams and schematics. / Repair as necessary.

CAUTION: If the electric motor is being rewound, it must be rewound to the factory specifications because this special application requires the phases to be split.

Full Load Current Test—Used to check the overall performance of the phase conversion system.

Use an inductive ammeter to check the current in motor leads 1 and 7, 3 and 9, and 2 and 8. The wires should have the following currents:

- Leads 1 and 7 together—8 to 18 amps
- Leads 3 and 9 together—10 to 14 amps
- Leads 2 and 8 together—9 to 14 amps

The three motor windings will exhibit a slight imbalance of currents. A difference of as much as 6 amps is possible.

The currents through L1 and L2 can be as high as 85 amps while starting, and as high as 23 amps when running at normal speed in high ambient temperatures. High suction pressure settings can cause high current values.

Parts List for the MD-II Single-Phase Electric Motor System

Quantity	Description	Part Number
1	Electric Motor	104-466
1	Electric Motor Pulley	77-1980
1	Motor Contactor	44-2853
1	Overload Relay	44-6662
1	Current Relay	44-8755
1	Motor Start Relay	44-5837
1	Motor Start Contactor	44-2853
1	Transformer	44-8756
2	Start Capacitors	44-8758
2	Run Capacitors	44-8757
1	Filter Capacitor	44-8759
2	Run Capacitor Resistors	44-8760
2	Start Capacitor Resistors	44-8761

EMI 2000

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

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

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

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

Engine Lubrication System

The TK 3.74 diesel engine has a pressure lubrication system. Oil is circulated by a trochoid type oil pump driven by the crankshaft timing gear and has several times the capacity required by the engine. Oil is picked up through a suction tube with a screened inlet. Oil to the rocker arm shaft flows through a tube on the outside of the engine and into the head through a restrictor fitting.

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

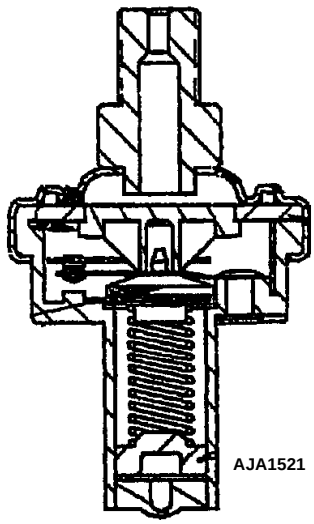


Figure 28: Engine Oil Pressure Switch

Engine Oil Pressure Switch

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

Engine Oil Change

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

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

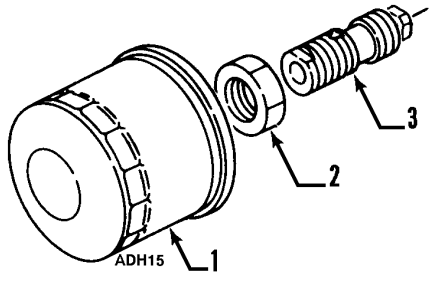
Add oil as necessary to reach the full mark. See Specifications chapter of this manual for correct type of oil.

Oil Filter Change

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

Spin-on Filters:

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



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

Figure 29: Oil Filter Parts

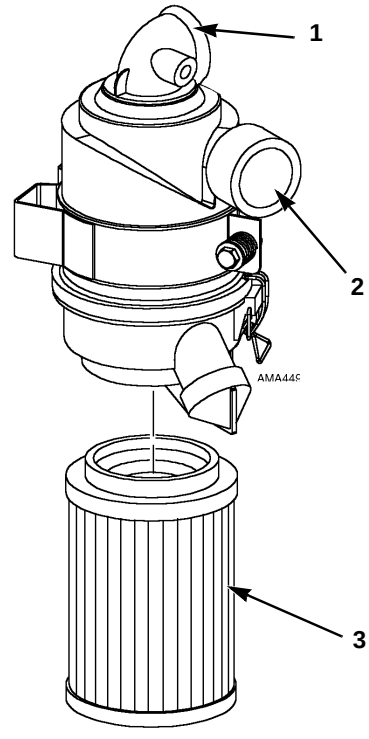
Crankcase Vent

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

Engine Air Cleaner (EMI 2000)

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

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



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

Figure 30: Dry Type Air Cleaner

Engine Cooling System

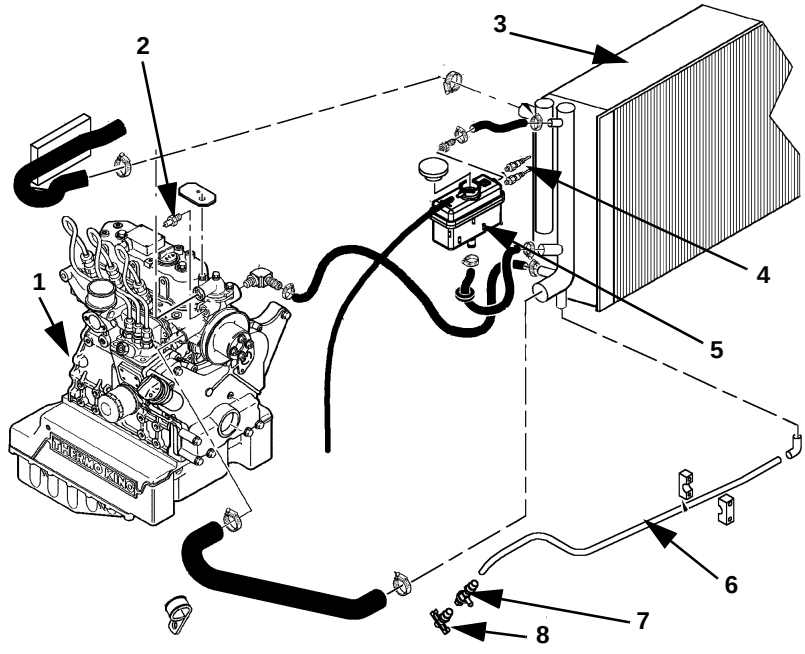
General Description

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

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

This provides the following:

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



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

Figure 31: Engine Cooling Components

ELC (Extended Life Coolant)

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

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

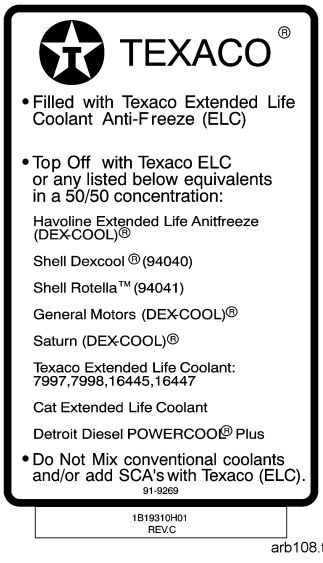


Figure 32: ELC Nameplate—Located On Expansion Tank

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

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

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

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

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

To upgrade new production engines for ELC use, all water pump seal bellows were changed from NBR to HNBR elastomer, and the o-rings upgraded from NBR to EPDM elastomer. These changes were made as of TK 3.74 engine serial number A02105.

Units with engine serial numbers A02105 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 A02105 must have the water pump replaced to change over to ELC coolant. See Service Bulletin T&T 275 for information about retrofitting the new water pump.

Antifreeze Maintenance Procedure

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

Do not mix green or blue-green engine coolant with ELC (red) engine coolant.

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

Checking the Antifreeze

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

Changing the Antifreeze

1. Run the engine until it is up to operating temperature. Stop the unit.
2. Open the drain cock (see Figure 33 on page 74) and completely drain coolant. Observe coolant color. If the coolant is dirty, proceed with a, b, and c. Otherwise go to step 3.

CAUTION: Avoid direct contact with hot coolant.

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

   b. Close the drain cock and install a commercially available radiator and block flushing agent, and operate the unit in accordance with instructions of the flushing agent manufacturer.

   c. Open the drain cock to drain water and flushing solution.

CAUTION: Avoid direct contact with hot coolant.

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

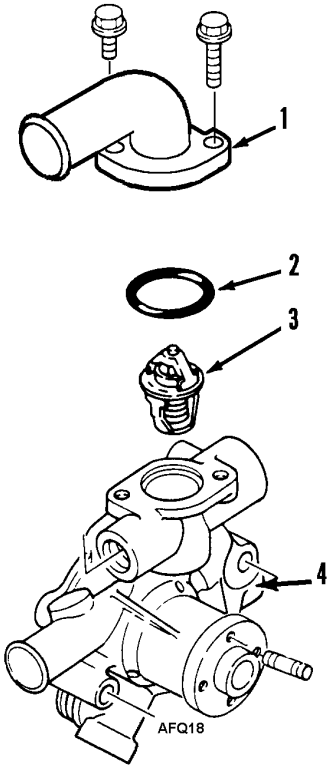
Bleeding Cooling System

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

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

Engine Thermostat

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



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

Figure 33: Water Pump Assembly and Thermostat

Engine Fuel System

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

The components of the fuel system are:

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

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

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

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

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

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

The following procedures can be done under field conditions:

- Bleeding air from the fuel system.
- Maintenance involving the fuel tank and filter system.
- Speed and governor adjustments.
- Electric transfer pump replacement or repair (10 psig [69 kPa] pump with diesel filter).
- Injection line replacement.

- Pump timing.
- Nozzle spray pattern testing and adjustment.
- Minor rebuilding of nozzles.

Bleeding the Fuel System

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

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

Proceed as follows:

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

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

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

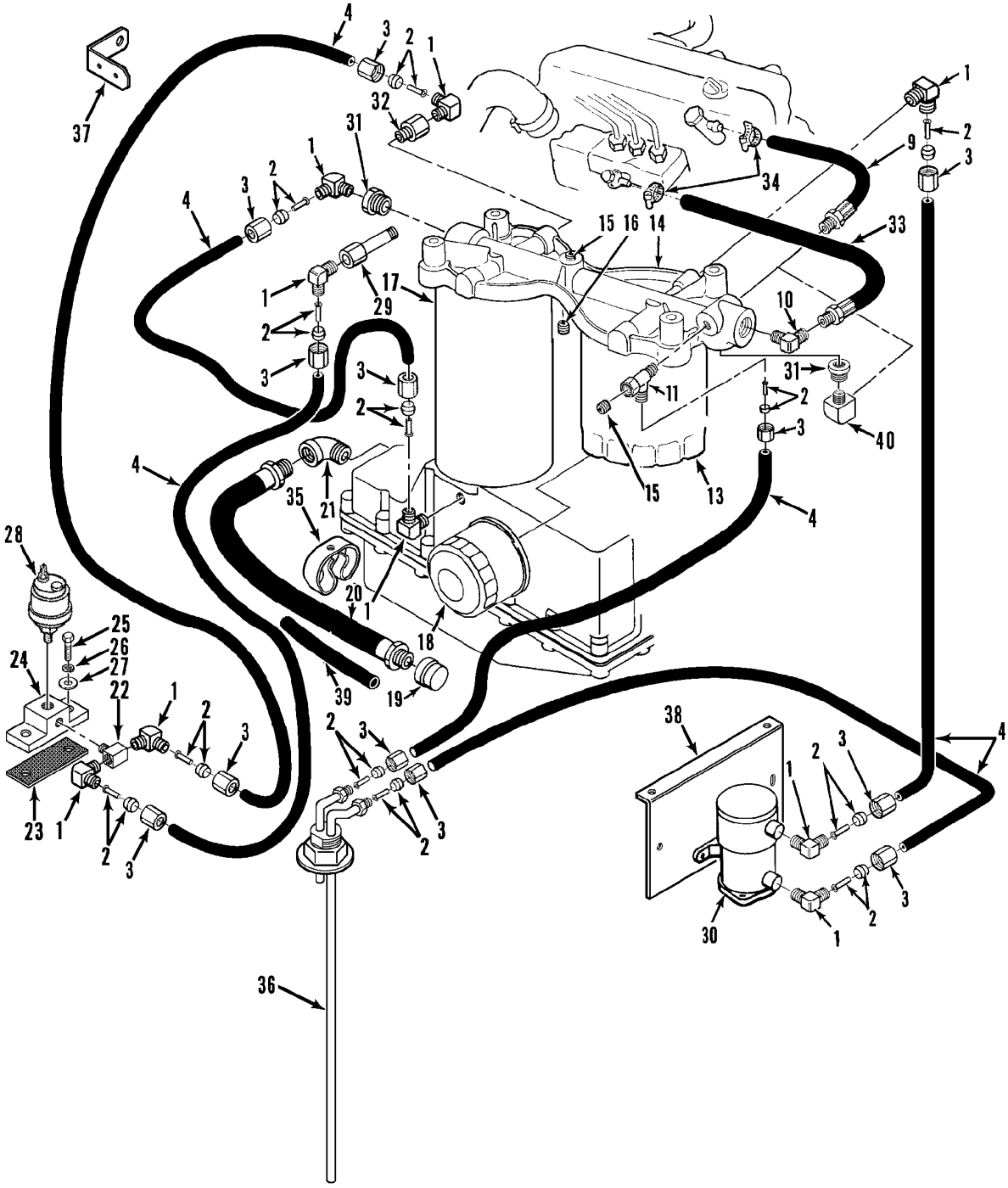


Figure 34: Fuel and Oil System Components

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

Figure 35: Fuel and Oil System Components for Figure 122

Draining Water from Fuel Tank

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

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

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

Fuel Filter Replacement

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

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

Reassembly

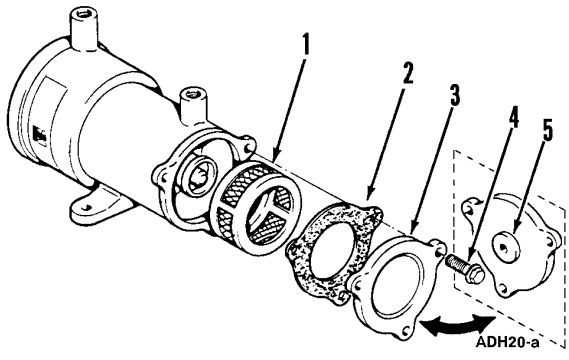
Place the cover gasket on the bottom cover and install the filter and cover assembly. Replace the three screws.

Electric Fuel Pump

Operation

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

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



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

Figure 36: Electric Fuel Pump

Maintenance

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

Disassembly

1. Remove the three screws from the cover.

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

If pump does not operate, check for:

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

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

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

Injection Pump

Injection Pump Adjustments

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

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

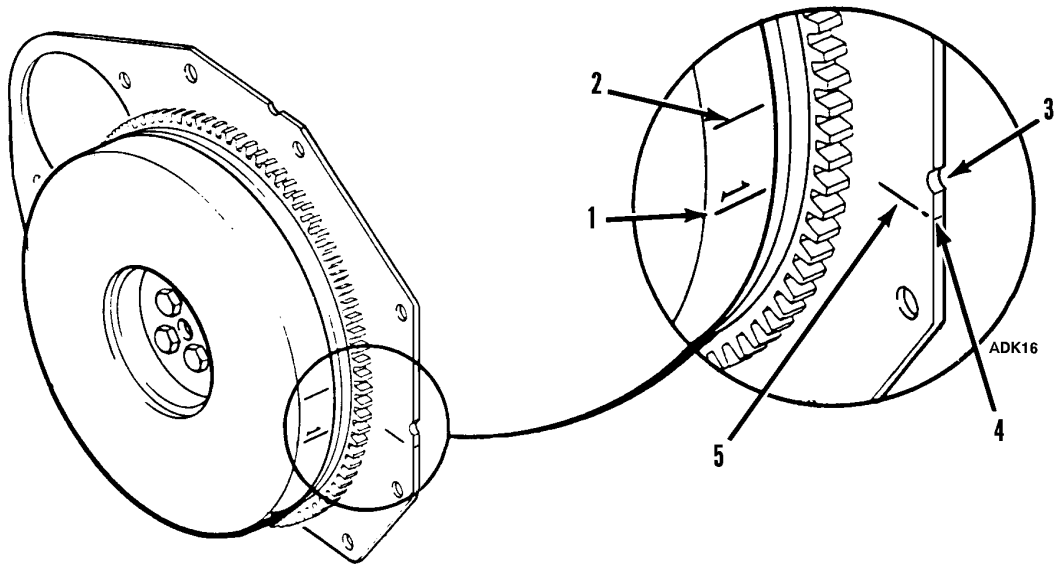
Make the engine speed adjustments with the engine fully warmed up.

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

Timing the Injection Pump to the Engine

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

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



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

Figure 37: Timing Marks

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

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

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

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

3. Install a drip valve on the nozzle holder.

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

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

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

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

Timing Individual Cylinder Injection

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

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

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

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

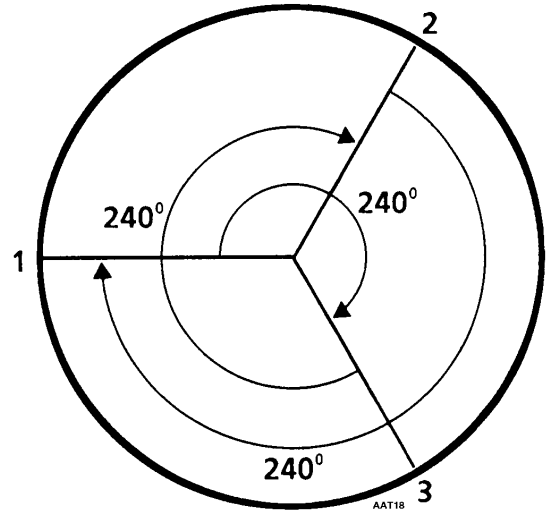


Figure 38: Individual Cylinder Timing and Firing Order

Adjust Engine Valve Clearance

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

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

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

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

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

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

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

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

Fuel Limit Screw

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

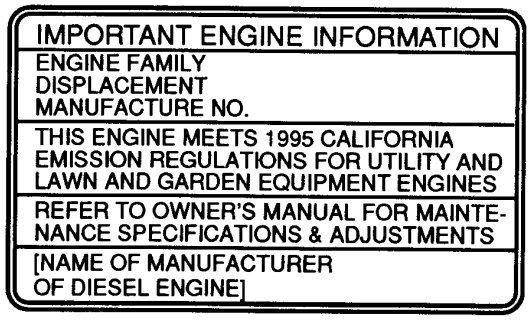


Figure 39: Emission Control Label

Integral Fuel Solenoid

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

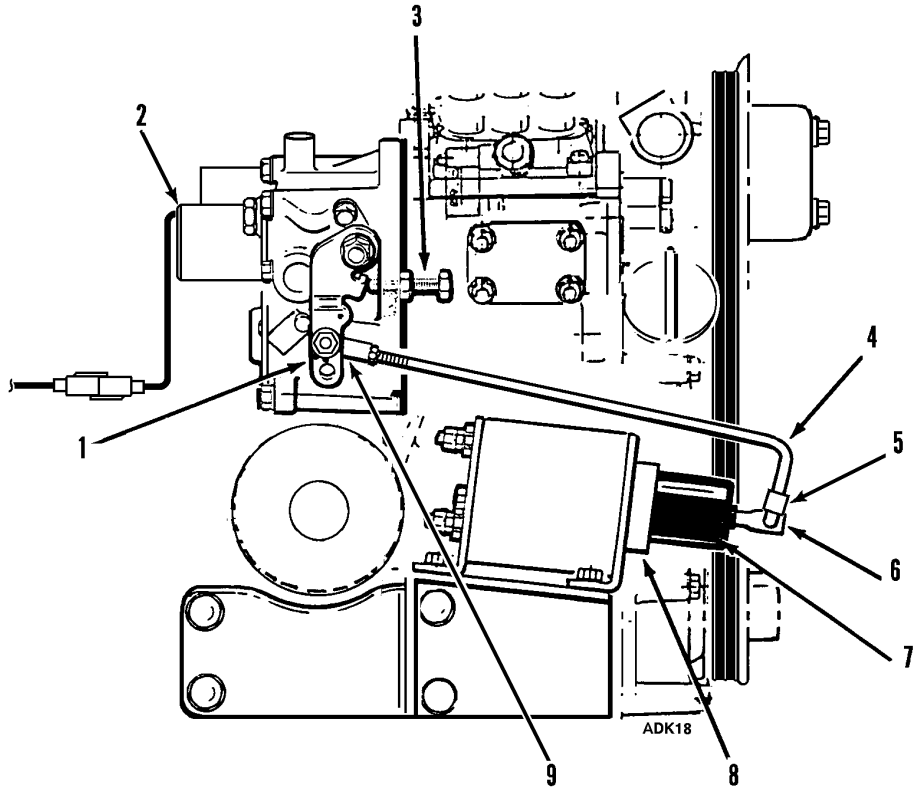
Operation of the engine is controlled by the operation of the fuel solenoid and the throttle (high speed) solenoid. The fuel solenoid consists of a spring loaded plunger and electro-magnetic coil. When the engine is Off, spring tension on the plunger maintains the plunger's "out" position. When pushed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

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

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

Fuel Solenoid Diagnostic and Replacement

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



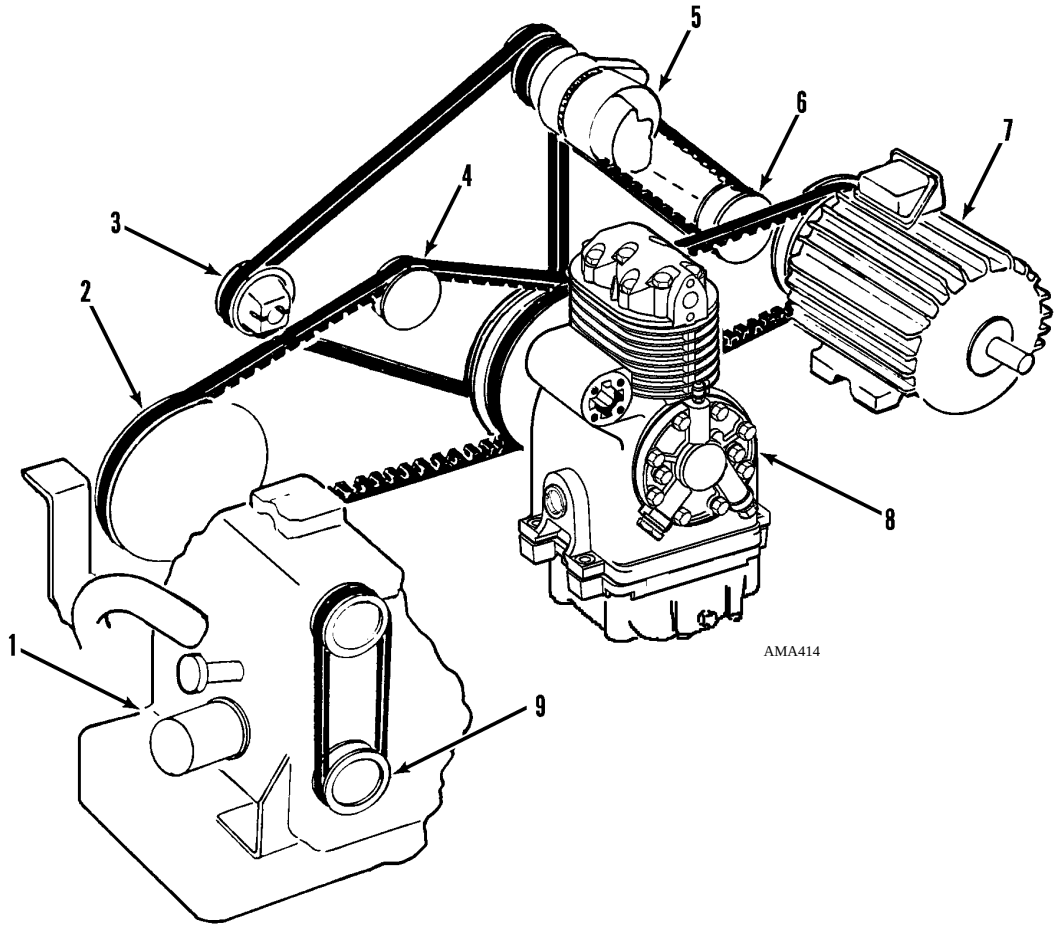
1.	Throttle Lever	6.	Eye Bolt
2.	Fuel Solenoid	7.	Boot
3.	Low Speed Adjustment Screw	8.	Throttle Solenoid
4.	Rod	9.	Ball Joint
5.	Clip		

Figure 40: Integral Fuel Solenoid Components

BELT TENSIONS

Correct belt tension is critical for proper unit operation. Belts that are too loose will slip, squeal or whip causing excessive vibration levels and poor unit performance. Belts that are too tight will cause excess vibration along with premature belt and bearing failures.

NOTE: DO NOT attempt to remove or install belts without adjustments. Belts that are installed by prying will fail prematurely due to internal cord damage.



1.	Engine	6.	Fan Pulley
2.	Engine Clutch	7.	Compressor Drive Motor (Model 50)
3.	Fan Pulley	8.	Compressor
4.	Idler	9.	Water Pump
5.	Alternator		

Figure 41: MD-II SR Belt Arrangement

WARNING: DO NOT jump belts on by cranking the engine; personal injury may result.

WARNING: DO NOT attempt to adjust belts with the unit running.

Auto Start/Stop

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

NOTE: Tension specifications are measured using gauge TK 204-427.

Compressor/Electric Motor/Jackshaft Belt

Slide the jackshaft or induction alternator away from the compressor to tighten this belt.

Belts should be tensioned cold and retensioned cold after 10 hours of unit running.

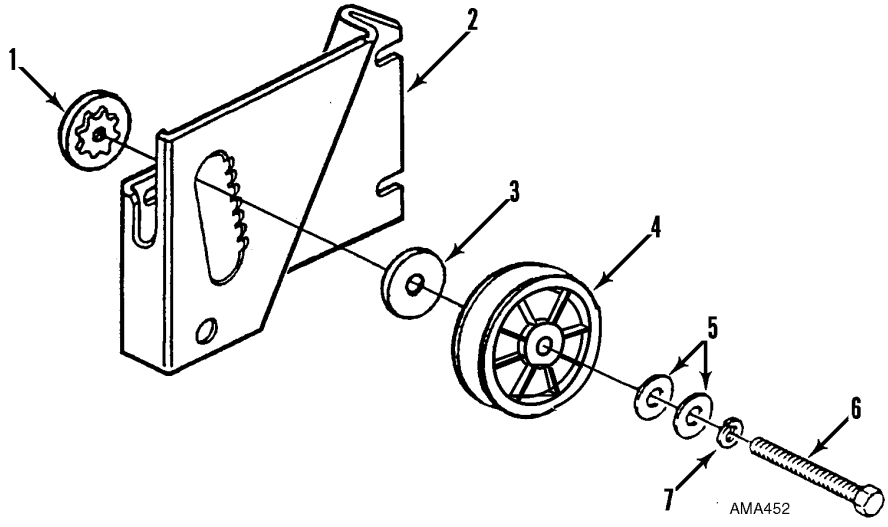
Gauge tension on new belts should be 72 ± 3. Gauge tension on used belts should be 67 ± 3.

This tension allows 1/2 in. (13 mm) deflection in the center of the span.

Water Pump Belt

Adjust tension by adding or removing shims between pulley sheaves, until the belt allows 1/2 in. (13 mm) of deflection at the center of the span.

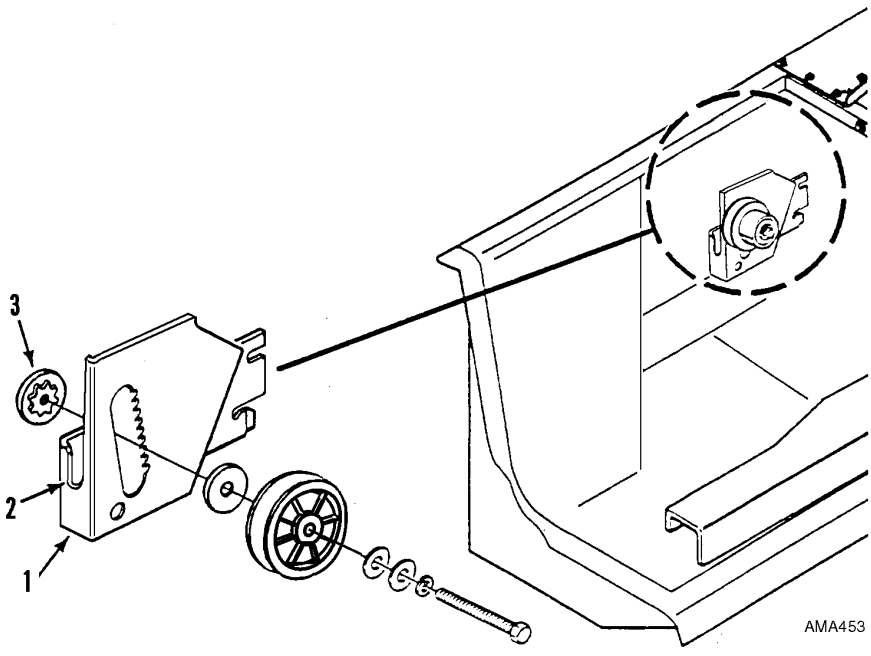
IDLER ASSEMBLY



1.	Sprocket	5.	Flatwasher—1/2 SS
2	Idler Bracket	6.	Hex Head Screw—1/2-13 UNC x 4.00 STL
3.	Special Water—1/2 STL	7.	Lockwasher—1/2 SS
4.	Pulley		

Figure 42: Idler Assembly

Engine/Compressor/Jackshaft Belt



1.	Idler Bracket	2.	Slot	3.	Sprocket

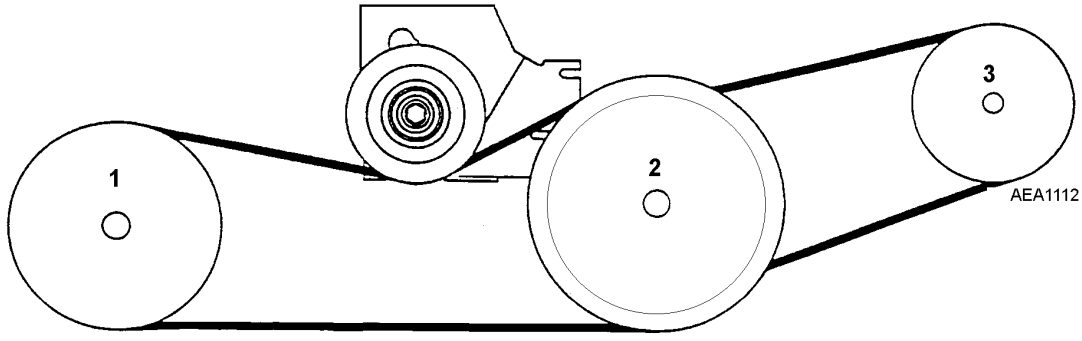
Figure 43: New Idler Assembly

Tension Adjustments

1. Place the engine/compressor belt in the idler pulley. Make sure the belt is also placed in the engine pulley and the compressor pulley.
2. Turn the sprocket with a 7/8 in. wrench to tension the belt. Tighten the pulley bolt with a 3/4 in. wrench when the belt is at the proper tension. Use one of following methods to check (or set) the belt tension.
   a. The belt tension should be set at a reading of 70 to 80 on the Thermo King Belt Tension Gauge P/N 204-427.
   b. The belt should deflect 1/2 in. (13 mm) at the center of the longest (lower) span.
   c. Use a 7/8 in. crow's foot attached to a 3/8 in. torque wrench to turn the sprocket and obtain a reading of 40 in-lb (4.5 N•m) on the torque wrench for used belts and 45 in-lb (5.0 N•m) for new belts. Tighten the pulley bolt while holding the sprocket in this position. When using this procedure, the pulley bolt must at first be loose enough to allow the sprocket to rotate freely. If not, the reading on the torque wrench will not produce the proper belt tension.
3. Place the compressor/evaporator fan/alternator belt in the compressor pulley and check to see that it is centered in the slot on the left side of the idler bracket. If not, adjust the position of the left evaporator fan pulley on the fan shaft so the belt is centered in the slot. Adjust the compressor/evaporator fan/alternator belt to the proper tension after it is centered in the slot.
4. Adjust the compressor/jackshaft (electric motor) belt to the proper tension. The belt tension should be set at a reading of 64 to 70 on the Thermo King Belt Tension Gauge P/N 204-427. If the Thermo King Belt Tension Gauge is not used, the belt should deflect 1/2 in. (13 mm) at the center of the longest span.

IMPORTANT

The Belts Must Be Adjusted To The Proper Tensions!



1.	Engine
2.	Compressor
3.	Jackshaft or Electric Motor

Figure 44: Belt Layout

The engine/compressor belt tension should be set at a reading of 70 to 80 on the Thermo King Belt Tension Gauge P/N 204-427.

The compressor/jackshaft (electric motor) belt tension should be set at a reading of 64 to 70 on the Thermo King Belt Tension Gauge P/N 204-427.

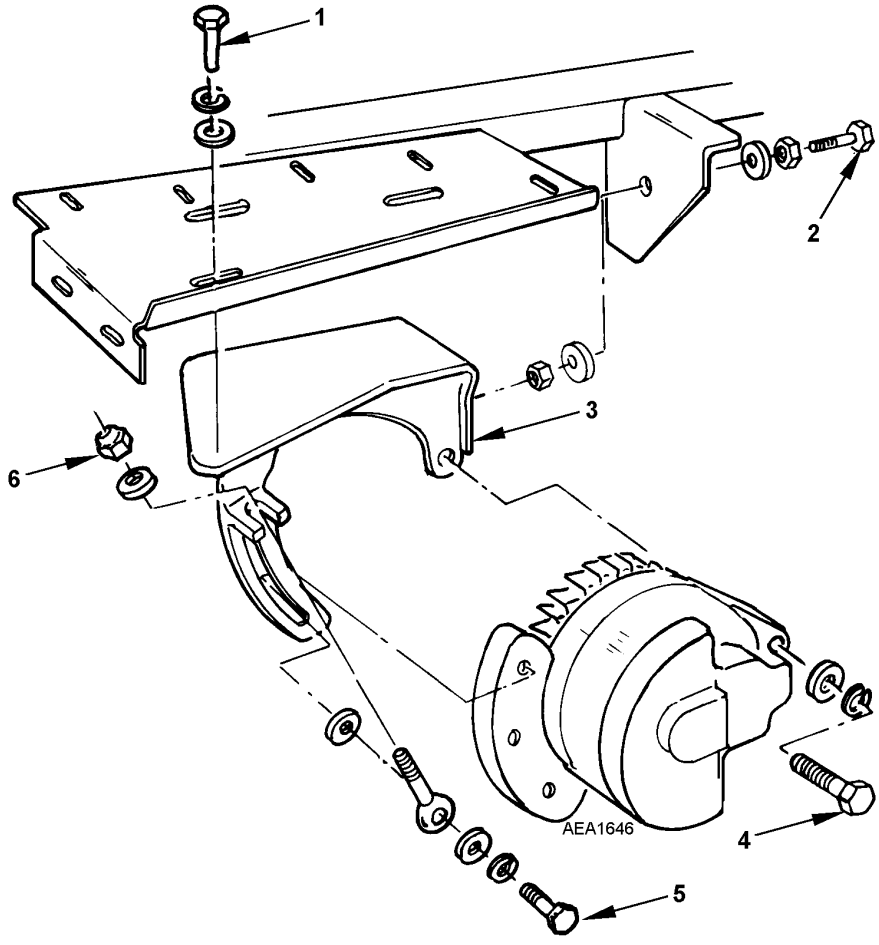
If the Thermo King Belt Tension Gauge is not used, the belt should deflect 1/2 in. (13 mm) at the center of the longest span.

Belts should be tensioned cold and retensioned cold after 10 hours of running.

Compressor/Evaporator/Alternator and Alternator/Evaporator Fan Belts

Move the alternator upward to tighten the belts enough to obtain 1/2 inch (13 mm) deflection at the center of the longest span of the Compressor/Evaporator Fan/Alternator belts, and 1/2 inch (13 mm) deflection at the center of the span on the Alternator/Evaporator Fan belt.

Belts should be tensioned cold and retensioned cold after 10 hours of running.



1.	Belt Adjustment Nut	4.	Pivot Bolt
2.	Bracket Mounting Bolt	5.	Alternator Mounting Bolt
3.	Belt Adjustment Screw	6.	Bracket

Figure 45: Alternator Mounting and Belt Tension Screws

Engine Speed Adjustments

Low Speed Adjustment

1. Start the unit and let it run until the engine is warmed up.
2. Set the thermostat to make the engine run in low speed and check the engine speed. The engine speed should be 1625 ± 25 rpm.
3. If the engine speed is not correct, loosen the jam nut on the low speed adjustment screw.
4. Turn the low speed adjustment screw to change the engine speed. Turn the screw in to increase the engine speed. Turn the screw out to decrease the engine speed.
5. Set the engine speed at 1625 ± 25 rpm and tighten the jam nut.

High Speed Adjustment

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

Evacuation

Evacuation is Important and is Critical to System Performance!

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

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

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

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

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

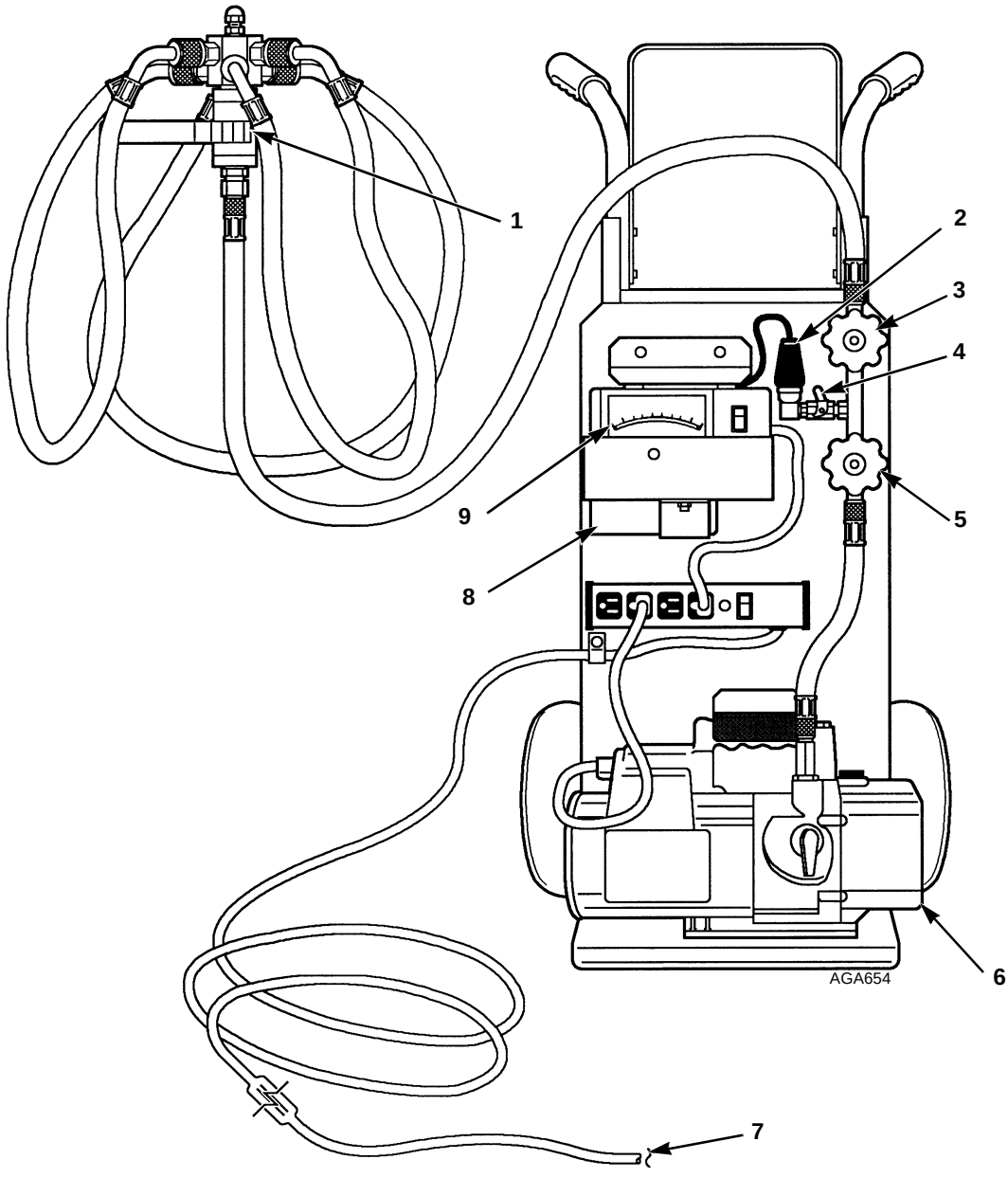
See the diagram of the Thermo King Evacuation Station and note the location of the valves.

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

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

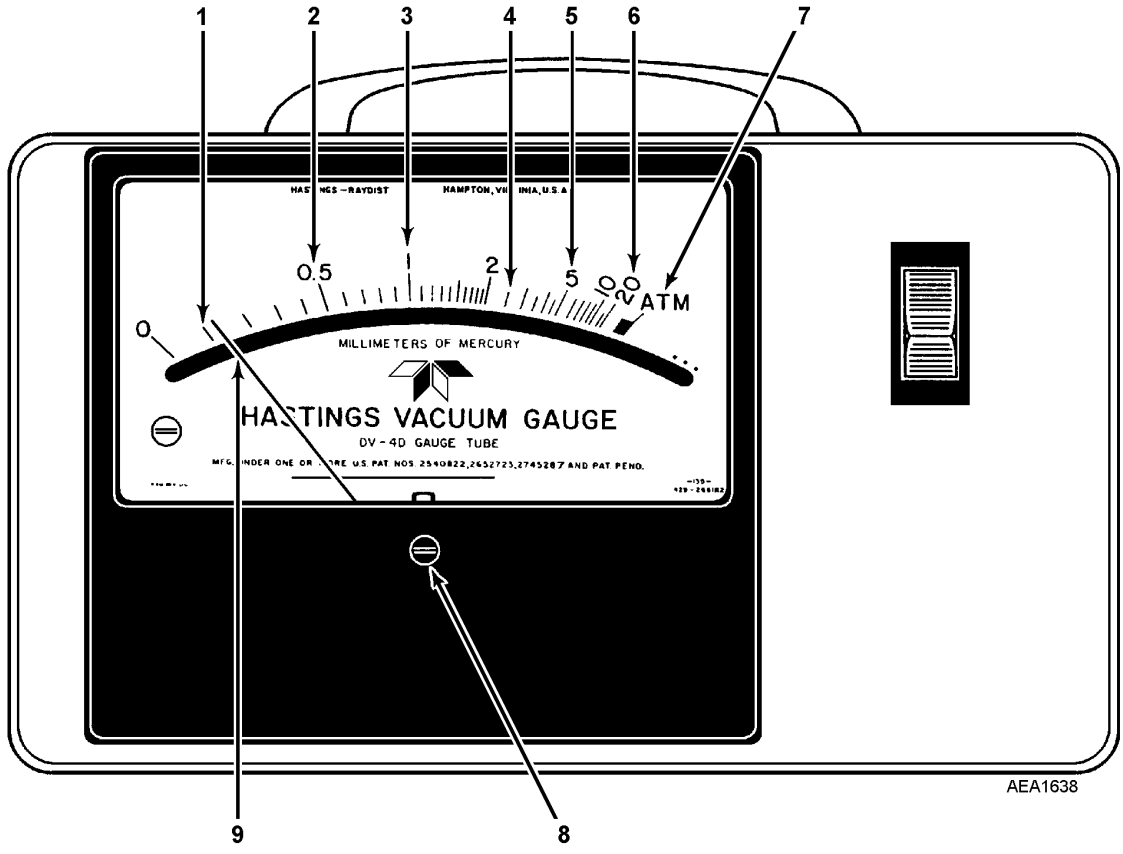
Valve #3 (V-3): Is in the open position during unit evacuation. When closed, V-3 isolates the micron gauge and the vacuum pump from the other evacuation hoses.

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



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

Figure 46: Evacuation Station



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

Figure 47: Vacuum Gauge

Set Up and Test of Evacuation Equipment

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

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

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

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

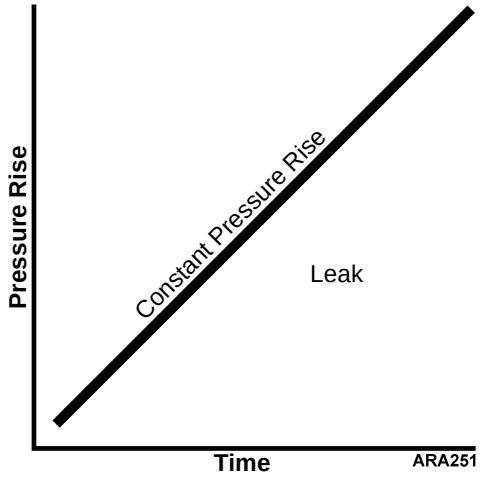


Figure 48: Leak

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

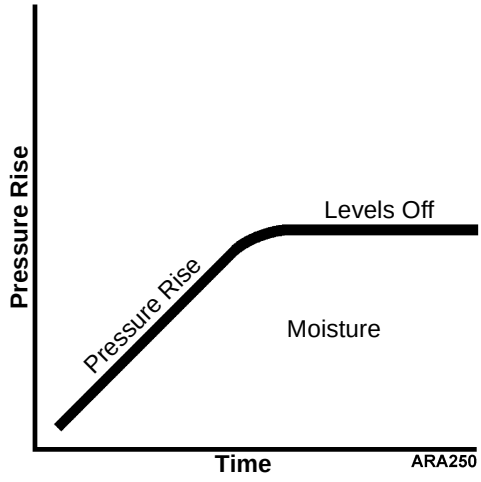


Figure 49: Moisture

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

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

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

Unit Evacuation

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

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

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

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

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

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

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

Refrigerant Leaks

NOTE: Refer to Diagnosing Thermo King Refrigeration Systems (TK 5984-3-TM) for leak detection procedures.

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

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

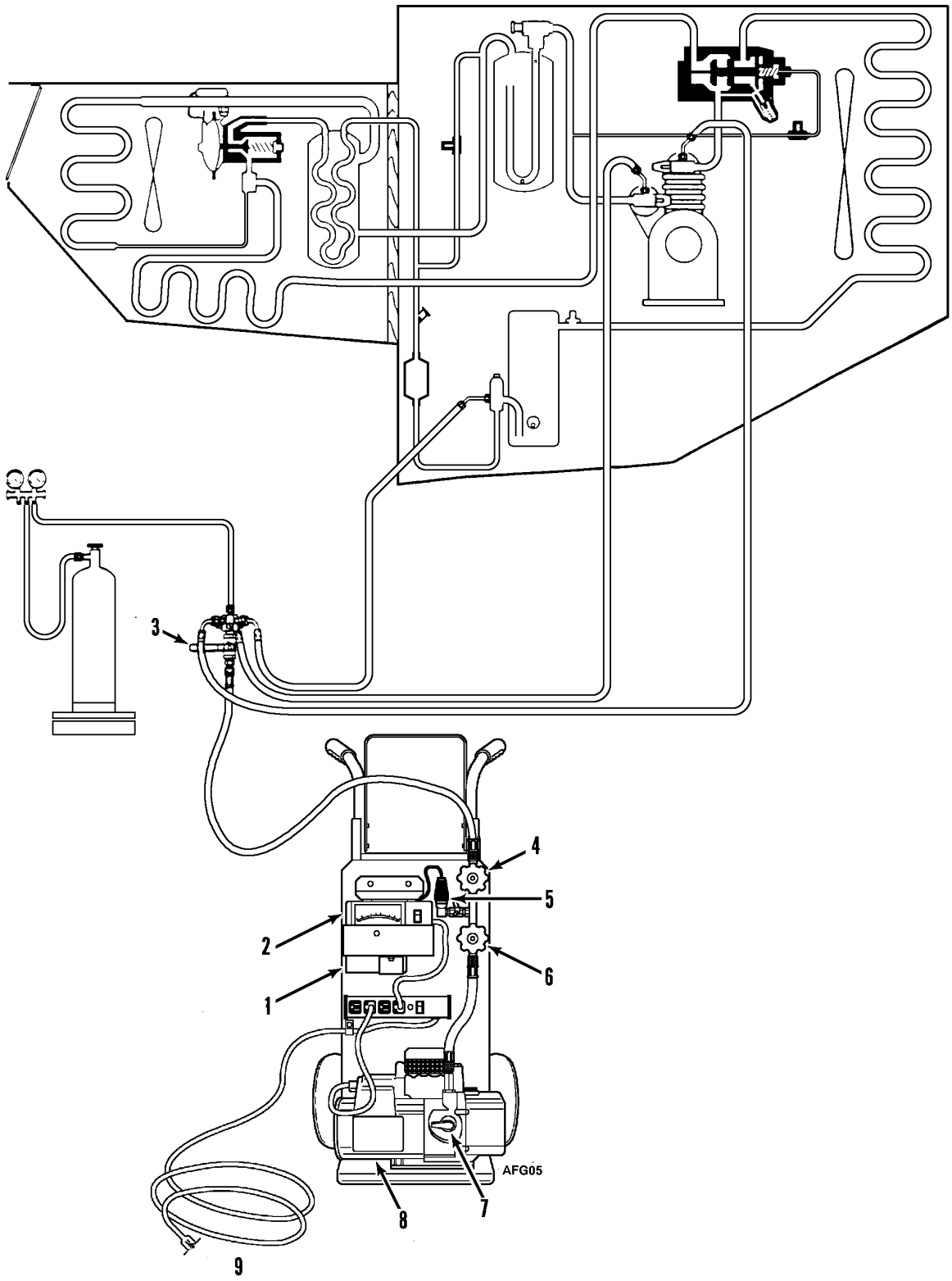
Unit Charging

NOTE: Unit must be leak checked and fully evacuated before charging. Before charging, make sure that the refrigerant lines from the gauge manifold to the refrigerant supply bottle have been evacuated or purged.

NOTE: Refer to the diagram on the next page for the following discussion.

1. Back seat the suction service valve. The discharge and receiver outlet valves remain open to port.
2. Set the refrigerant supply bottle for liquid. Open the gauge manifold hand valve, and charge liquid refrigerant until the system has the proper charge or until the system will take no more liquid. If more charge is required, charge will be added as a liquid through the suction service valve if more refrigerant is required.
3. After the liquid refrigerant is added, close the gauge manifold hand valve.

4. Back seat (close) the receiver outlet valve. Back seat the discharge service valve. Open the suction service valve.
5. Open the refrigerant supply valve for liquid. Open the gauge manifold hand valve.
6. Start and operate the unit with the thermostat set for cool. Add liquid through the suction service valve until the correct charge is attained. Make sure that the liquid level does not rise above the sight glass. Refer to the unit serial plate for the correct amount of charge.



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

Figure 50: Unit Charging

Refrigerant Charge

Testing the Refrigerant Charge with an Empty Box

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

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

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

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

Testing the Refrigerant Charge with a Loaded Box

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

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

Checking Compressor Oil

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

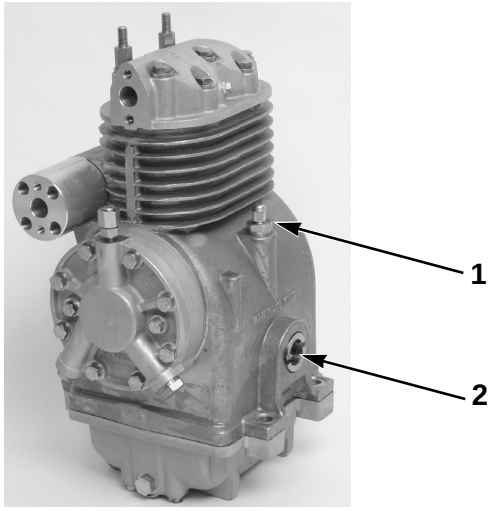
To check compressor oil level with an ambient air temperature above 50 F (10 C):

Install a gauge manifold on the compressor.

R-134a Systems: Operate the unit on Cool with a 10 psig (69 kPa) minimum suction pressure and a 100 psig (689 kPa) minimum discharge pressure for 15 minutes or more.

R-404A Systems: Operate the unit on Cool with a 10 psig (69 kPa) minimum suction pressure and 185 psig (1275 kPa) minimum discharge pressure for 15 minutes or more.

After the unit has maintained the above conditions for 15 minutes, observe the oil level. The oil should be 1/4 to 1/2 up in the sight glass.



1.	Add Compressor Oil Here
2.	Oil Level Sight Glass

Figure 51: X214 Compressor

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 COOLING for ten minutes. Observe the oil level. The oil should be 1/4 to 1/2 up in the sight glass.

If the evaporator temperature is below 32 F (0 C), it will be necessary to force defrost. To force defrost, use a jumper wire and jump the number 12 wire at the defrost relay to ground. Then push the manual defrost switch. Allow evaporator temperature to rise to approximately 45 F (7.2 C). Remove the jumper wire from the defrost relay. If the box is empty, you can run the unit on the heat cycle instead of the defrost cycle.

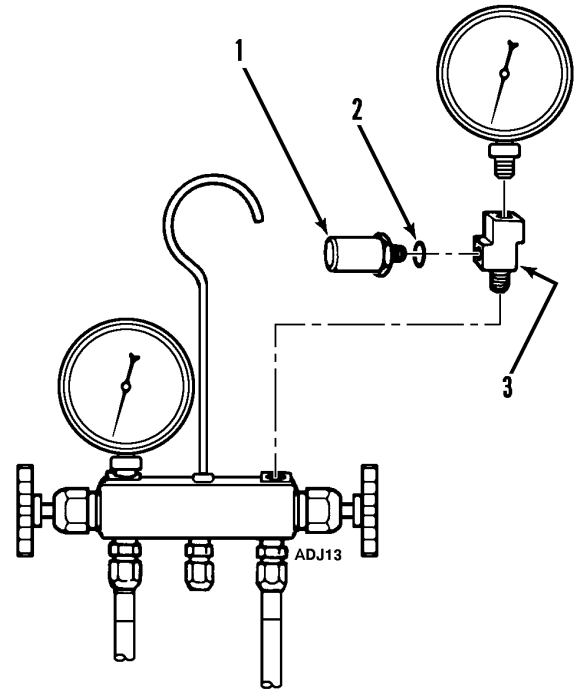
NOTE: Use refrigeration compressor oil ONLY. R-134a and R-404A systems use a special Ester oil TK No. 203-413.

To add oil to the compressor, pump down compressor, see “Compressor Pump Down and Checkout.”

High Pressure Cutout (HPCO)

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

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



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

Figure 52: High Pressure Cutout Manifold

2. Set the thermostat well below the box temperature so that the unit will be in High Speed Cool.
3. Raise the discharge pressure of the compressor by blocking the condenser coil air flow by covering the roadside condenser grille with a piece of cardboard.

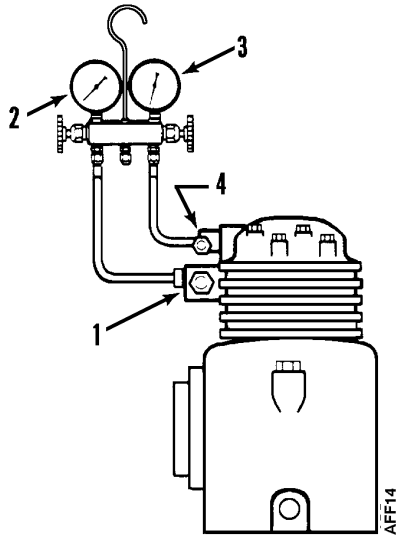
   NOTE: The discharge pressure should never be allowed to exceed a pressure of 470 psig (3241 kPa) on R-404A systems.
4. Failure of the HPCO system to stop compressor operation should be investigated first by checking the control circuit operation and secondly by HPCO switch replacement.

Compressor Pump Down And Checkout

1. Install a gauge manifold set on the compressor. Open the service valves (crack the valves off of the back seated position) to access system pressure.

   NOTE: Purge air from the gauge set.

2. Set the thermostat well below box temperature, and run the unit in cooling mode until temperature is stabilized (at least 5 minutes).



1.	Suction Service Valve
2.	Compound Gauge
3.	High Pressure Gauge (0 to 500 psig)
4.	Discharge Service Valve

Figure 53: Install Gauge Manifold

3. Close (front seat) the suction service valve. Pump the compressor down into a deep vacuum (25 in.). Stop the unit. If the suction pressure does not rise above 10 psig (69 kPa) in 2 minutes, perform check procedures on the three-way valve and the bypass check valve. If the pressure does not rise, go to step 4.

4. Front seat discharge service valve, and equalize the compressor to slightly positive. Disassemble and inspect the discharge valve plates.

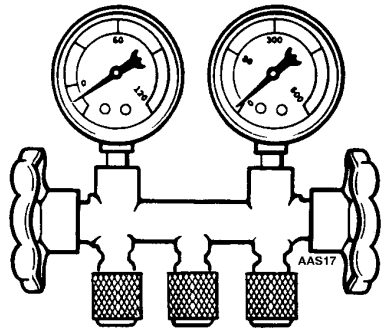


Figure 54: Compound Gauge Indicating 20 in. Vacuum

WARNING: Any time the discharge valve is front seated, disconnect the unit battery or power source to prevent accidental compressor start-up.

Low Side Pump Down

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

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

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

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

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

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

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

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

Three-way Valve Condenser Pressure Bypass Check Valve

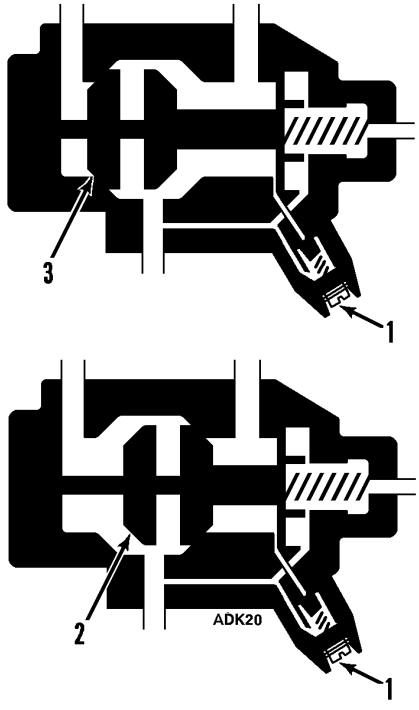
The condenser pressure bypass check valve is built into the three-way valve. This check valve controls the bypass flow of refrigerant gas between the condenser inlet line and compressor discharge line.

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

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

To check the operation of the valve:

1. Remove the condenser pressure bypass check valve cap from the three-way valve.
2. Using a screwdriver, gently turn the check valve stem in until the valve is front seated.
3. Install a service gauge manifold set on compressor.
4. Close (front seat) the receiver tank outlet valve.
5. Operate the unit on cool, and pump down the low side to 0 in. (0 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 heat position using relay board test. Low side gauge will raise slightly. High side gauge will drop to approximately 30 to 50 psig (207 to 345 kPa). Gauges will equalize.



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

Figure 55: Three-way Valve Condenser Pressure Bypass Check Valve

8. Gauges will remain in this position (approximately 30 to 50 psig [207 to 345 kPa]) 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.

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

Accumulator

Removal

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

Installation

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

Compressor

Removal

1. Pump down the compressor and equalize the pressure to slightly positive (1 to 2 psig [7 to 14 kPa]).
2. Loosen and remove the belts from the compressor pulley.
3. Front seat the discharge and suction service valves. Recover the remaining refrigerant from the compressor.
4. Unbolt the discharge valve and suction valves from the compressor.
5. Disconnect the high pressure cutout switch wires.
6. Remove the compressor mounting bolts.
7. Lift the compressor out 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. Lift the compressor into the unit and install the mounting bolts.
2. Install the service valves using new gaskets soaked in refrigeration oil. Connect the high pressure cutout switch wires.
3. Reconnect the pilot valve and compound pressure gauge hoses.
4. Pressurize the compressor and test for refrigerant leaks.
5. If no leaks are found, **evacuate the compressor**. Replace the compressor/electric motor belt and adjust the tension.
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.

Condenser/Radiator Coil

Removal

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

5. Unbolt and remove the condenser/radiator cap.

Installation

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

Liquid Line Check Valve Replacement

Removal

1. Remove the refrigerant charge.
2. Unsolder the lines and remove the check valve.

NOTE: Disassemble valve before unsoldering.

Installation

1. Clean the tubes for soldering.
2. Place the disassembled check valve in position. Arrow on the valve body indicates the direction of refrigerant flow through the valve.
3. Solder the inlet and outlet connections. After the valve cools, reassemble the valve.
4. Pressurize the refrigeration system and test for leaks.
5. If no leaks are found, **evacuate the system**.
6. Recharge the unit with refrigerant and check the compressor oil.

Dehydrator (Filter-Drier)

Removal

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

Installation

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

Evaporator Coil

Removal

1. Remove the refrigerant charge.
2. Remove the evaporator top panel.
3. Disconnect the expansion valve from the distributor. Disconnect the air switch hoses.
4. Unsolder the suction line and drain pan hot gas line from the evaporator coil.
5. Disconnect the electric heaters and high temperature cutout switch on Model 50 units.
6. Remove the mounting bolts and slide the coil from the evaporator housing.

Installation

1. Place the evaporator coil in the housing.
2. Install the mounting bolts and tighten.
3. Clean the tubes for soldering.

4. Solder the suction line and drain pan hot gas line connections to the evaporator coil.
5. Connect the distributor to the expansion valve assembly.
6. Connect the air switch hoses and install the high temperature cutout switch and electric heaters (Model 50).
7. Pressurize the low side and test for leaks. If no leaks are found, *evacuate the unit*.
8. Open the refrigeration valves and place the unit in operation. Install the refrigerant charge and compressor oil and add as required.

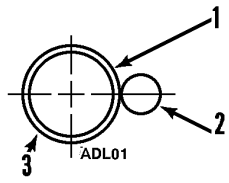
Expansion Valve Assembly

Removal

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

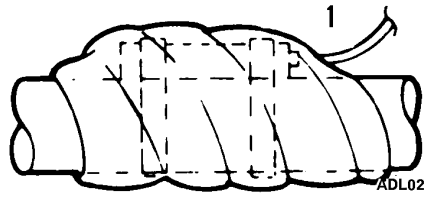
Installation

1. Install and bolt the expansion valve assembly in the unit.
2. Solder (95-5 Solder) the inlet liquid line and the distributor to the expansion valve.
3. Solder (95-5 Solder) the equalizer line to the expansion valve.
4. Clean the suction line to a bright polished condition. Install the feeler bulb clamps and the feeler bulb on the 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.
5. Pressurize the low side and test for leaks. If no leaks are found, *evacuate the low side*.



1.	Suction Line
2.	Capillary Bulb
3.	End View

Figure 56: Location of Expansion Valve Bulb



1.	Top View

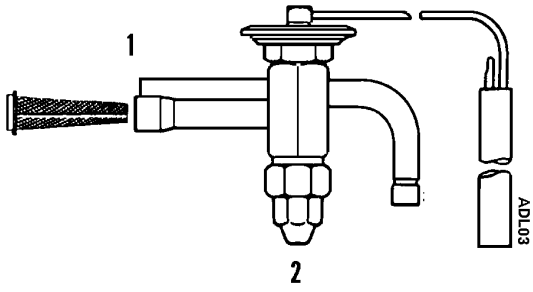
Figure 57: Completely Wrap Bulb with Tape

6. Open the refrigeration valves and place the unit in operation.
7. Test the unit to see that the expansion valve is properly installed.

Cleaning In-line Screen

1. Perform a low side pump down; bleed pressure back to 1 psig (7 kPa).
2. Remove the liquid line fitting.
3. A small tool with a slight hook may be needed to pull screen from the expansion valve.
4. Clean the screen and reinstall.

NOTE: Outlet screen points toward the distributor.



1.	Solder-in Expansion Valve Screen
2.	Solder-in Type

Figure 58: Expansion Valve

Heat Exchanger

Removal

1. Remove the refrigerant charge.
2. Remove the evaporator top cover.
3. Remove the mounting bolts that hold the heat exchanger on the bulkhead.
4. Disconnect the equalizer line from the suction line.
5. Disconnect liquid outlet line flare nut 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 putty from around the lines before unsoldering the connections.
9. Lift 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 liquid inlet and suction outlet line connections on the condenser side of the bulkhead. Seal openings through bulkhead with putty when refrigerant lines have cooled off.
4. Tighten the heat exchanger mounting hardware securely.
5. Solder suction line connection to the evaporator coil.
6. Connect the equalizer line flare fitting to the suction line and liquid outlet line flare fitting to the expansion valve.
7. Pressurize the low side and test for leaks. If no leaks are found, evacuate the unit.
8. Clean the suction tube to a bright polished condition. Install the feeler bulb clamps and feeler bulb on the side of the suction line in its former position. The feeler bulb must make good contact with the suction line or operation will be faulty. Wrap with insulating tape.
9. Open the refrigeration valves and place the unit in operation. Install refrigerant charge.
10. Test the unit to see that the expansion valve is properly installed.

High Pressure Cutout Switch

Removal

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

Installation

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

High Pressure Relief Valve

Removal

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

Installation

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

Pilot Solenoid

Removal

1. Pump down the low side and equalize pressure to slightly positive.
2. Disconnect the lines to the solenoid and immediately cap to prevent moisture and air from entering the system.

NOTE: The lines from the three-way valve to the pilot solenoid will leak refrigerant at a high velocity and should be capped.

3. Disconnect the electrical wires and remove the pilot solenoid.

Installation

1. Replace the pilot solenoid in the unit.
2. Remove the caps from the lines and connect lines to the pilot solenoid. Connect line from the three-way valve first. Connect wires to the valve.
3. Open the refrigeration valves and place the unit in operation.
4. Check for leaks.

Pressure Regulator Valve

Removal

1. Pump down the low side and equalize pressure to slightly positive.
2. Release remaining pressure and unsolder pressure regulator valve from the accumulator tank and suction tube.

Installation

1. Clean the tubes for soldering.
2. Place the valve in position and solder connections.
3. Pressurize the low side and check for leaks.
4. If no leaks are found, evacuate the low side.
5. Open the refrigeration valves, and place the unit in operation. Check the refrigerant charge and add refrigerant as required.

Receiver Tank

Removal

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

Installation

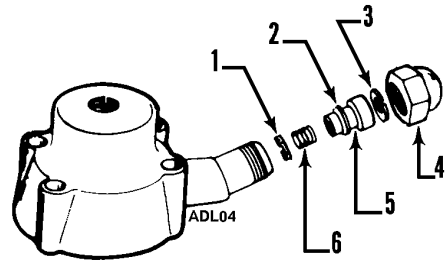
1. Place the receiver tank in the unit and install the mounting bolts and nuts loosely. Position the receiver tank so the sight glass is clearly visible and the outlet tube lines up.
2. Solder the condenser inlet tube.
3. Solder the filter drier line to the receiver tank outlet valve.
4. Tighten the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

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 check valve.
3. Remove the snap ring.
4. Unscrew the check valve stem by using a screwdriver in the slot provided.

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



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

Figure 59: Condenser Pressure Bypass Check Valve

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

Installation

1. Coat the o-ring with compressor oil (use same type of oil that is used in the system) 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 check valve seat in the three-way valve.

CAUTION: The Teflon 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: Valve stem must be back seated during normal unit operation.

7. Coat sealing area in cap with compressor oil (use same type of oil that is used in the system), 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.

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.

Removal

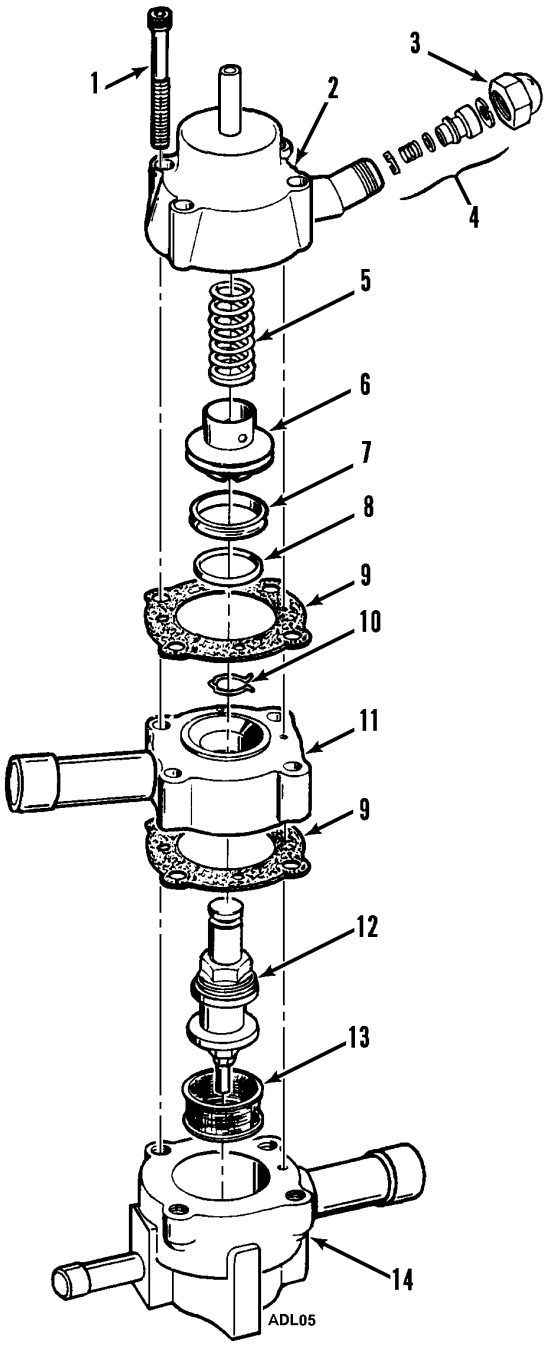
1. Remove the refrigerant charge.
2. Clean the exterior surface of the valve.
3. Remove the 1/4 in. copper line from the three-way valve to the pilot solenoid.
4. Loosen the four 1/4 in. Allen head screws (*do not remove*); use tool (see Tool Catalog) to break the gasket at each side of the center section.

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

5. Unsolder the condenser line from the condenser.
6. Remove the 4 bolts from the valve.
7. Remove the top cap and spring.
8. Remove the spring clip. Observe the slot in the spool shaft and slide piston away from this slot.
9. Remove the piston.
10. Remove the center section and stem assembly.
11. Inspect the following parts for wear and damage:
    a. Bottom cap sealing and support areas
    b. Center section, sealing surface
    c. Top cap, sealing and support surface

    The following parts will be discarded:
    a. Stem assembly
    b. All gaskets
    c. Teflon seal and o-ring
12. Remove the screen.

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



1.	Screw	8.	O-ring
2.	Top Cap	9.	Gasket
3.	Cap	10.	Clip
4.	Check Valve Assembly	11.	Seat
5.	Spring	12.	Stem Assembly
6.	Piston	13.	Screen
7.	Teflon Seal	14.	Bottom Cap

Figure 60: Three-way Valve Assembly

Installation

NOTE: Three-way valve kit is used to repair three-way valves (see Tool Catalog).

After cleaning and inspecting all parts, reassemble the valve. Clean solder off the condenser line and condenser head with sandpaper and tubing brush.

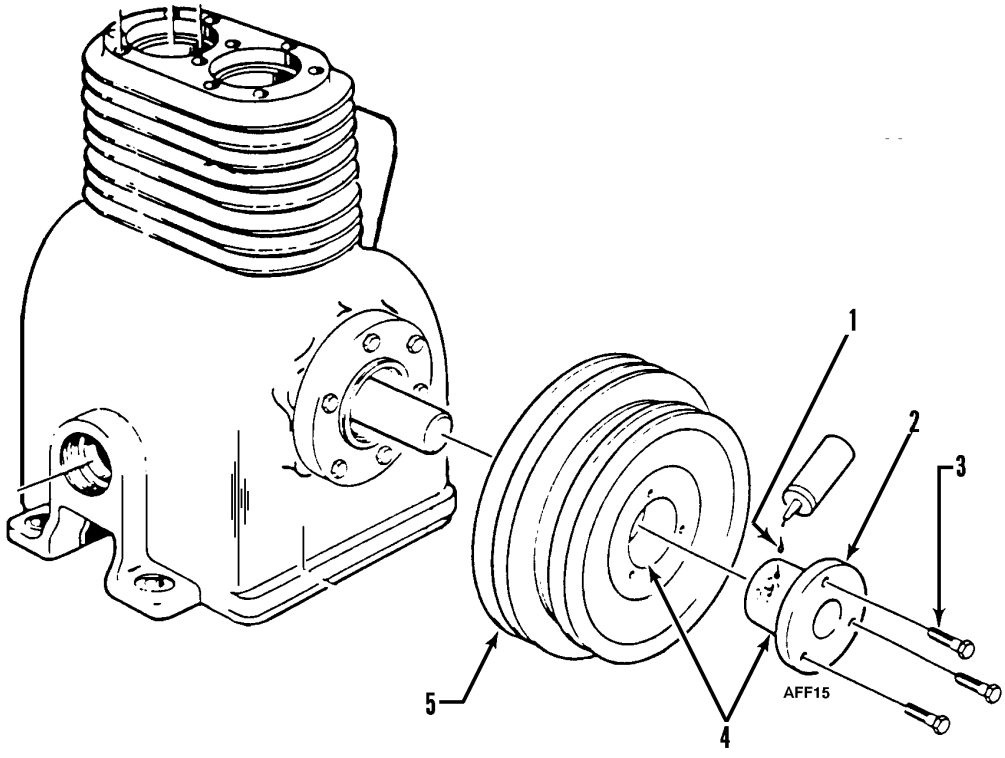
1. Install the screen into the bottom cap.
2. Install new stem into the center section.
3. Install new gaskets on both sides of the valve body. Dip gaskets in compressor oil (use same type of oil that is used in the system) before installing.
4. Install a new o-ring on the piston, then place the Teflon seal over the o-ring.
5. Install the piston on the stem and attach with spring clip.

   NOTE: The Teflon seal will stretch when it is installed. To prevent this from becoming permanent (and possibly malfunction), the top cap must be installed immediately.
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 bolts and tighten in rotating sequence.
9. Solder condenser line to the condenser inlet.
10. Install pilot solenoid line and pressurize system with refrigerant to check for leaks.
11. If there are no leaks, evacuate the system and recharge with refrigerant.
12. Run the unit to check for proper three-way valve operation.

Compressor Pulley Removal and Installation

Units with the X214 compressor will have an anti-seize lubricant on the tapered surfaces of the two-piece compressor pulley. The anti-seize lubricant facilitates the installation and removal of the two-piece pulley. To ensure correct pulley alignment, all rust and/or paint should be removed from the tapered portion of both the pulley and hub, and the mounting screws should be torqued

to 7 to 10 ft-lb (23 to 14 N•m). Whenever the two-piece pulley is removed from any type of unit service, anti-seize lubricant should be applied to the outside of the tapered surface on the pulley bushing. Use one of the following recommended anti-seize lubricants: Fel-Pro C5-A, Loctite 767, Never-Seez NS-12, or Never-Seez NS-160.

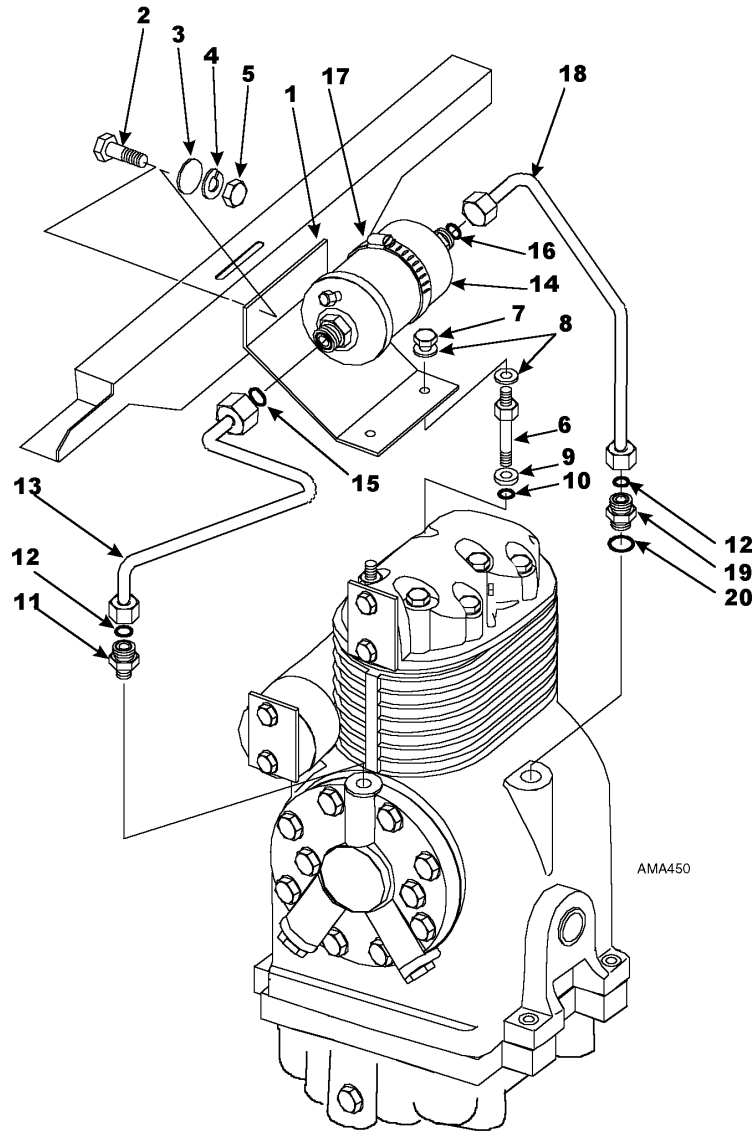


1.	Apply Anti-Seize Lubricant to the Tapered Surface of the Bushing Only.
2.	Bushing
3.	Torque Evenly to 7 to 10 ft-lb (23 to 14 N•m)
4.	Clean All Rust and Paint Off These Tapered Surfaces Before Installing.
5.	Pulley

Figure 61: Anti-Seize Lubricant Application

Oil Filter Maintenance

X214 compressors using R-134a and R-404A are equipped with a bypass oil filter. To ensure the system stays clean, the oil filter and filter-drier MUST be changed every 2 years or whenever a major service procedure has been performed.



1.	Stabilizer Bracket	8.	Flatwasher	15.	1/4 O-ring
2.	Bracket Screw	9.	Sealing Washer	16.	3/8 O-ring
3.	Flatwasher	10.	O-ring	17.	Clamp
4.	Lockwasher	11.	ORS Adapter	18.	Compressor Outlet Tube
5.	Nut	12.	3/8 O-ring	19.	ORS Adapter
6.	Cylinder Head Stud	13.	Compressor Inlet Tube	20.	9/16 O-ring
7.	Bracket Nut	14.	Filter Assembly		

Figure 62: Compressor Oil Filter

Compressors Shipped with R-134a

X214 Thermo King compressors are charged with Polyol Ester oil (POE) (TK No. 203-413). All gauge fittings are 1/4 inch fittings.

CAUTION: POLYOL ESTER (POE) IS THE ONLY OIL FOR USE WITH THERMO KING UNITS USING R-134a AND R-404A. IT SHOULD NOT BE ADDED TO STANDARD THERMO KING UNITS, NOR SHOULD THE STANDARD OR SYNTHETIC OIL BE ADDED TO SYSTEM CONTAINING R-134a AND R-404A. COMBINING THE TWO OILS COULD RESULT IN DAMAGE TO THE SYSTEM

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

Equipment Recommendations For Use With R-404A

Dedicated Equipment

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

Vacuum Pumps

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

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

An oil filter TK P/N 66-7800 is added to the vacuum pump.

The Thermo King Evacuation Station is recommended. This station is available from service parts under part number 204-725. See Truck and Trailer Service Bulletin T&T 061 for additional details.

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

Gauge Manifold Sets

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

System Clean-up

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

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

Refrigerant Recovery

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

Large Truck Unit Centrifugal Clutch Change

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

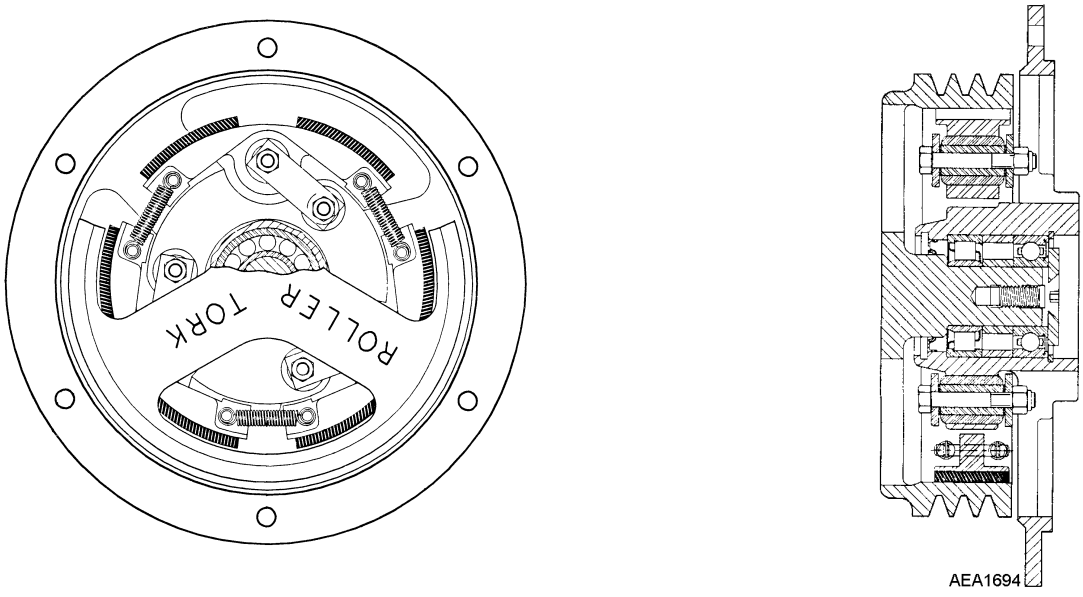
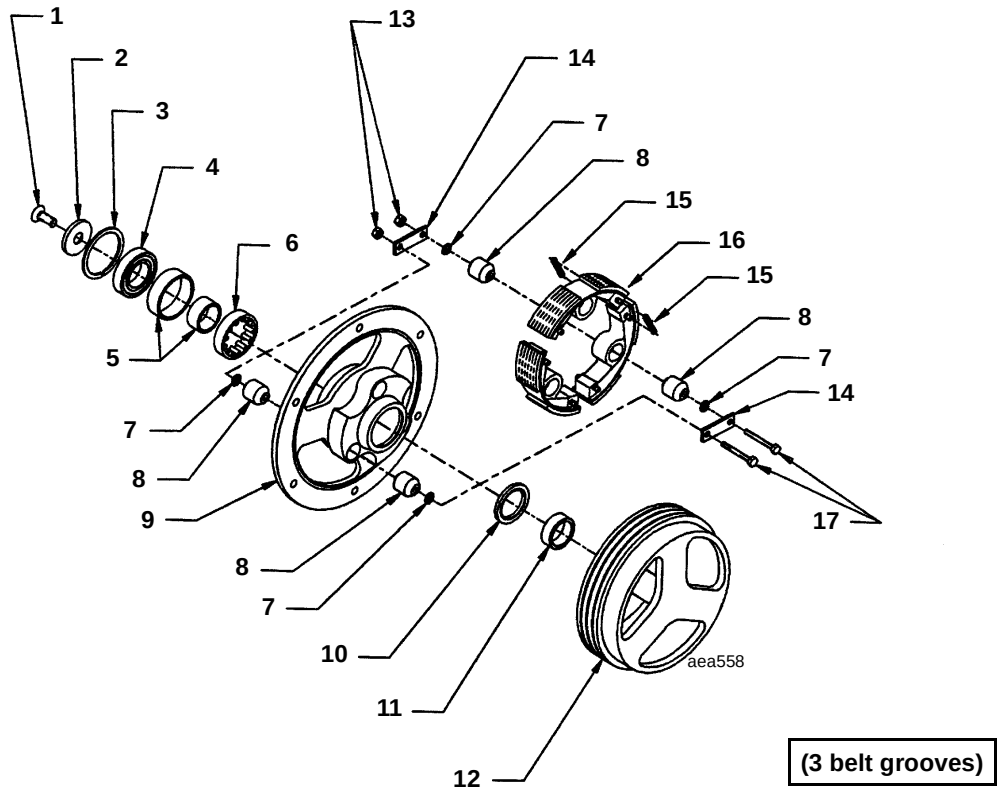


Figure 63: Front View and Cross Section



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

Figure 64: Hilliard Centrifugal Clutch

Clutch Maintenance

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

Tools Required

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

Grease

Mobil™ (Synthetic) (see Tool Catalog).

Disassembly Procedure

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

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

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

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

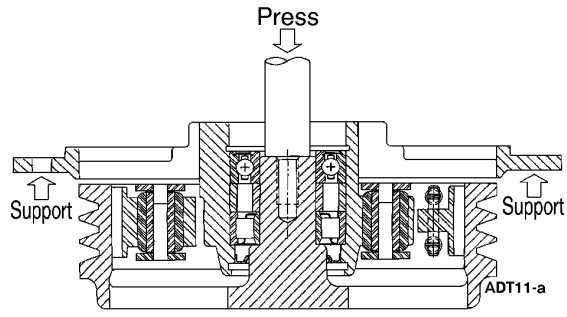


Figure 65: Housing Removal

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

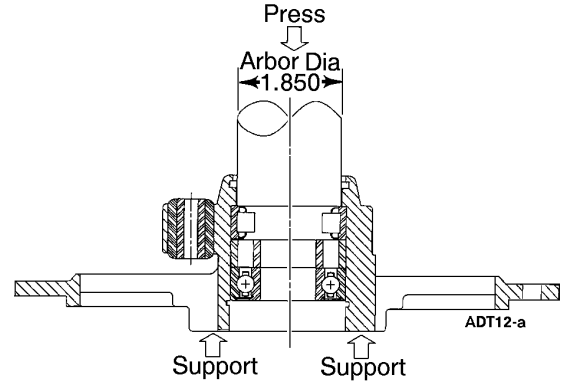


Figure 66: Bearing Removal

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

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

7. Press bushings out of hub.

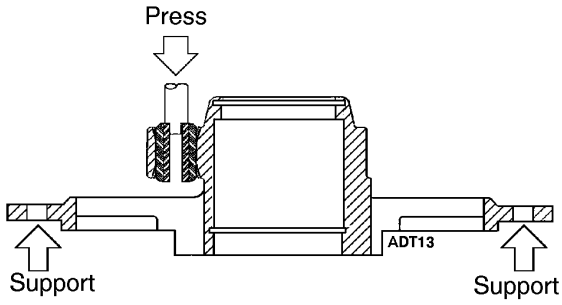


Figure 67: Bushing Removal

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

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

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

Assembly Procedure (Using New Bearings and Seal)

1. Press bushings into hub side opposite flange.

   NOTE: It is important to press bushings in straight.

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

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

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

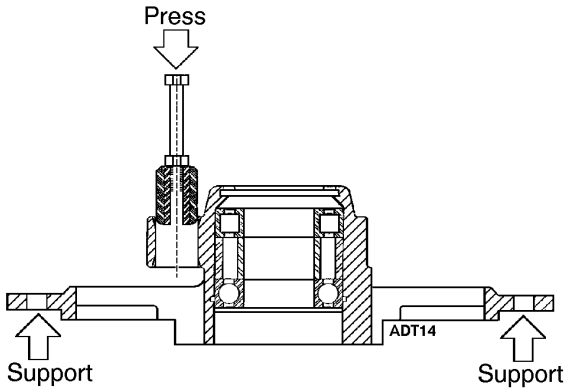


Figure 68: Bushing Insertion

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

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

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

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

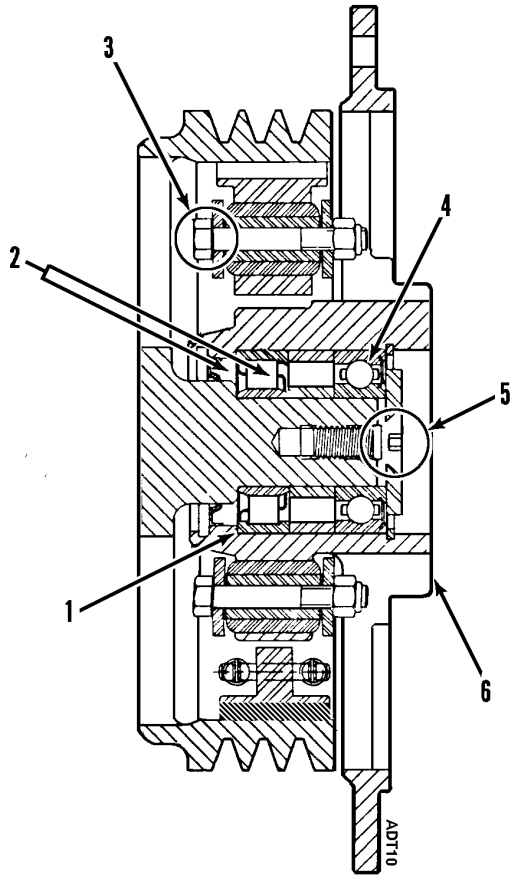
4. Apply a *small* amount of Loctite™ (see Tool Catalog) to O.D. of roller bearing and press into hub bore from the flange end until seated against the step in bore.

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

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

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

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

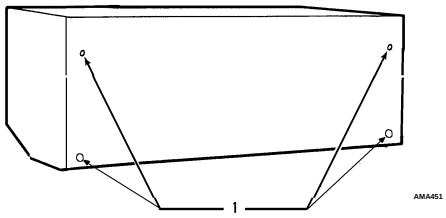


1.	Roller Bearing, Pack with Mobil™ (see Tool Catalog) grease
2.	Pack These Areas with Mobil™ (see Tool Catalog) grease at Assembly
3.	HEX HD Cap Screw (6X), 1-4/28 UNF X 1.75 Long. Torque to 110 ± 5 in-lbs (12.5 ±.6 N•m) ***NOTE: Shoes must be disengaged while tightening 6 bolts and MUST be held tightly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

Figure 69: Clutch

Unit And Engine Mounting Bolts

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



1.	Check Mounting Bolts for Tightness

Figure 70: Check Bolts For Tightness

Lift Points

The unit lifting points are noted below. Note that three lift points must be used.

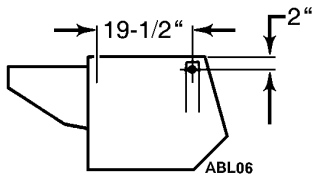


Figure 71: Lift Points

Unit Inspection

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

Evaporator Coil

Clean the evaporator coil during scheduled maintenance inspections by blowing compressed air opposite normal air flow. Inspect the coil and fins for damage and repair if necessary.

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

Condenser Coil

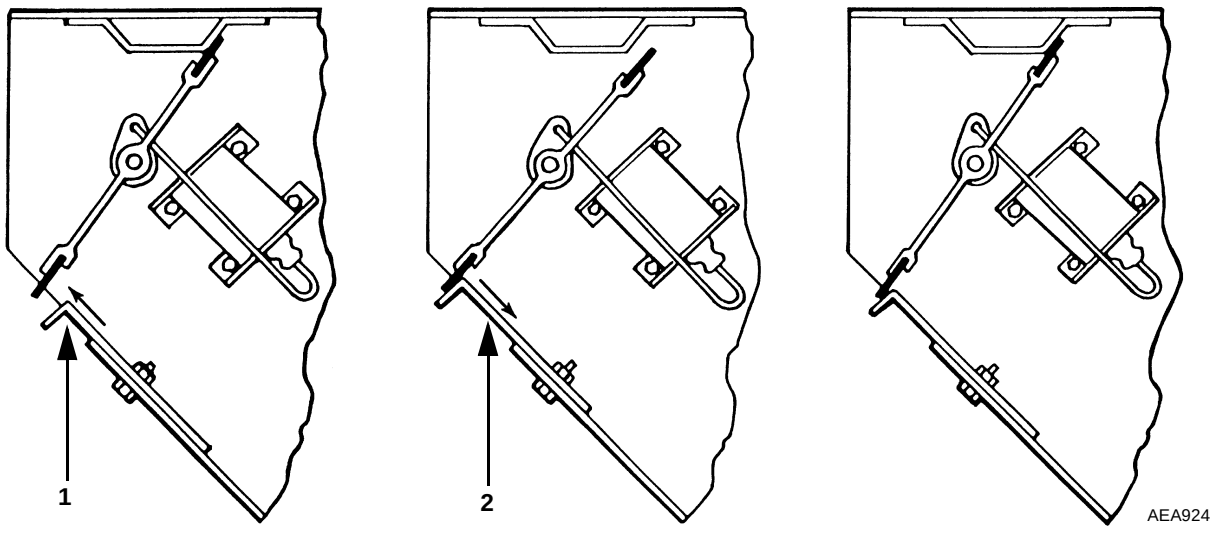
Clean the condenser coil during scheduled maintenance inspections by blowing compressed air from the back side of the coil out toward the front of the unit (direction opposite normal air flow). Inspect the coil and fins for damage and repair if necessary.

Defrost Damper

Check the damper during scheduled maintenance inspections for shaft wear, end play and sealing against air flow.

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

1. If the damper does not close completely:
   a. Energize damper solenoid by placing a jumper wire from 12 Vdc to No. 29 wire in the evaporator harness.
   b. If damper blade closes, proceed to step 2. If not, proceed to step 1.c.
   c. Remove the jumper wire, loosen the evaporator outlet adjustment angle and move so when energized, the damper will close.
   d. Retighten the adjustment angle and repeat steps a. and b.
2. If the damper blade does not seal evenly along full width of blade:
   a. Loosen the damper bearing blocks.
   b. Manually close the damper so the blade makes contact at the top and bottom of the funnel, the full width of the blade.
   c. Retighten damper bearing blocks.
   d. Lube bearing block and shaft with low temperature grease (see Tool Catalog).



1.	Move Angle Down
2.	Move Angle Up

Figure 72: Defrost Damper Adjustment

Jackshaft Assembly

The MD-200 30 does not have electric standby capability, therefore, the electric motor is replaced by a jackshaft. The jackshaft assembly oil level plug should be removed, and the oil level checked every 1000 operating hours. Check the jackshaft during the pre-trip inspection for oil leakage. If there is any sign of leakage, remove the jackshaft assembly.

Model 30 truck units are equipped with jackshafts that have improved venting. This improvement was made by using a new air vent (P/N 55-6417), adding an oil sling retainer (P/N 77-2434), and using fanshaft oil (P/N 203-278). The new air vent, oil sling retainer, and fanshaft oil reduce the build-up of pressure inside the jackshaft.

Disassembly

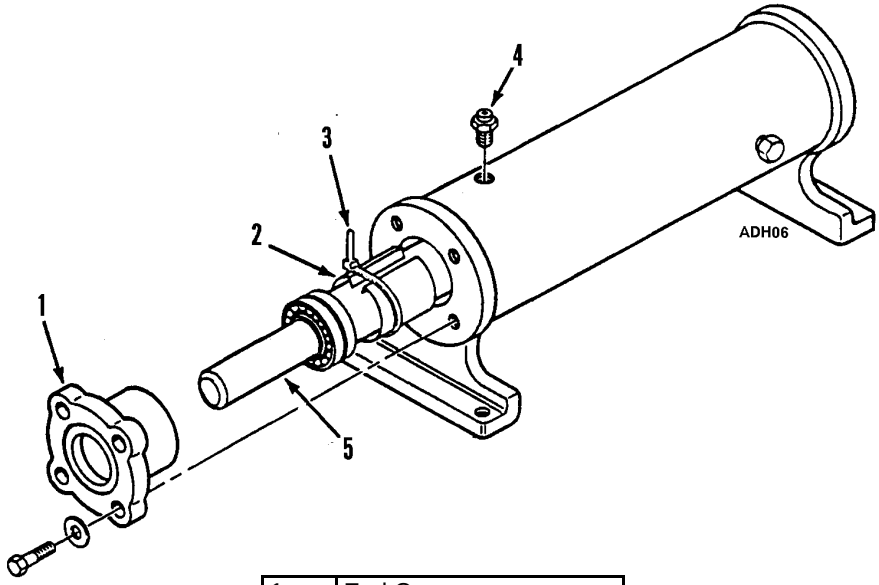
1. Remove jackshaft assembly from the unit and remove the pulleys.
2. Remove the level and fill plugs and drain oil reservoir.
3. Remove bearing retainer cap from fill plug end of the jackshaft assembly.

NOTE: There are shims between the bearing retainer cap and the housing. These should be saved for possible reuse during reassembly.

4. Remove the shaft and bearings.
5. NOTE: The oil sling retainer is pulled out by the bearing assembly on shaft.
6. Remove the retainer cap from level plug end of assembly.
7. Use a punch and hammer to remove the seals and bearing cups from bearing retainer caps.
8. Use a bearing splitter or similar tool to remove the bearing cones from the shaft.
9. Clean all parts in clean solvent and then examine the bearing cups and cones for damage.

Reassembly

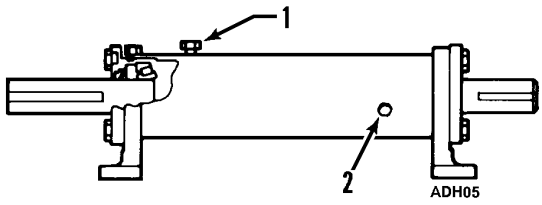
1. Coat the edges of the oil seals with a gasket sealant.
2. Using a suitable tool, install the seals in the end caps. Fill the space between the seal lips with grease. Install the assembled end cap (seal and bearing race installed) on the oil level plug end of jackshaft housing.
3. Place the oil sling retainer on the shaft. If the bearings were removed from the shaft, place the oil sling retainer on the shaft while installing the bearings. If the bearings were not removed from the shaft, press the oil sling retainer onto the shaft through the opening in the top of the oil sling retainer.
4. Use a tie band or a hose clamp as tool to compress the oil sling retainer enough to fit inside the jackshaft housing.
5. Install the shaft into the jackshaft housing with oil sling retainer on the shaft with bearing. Align the opening in the oil sling retainer with the air vent opening in the top of the jackshaft housing.
6. Use a punch and hammer to tap the oil sling retainer into the jackshaft housing until it is centered beneath the air vent opening and past the housing lip that holds the outer race.
7. Remove the tie band or hose clamp.
8. Install the remaining end cap.
9. Torque the bolts to 10 ft-lb (13.6 N•m).
10. Check end play of the shaft with a dial indicator. End play should be between 0.001 to 0.005 in. 0(.025 to 0.127 mm). Change shims if necessary.



1.	End Cap
2.	Oil Sling Retainer
3.	Tie Band
4.	Air Vent (P/N 55-6417)
5.	Shaft

Installing Oil Sling Retainer

11. Pour 3.5 ozs (104 ml) of fanshaft oil P/N 203-278 into the jackshaft housing.



1.	Fill Plug and Vent
2.	Oil Level Plug

Figure 73: Jackshaft Assembly

FanShaft Assembly

The unit is equipped with a one-piece fanshaft 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 utilized except after removal and repair of the fanshaft assembly. The condenser end oil seal and the evaporator end oil seal should be checked during the pre-trip inspection for oil leakage. If there is any sign of leakage, the fanshaft assembly should be removed and repaired.

NOTE: The fanshaft assembly requires a special lubricant, TK P/N 203-278.

Fanshaft Assembly Overhaul

Disassembly

1. Remove the fanshaft assembly from the unit. Remove both oil plugs and drain the oil from the housing.

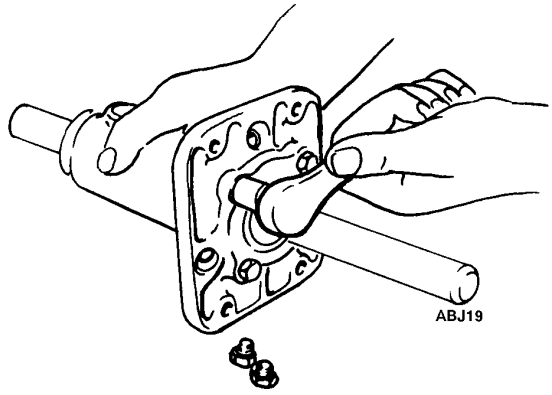


Figure 74: Removing Bearing Retainer Bolts

2. After draining the oil from the housing, remove the four retaining bolts from the bearing retainer cap.

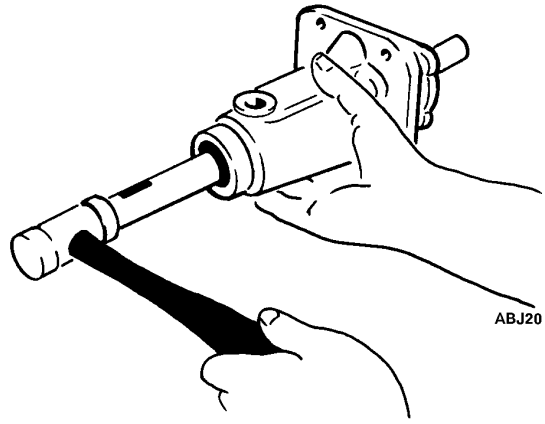


Figure 75: Removing Shaft

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.

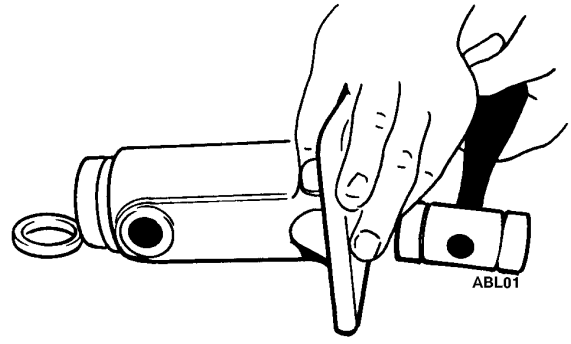


Figure 76: Removing Oil Seal

4. Using a punch, remove the oil seal from the evaporator 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 remove the roll pin that is in the center of the shaft.

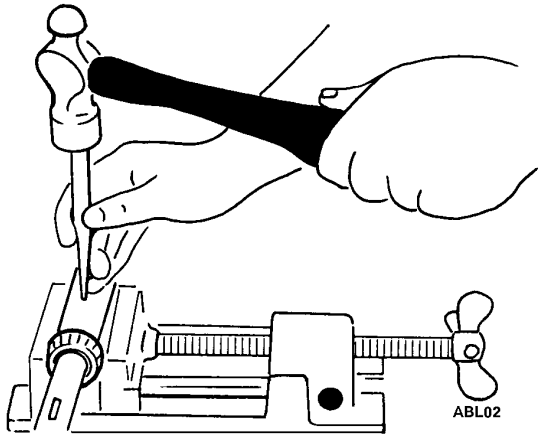


Figure 77: Removing Roll Pin

8. With the roll pin removed, place a pipe over the shaft and drive one bearing down until the opposite bearing and bearing spacer release from the shaft.
9. After removing one bearing and the bearing spacer, turn the shaft upside down and drive the other bearing off, using the pipe.
10. The bearing races can now be driven out with a punch and replaced in the same manner.

Reassembly

1. Install the new bearings on the shaft with a pipe in the same way they were removed.

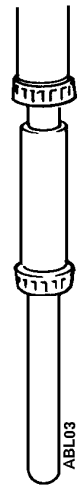


Figure 78: Installing Bearings

2. When replacing the bearing race on the evaporator end of the assembly, the splash guard will come out with the race. Reinstall the splash guard after replacing the bearing race.

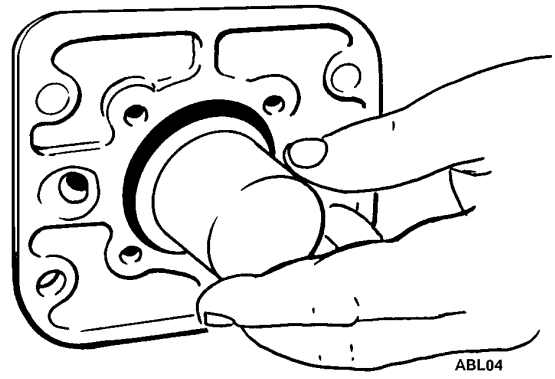


Figure 79: Installing Splash Guard

3. Install a new oil seal after replacing the bearing race and splash guard.

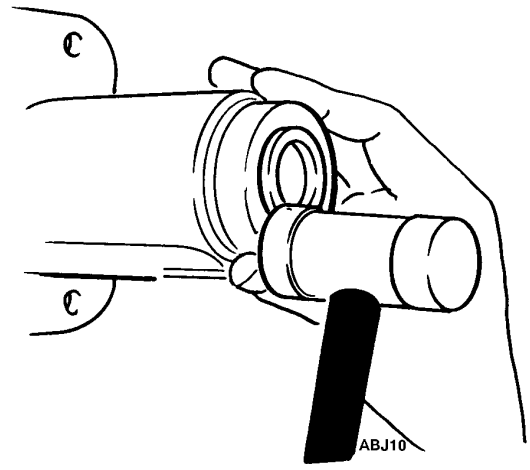


Figure 80: Installing Oil Seal

4. Place the shaft in the housing. Install a new seal in the retainer cap. Use the original shims and replace the O-ring if necessary.

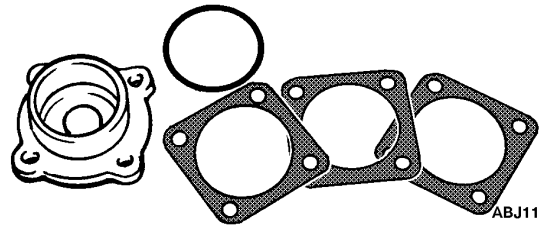


Figure 81: Shims and O-ring

5. Install the retainer cap assembly over the shaft, and then install the bolts.
6. Torque the bolts in a criss-cross pattern in equal steps to 80 in-lbs (9.04 N•m).

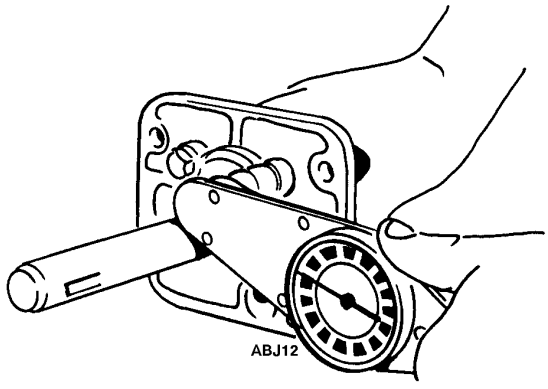


Figure 82: Torquing Retainer Plate Bolts

7. Lock the assembly in a vise and set up a dial indicator to read the 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. The end play should be 0.001 to 0.005 in. (0.025 to 0.127 mm). If the end play is incorrect, use different shims to obtain the correct end play.

Shims available from the Service Parts Department:

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

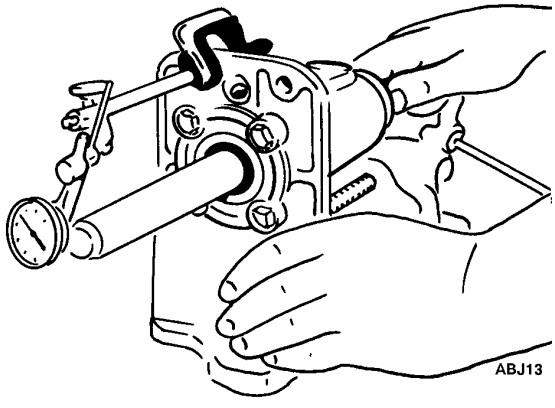


Figure 83: Checking End Play

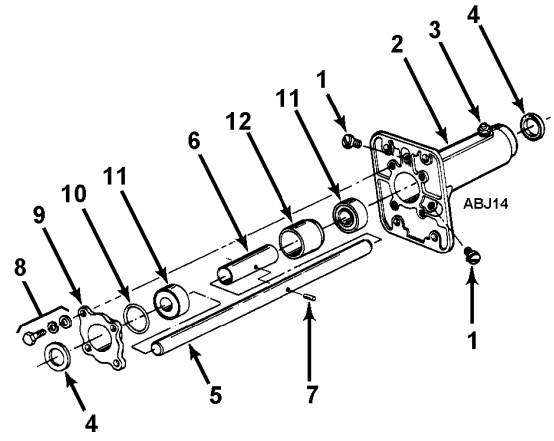
8. After the correct end play is obtained, add grease for the bearings.

NOTE: Use ONLY Thermo King special fanshaft grease (P/N 203-278) in this assembly.

Lock the assembly in a vise with the vent facing up. Pour grease 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 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 fanshaft assembly, make sure that the vent is mounted facing up.



1.	Oil Plug Screw with O-ring
2.	Housing
3.	Breather Vent
4.	Oil Seal
5.	Shaft
6.	Sleeve
7.	Pin
8.	Screw with Flatwasher and Lockwasher
9.	Cap and Shims
10.	O-ring
11.	Roller Bearing
12.	Splash Guard Tube

Figure 84: Fan Shaft Assembly

Mechanical Diagnosis

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

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

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

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

Electric Standby (Optional) Diagnosis

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

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

Refrigeration Diagnosis

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

Rapid cycling between Cool and Heat	Unit cools in Heat and Defrost cycle	Unit heats in Refrigeration cycle	High head pressure	Low head pressure	No head pressure	High suction pressure	Low suction pressure	No suction pressure	Unit operating in a vacuum	Receiver sight glass empty	Suction line frosting back	Unable to pump down system	Unable to pull vacuum in low side	Unable to hold vacuum in low side	Noisy compressor	Unit not refrigerating	Unit not heating or defrosting	**Symptom** / **Possible Causes**
						•					•					•		Expansion valve feeler bulb making poor contact
						•					•							Expansion valve open too much
							•									•		Expansion valve closed too much
						•					•							Expansion valve needle eroded or leaking
							•		•							•		Expansion valve partially closed by ice, dirt or wax
						•					•				•			Liquid refrigerant entering compressor
							•		•									Restricted line on the low side
			•				•		•							•		Restricted line on the high side
			•				•		•							•		Restricted drier
																	•	Evaporator shutter open
							•		•							•		Evaporator shutter stuck closed
								•										Suction service valve back seated
	•	•		•		•						•		•			•	Faulty CIS
	•	•										•				•	•	Faulty Hot Gas Solenoid
	•																•	Loose or broken electrical connections
•						•	•		•							•		Thermostat or thermometer out of calibration
						•	•	•	•									Suction pressure gauge out of calibration
												•						Leaky receiver tank outlet valve
			•														•	DPR Valve Faulty

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Wiring and Schematic Diagrams Index

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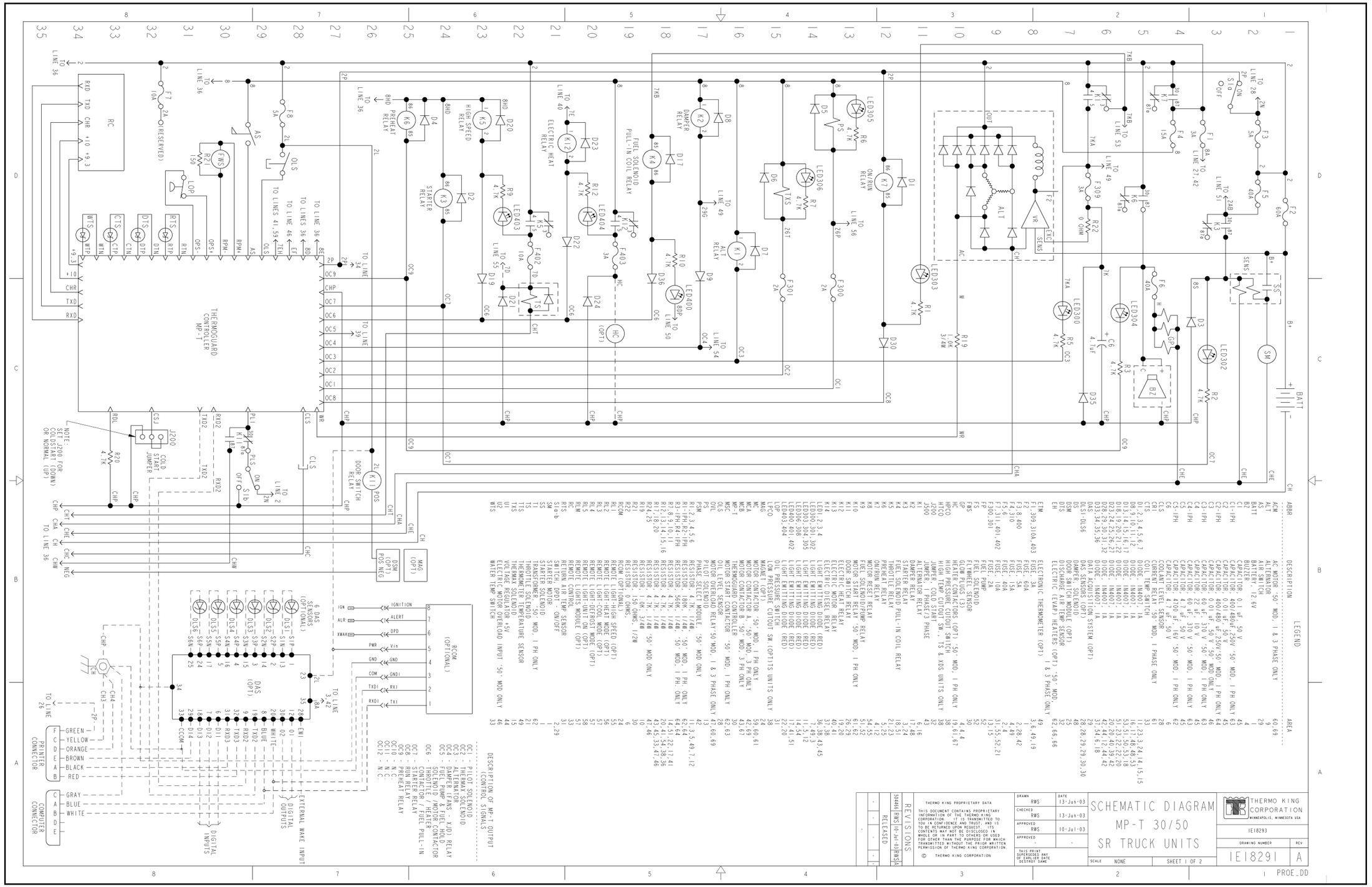

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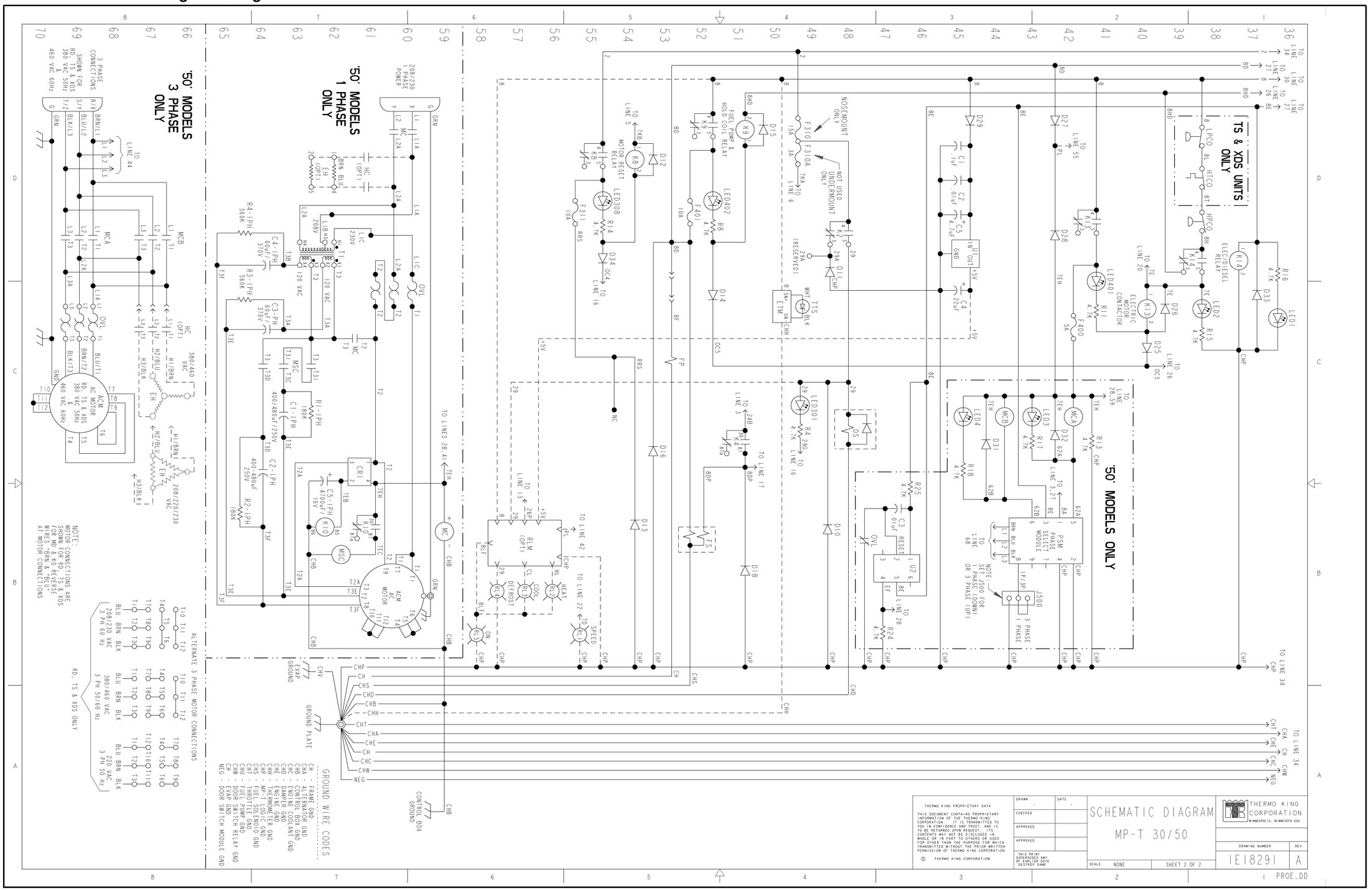

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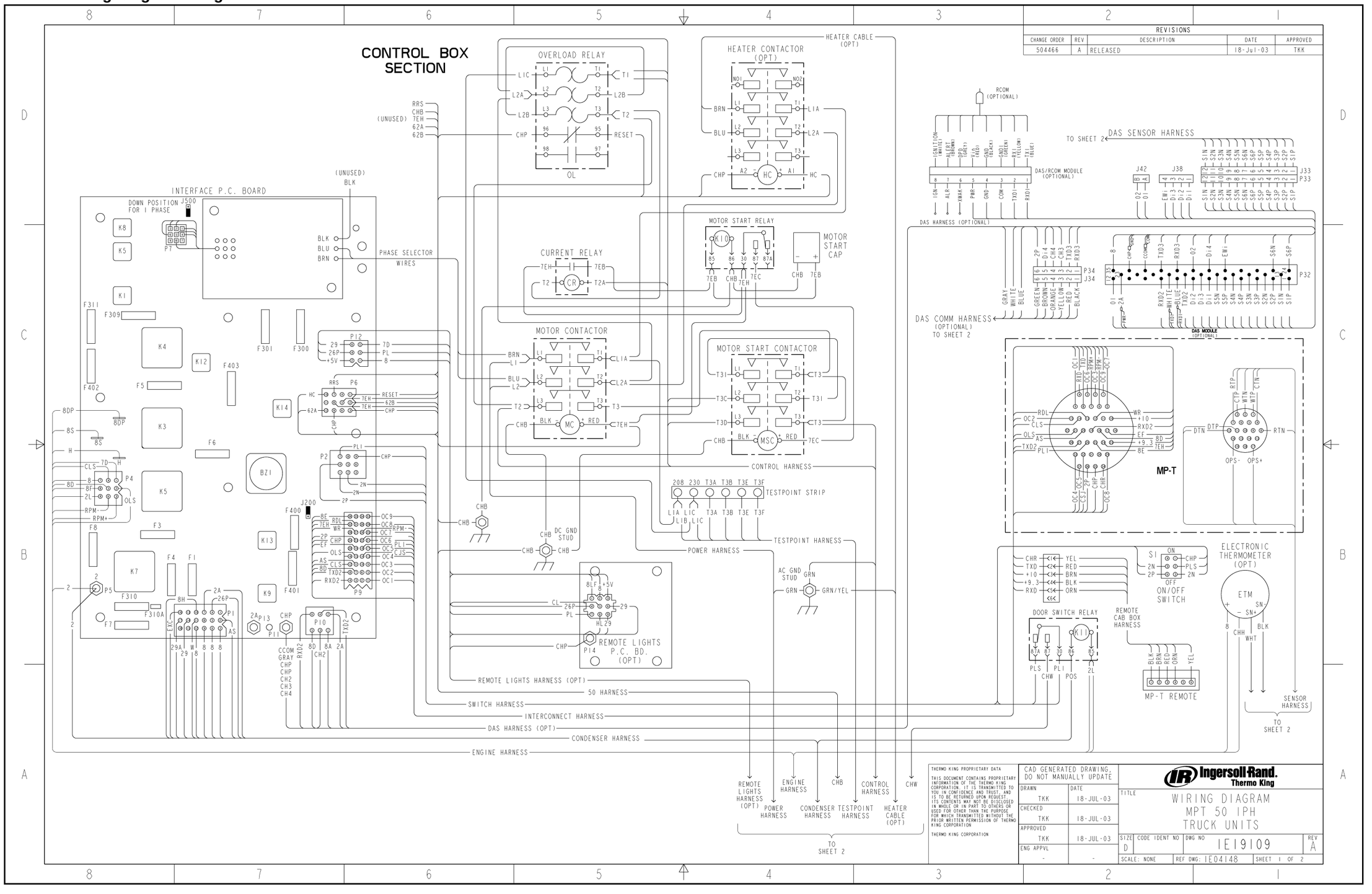

REVISIONS				
CHANGE ORDER	REV	DESCRIPTION	DATE	APPROVED
504466	A	RELEASED	18-Jul-03	TKK

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ENG APPVL	-	-

Ingersoll-Rand. Thermo King

TITLE: WIRING DIAGRAM MPT 50 IPH TRUCK UNITS

SIZE	CODE IDENT NO	DWG NO	REV
D		IEI9109	A

SCALE: NONE | REF DWG: IE04148 | SHEET 1 OF 2

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