MD-II MAX w/TK 3.74

TK 41013-1-MM (Rev. 1,10/03)

The maintenance information in this manual covers unit models:	
MD-II 30 MAX (914980)	**MD-II 50 MAX 230/3/60 (914981)**
MD-II 50 MAX 230/1/60 (914982)	**MD-II 50 MAX 380/460 (914983)**
MD-II 30 MAX 220/3/50 EEC (914984)	**MD-II 50 MAX EEC 380/3/50 (914985)**
For further information, refer to:	
MD-II MAX Operation Manual	**TK 41034**
MD-II MAX Parts Manual	**TK 41074**
2.44, 2.49, 3.66, 3.74, 3.88, and 3.95 Engine Overhaul Manual	**TK 8312**
Diagnosing Thermo King Refrigeration Systems	**TK 5984-7**
Tool Catalog	**TK 5955**
X214 Compressor Overhaul	**TK 4416**
CYCLE-SENTRY IV Operation and Diagnosis	**TK 40288**
Microprocessor Controller TG-V Operating Manual	**TK 40283**
Set-up Manual	**TK 40284**
In-Cab Controller Operating Manual	**TK 40940**
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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Refrigeration Service Operations (continued)

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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—TK 3.74

Engine	TK 3.74
Fuel Type	No. 2 Diesel fuel under normal conditions No. 1 Diesel fuel is acceptable cold weather fuel
Oil Capacity: Crankcase & Oil Filter w/Bypass Oil Filter	 9 quarts (8.6 liters) 10 quarts (9.6 liters) Fill to full mark on dipstick
Oil Type*	API Type CF-4 or CG-4 or better multigrade oil API Synthetic Type CF-4, CG-4 or better after first 500 hours (optional)
Oil Viscosity*	-15 to 40 C (5 to 104 F): SAE 15W-40 -20 to 40 C (-4 to 104 F): SAE 10W-40 -20 to 30 C (-4 to 86 F): SAE 10W-30 -30 to 30 C (-22 to 86 F): SAE 5W-30
Engine RPM: Low Speed Operation High Speed Operation	 1625 ± 25 RPM 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 degrees BTDC
Injection Nozzle Pressure	1700 psig (11721 kPa)
Low Oil Pressure Switch (Normally Closed)	10 ± 2 psig (69 ± 14 kPa)
High Coolant Temperature Switch: Closes Opens	 220 ± 5 F (104 ± 3 C) 190 F (88 C)
Engine Thermostat	180 to 190 F (82 to 88 C)
Coolant System Capacity	4 quarts (3.8 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)
CYCLE-SENTRY Block Temperature: Start Off	 30 ± 18 F (0 ± 10 C) 90 ± 8 F (32 ± 4.4 C)

* 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	Thermo King X214
Refrigerant Charge	8 lb. 5 oz. (3.77 kg) R-134a
Compressor Oil Charge	66 oz. (1.95 liters)*
Compressor Oil Type	Polyol Ester type (refer to Tool Catalog)
Suction Pressure Regulator Setting	18 psig (124 kPa)
Heat/Defrost Method: Engine Operation Electric Operation	 Hot gas Hot gas and electric heater strips (Model 50)
High Pressure Cutout	450 ± 10 psig (3103 ± 69 kPa) Automatically reset @ 375 ± 38 psig (2585 ± 262 kPa)
Electronic Defrost Termination Timer: Opens Closes	 52 F (11 C) 42 F (6 C)
Timer—Part of TG-V Microprocessor	Programmable 2 to 16 hours in 2 hour increments through TGV controller

* 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.

R-404A Refrigeration System

Compressor Model	Thermo King X214
Refrigerant Charge	7.5 lb. (3.4 kg) R-404A
Compressor Oil Charge	66 oz. (1.95 liters)*
Compressor Oil Type	Polyol Ester type (refer to Tool Catalog)
Suction Pressure Regulator Setting	18 psig (124 kPa)
Heat/Defrost Method: Engine Operation Electric Operation	 Hot gas Hot gas and electric heater strips (Model 50)
High Pressure Cutout	450 ± 10 psig (3103 ± 69 kPa) Automatically reset @ 375 ± 38 psig (2585 ± 262 kPa)
Electronic Defrost Termination Timer: Opens Closes	 52 F (11 C) 42 F (6 C)
Timer—Part of TG-V Microprocessor	Programmable 2 to 16 hours in 2 hour increments through TGV controller

* 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.

Air Switch

Air Switch Setting:	0.7 ± 0.05 in. (17.78 ± 1.3 mm) H_20

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	1/2 in. (13 mm) deflection	
Alternator/Evaporator Fan	1/2 in. (13 mm) deflection	
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
Alternator	12 V 65 amp brush type integral alternator
Voltage Regulator Setting	14 V @ 70 F (21.1 C)
Alternator/Regulator LED 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	7 to 8.3	1.5 ± 0.15
Fuel Solenoid: Pull In Hold In	 30 to 40 0.97	 0.41 to 0.31 12.8
Pilot Solenoid	0.657	19
Starter Motor	90 to 105 (cranking)	
Damper Solenoid	5.68	2.2
DC Circuit Breakers	50 amp 20 amp	10.4
High Speed Solenoid	5 amp (approx.)	2.5 (approx.)

Thermostat

Type	Solid state THERMOGUARD V Thermostat
Range	-20 to 80 F (-29 to 27 C)
Heat Lockout:	
Continuous Run Operation	High Speed Heat locked out below 15 ± 3 F (-9.4 ± 1.7 C)
CYCLE-SENTRY Operation (Optional Equipment)	All Heat locked out below 15 ± 3 F (-9.4 ± 1.7 C)
Electric Standby Operation (Optional Equipment)	All Heat locked out below 15 ± 3 F (-9.4 ± 1.7 C)

Electric Standby

Electric Motor	5 hp, 230 V, 60 Hz	
RPM	1750	
Full Load Amps	14.4 (230)	
Locked Rotor Amps	58	
Power Requirements	230/3/60	30 Amp, Power Cord Size 10 (AWG) for 50', 8 for 75'

Electrical Standby Compressor Motors

(Model 50 Units Only)

Voltage/Phase/Frequency	Horse-power	Kilowatts	RPM	Full Load (Amps)	Locked Rotor Amps	Unit Full Load* Amps
220/3/50	4.2	3.1	1450	12.7	55	12.7
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

* w/Heater Strips		
Electric Heater Strips (Optional):	Number Watts (each)	3 750
Evaporator High Temperature Cutout Switch:	Opens: Closes:	150 ± 5.0 F (66 ± 3 C) 120 ± 5.0 F (49 ± 3 C)

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

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	750 Hours	Annual/ 3,000 Hours	Inspect/Service These Items ***NOTE: The 750 hour maintenance interval may be extended to 1,000 hours or 1 year when equipped with a 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) (oil pressure gauge option).
•	•	•	Listen for unusual noises, vibrations, etc.
	•		Change engine oil and filters (hot).
	•		Change oil bath air cleaner element, replace dry type element, clean and service crankcase breather and check air cleaner hose for damage.
	•		Change fuel filter.
		•	Drain water from fuel tank and check vent.
	•		Inspect/clean fuel sediment bowl and electric fuel pump filter.
		•	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 engine coolant every 2 years.
			Electrical
	•		Check defrost initiation and termination.
	•		Check thermostat cycle sequence.
	•		Inspect battery terminals and electrolyte level.
	•		Check operation of protection shutdown circuits.
	•		Inspect electrical contacts for pitting or corrosion.
	•		Inspect wire harness for damaged wires or connections.
		•	Check calibration of return and discharge air sensor, and optional air sensors, in 32 F (0 C) ice water.
		•	Check air switch setting.
		•	Inspect electric motor bearings.*
		•	Inspect DC (battery charging) alternator bearings* and brushes.

Pre trip	750 Hours	Annual/ 3,000 Hours	Inspect/Service These Items ***NOTE: The 750 hour maintenance interval may be extended to 1,000 hours or 1 year when equipped with a bypass oil filter.***
			Refrigeration
•	•		Check refrigerant level.
•	•		Check compressor oil level.
	•	•	Check suction pressure regulator/throttling valve operation on Defrost or Heat.
		•	Check compressor efficiency and pump down refrigeration system.
		•	Replace dehydrator and compressor oil filter.
		•	Check discharge and suction pressures
			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*.
		•	Inspect idler bearings for leakage and bearing wear.*
		•	Clean entire unit including condenser and evaporator coils and defrost drains.
		•	Check all unit, fuel tank, engine and electric motor mounting bolts, brackets, lines, hoses, etc.

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

Unit Description

General Description

The MD-II MAX 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-II MAX Model 30: Cooling and heating on engine operation.

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

Power to the system is provided by a Thermo King TK 3.74, water-cooled, 3 cylinder diesel engine rated at 11.2 continuous horsepower (8.35 kW) at 2400 RPM. A belt drive system transfers power 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 MD-II MAX operates under the control of a TG-V microprocessor controller. The built-in microprocessor controller simplifies system monitoring and troubleshooting. 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 clutch engages fully at 900 ± 100 RPM on engine operation, constantly turning the compressor and fans at both high and low speed.

X214 Compressor

The MD-II MAX features the X214, 2 cylinder compressor with 13.92 cu. in (229 cc) displacement.

Microprocessor Controller TG-V

Thermo King has applied the newest technological advances to develop a programmable microprocessor controller that controls unit functioning and displays operating information quickly and accurately.

Features include:

Thermometer: Displays return air temperature with 0.1 degree accuracy.

Thermostat: Provides temperature control from -20 to 80 F (-28 to 28 C), in 0.5 degree increments.

Defrost Control: If the evaporator coil temperature is below 42 F (6 C), Defrost is automatically initiated every 4 hours during pulldown until the return air temperature is in-range. At in-range temperatures (between approximately 7 degrees above and 7 degrees below setpoint), the controller is programmable for 2 to 16 hours in 2 hour increments. The Defrost interval is set at the factory, but can be reprogrammed by your Thermo King dealer.

Fuel Saver: Can be programmed to delay high speed operation for optimum fuel economy.

Alarm: Can detect and display alarm conditions including sensor, microprocessor and defrost termination failures.

The TG-V Controller is programmed to lock out High Speed Heat if set below 15 F (-9.4 C).

Cab Control Box: The Cab Control Box allows the driver to control and monitor some of the unit functions from inside the cab. The auto start system controls the preheat, run, and start relays to automatically start the unit when all On/Off switches are in the On position.

Refer to the Operating Instructions for detailed description of the controller functions.

Operating Modes

The MD-II MAX uses a ThermoGUARD V microprocessor controller for operational control of the unit.

Engine Operation

Continuous Run Operation

When the unit is started with the box temperature higher than 3.4 F (1.9 C) above the thermostat setpoint, the unit will run on High Speed Cool.

When the temperature drops to 3.4 F (1.9 C) above setpoint, the thermostat de-energizes the High Speed engine solenoid circuit, placing the unit on Low Speed Cool.

When the box temperature reaches the thermostat setpoint, the pilot solenoid is energized. The three-way valve shifts to the Heat position, placing the unit on Low Speed Heat.

If the temperature continues to fall, the thermostat will shift the unit to High Speed Heat at 3.4 F (1.9 C) below setpoint. The unit will remain on High Speed Heat until the box temperature rises to 1.7 F (0.9 C) below setpoint.

If the temperature continues to rise to 1.7 F (0.9 C) above setpoint, the thermostat de-energizes the pilot solenoid. The three-way valve shifts back to the Cool position, placing the unit on Low Speed Cool.

If the temperature continues to rise to 5.1 F (2.9 C) above setpoint, the thermostat will energize the engine solenoid high speed circuit, placing the unit on High Speed Cool.

CYCLE-SENTRY Operation (Optional)

WARNING: With the selector switch in the Auto Start/Stop position and unit On/Off switch in the On position, the unit may start at any time without prior warning.

With the Auto Start/Stop-Continuous Run switch in the Auto Start/Stop position, the CYCLE-SENTRY system starts the unit on thermostat demand and shuts down the unit when the box temperature reaches the thermostat setpoint.

On CYCLE-SENTRY equipped units, unit start-ups may also be initiated by Defrost cycle initiation or engine block temperature thermostat demand. In cold ambients, the CYCLE-SENTRY system demand automatically maintains engine temperature by restarting the unit if the engine block temperature drops to 30.0 F (0 C). When the unit starts because of low engine block temperature, it will run in the operating mode called for by the unit thermostat until the battery is fully charged and the engine block temperature reaches 90.0 F (32.2 C)

After the unit starts, a Battery Sentry module monitors the voltage across the field of the alternator and will keep the unit running if the battery is not sufficiently recharging. The ThermoGUARD thermostat controls unit operating mode to maintain the box temperature thermostat setpoint. The unit runs in whichever operating mode the thermostat is calling for to properly maintain the box temperature.

Electric Operation (Model 50 Units)

When the unit switch is turned On with the box temperature higher than 3.4 F (1.9 C) above thermostat setpoint, the unit will run on Cool.

When the temperature drops to setpoint, the thermostat de-energizes the electric motor contactor, placing the unit on Null.

If the box temperature continues to fall, the thermostat energizes both the electric motor contactor and the heat contactor (optional) to place the unit on Heat at 3.4 F (1.9 C) below setpoint. The unit will remain on Heat until the box temperature rises to 1.7 F (0.9 C) below setpoint. The thermostat will then de-energize the electric motor contactor and optional heat contactor, placing the unit on Null.

If the temperature continues to rise to 5.1 F (2.9 C) above setpoint, the thermostat will energize the electric motor contactor, placing the unit on Cool.

Defrost Operation

The Defrost mode can be initiated any time the evaporator coil temperature is below 42.0 F (5.6 C). Defrost is initiated automatically by the defrost air switch and defrost timer or manually by pressing the Manual Defrost switch.

When a Defrost cycle is initiated, the defrost relay energizes the damper solenoid and pilot solenoid.

The unit remains on Defrost until the evaporator coil temperature rises to 52.0 F (11.1 C), causing the defrost termination switch to open. When the defrost termination switch opens, the unit may shift back to the Cool or Heat mode, or the Null mode (optional Start/Stop operation).

If the thermostat calls for the Null mode (optional Start/Stop operation) while the unit is defrosting, the unit will continue to run until defrosting is complete. Then the unit will stop.

Serial Number Locations

Unit: Nameplate on top of roadside of the unit frame above the switch panel.

Engine: Nameplate on top of the rocker arm cover.

Compressor: Stamped on the side below the sight glass.

Electric Motor: Nameplate attached to the motor housing.

Unit Features

- TK 3.74 Diesel Engine
- X214 Compressor
- ThermoGUARD V Microprocessor Controller
- Tapered Roller Bearing Fanshaft & Idler
- Heavy Duty Oil Bath Air Cleaner
- Three-way Valve Refrigeration System
- One-piece Main Wiring Harness
- Spin-on Fuel Filter
- Spin-on Full Flow Oil Filter
- Electric Fuel Pump
- Coolant Expansion Tank with Coolant Indicator
- 23 Ampere Alternator
- Defrost Timer (Part of TG-V)
- Air Defrost Switch
- Electronic Engine Hourmeter
- Alternator Discharge Light
- Digital Thermometer (Part of TG-V)
- TherMax™ Defrost/Heating System
- R-404A.

Unit Options

- Electric Standby Motor (Model 50)
- CYCLE-SENTRY Start/Stop Controls
- Remote Control Box (outside, beneath unit)
- In-Cab w/TG-V
- Hourmeter, Electric Operation (Model 50)
- Dry-type Air Cleaner
- Fuel Heater
- Ammeter
- Silicone Coolant Hoses
- Oil Pressure Gauge
- Remote Indicator Lights
- Top Screen
- Engine Coolant Temperature Gauge
- Suction Pressure Gauge
- Electric Heaters
- Spin-on Bypass Oil Filter
- R-134a.

Protection Devices

- Engine Coolant High Temperature Cutout Switch
- Engine Low Oil Pressure Cutout Switch
- Evaporator High Temperature Cutout Switch (Model 50 only) with Heater Option
- Refrigerant High Pressure Cutout
- Refrigerant High Pressure Relief Valve
- 20 Ampere Circuit Breaker in Control Circuit
- 12 V Fuse Link (50 Ampere) (Current Limiter)
- Overload Relay Protection for Electric Standby Motor (Model 50)
- 50 Ampere Circuit Breaker in Starting Circuit.

Unit Photographs

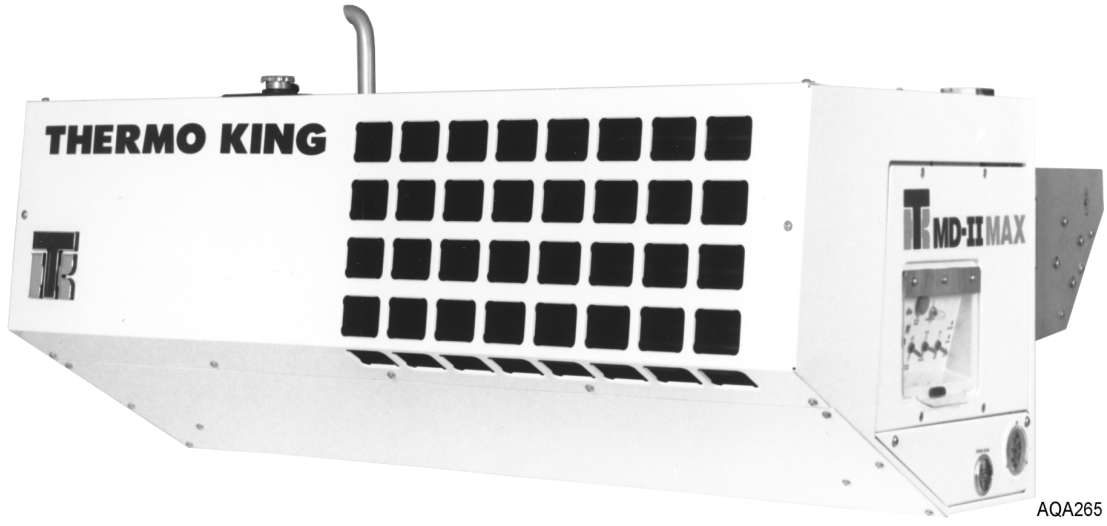
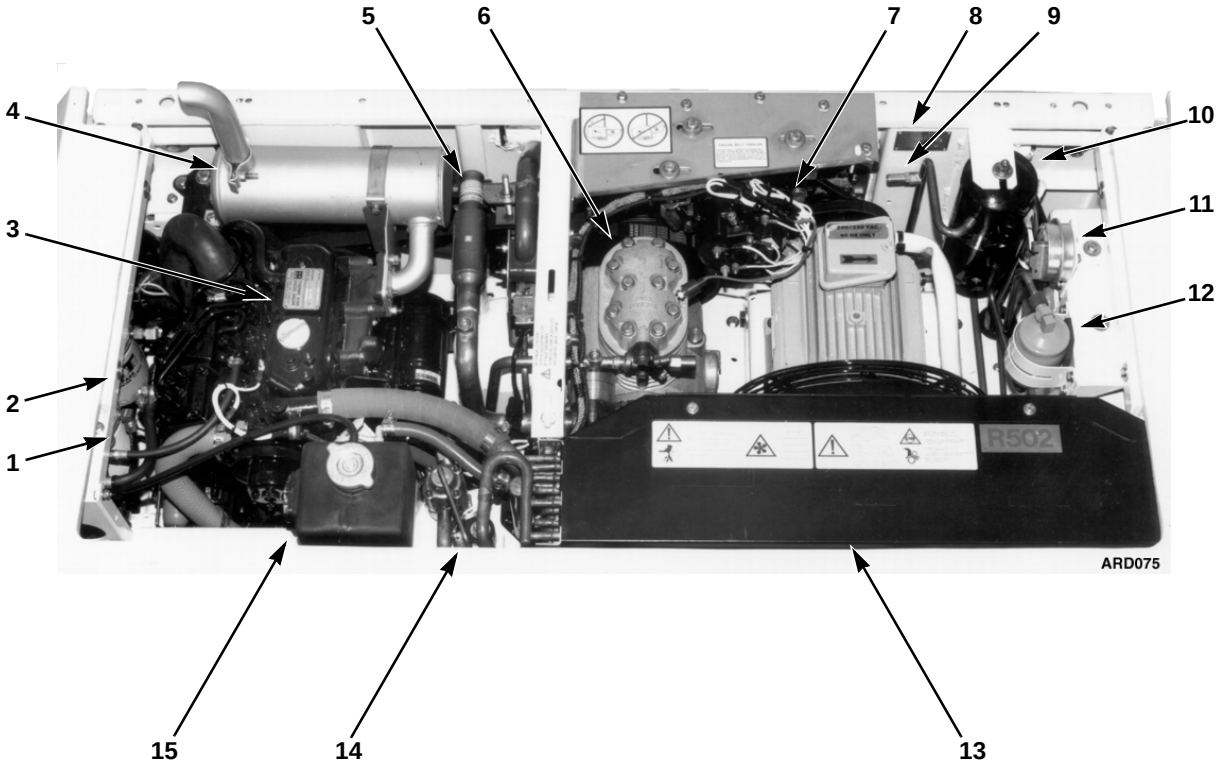
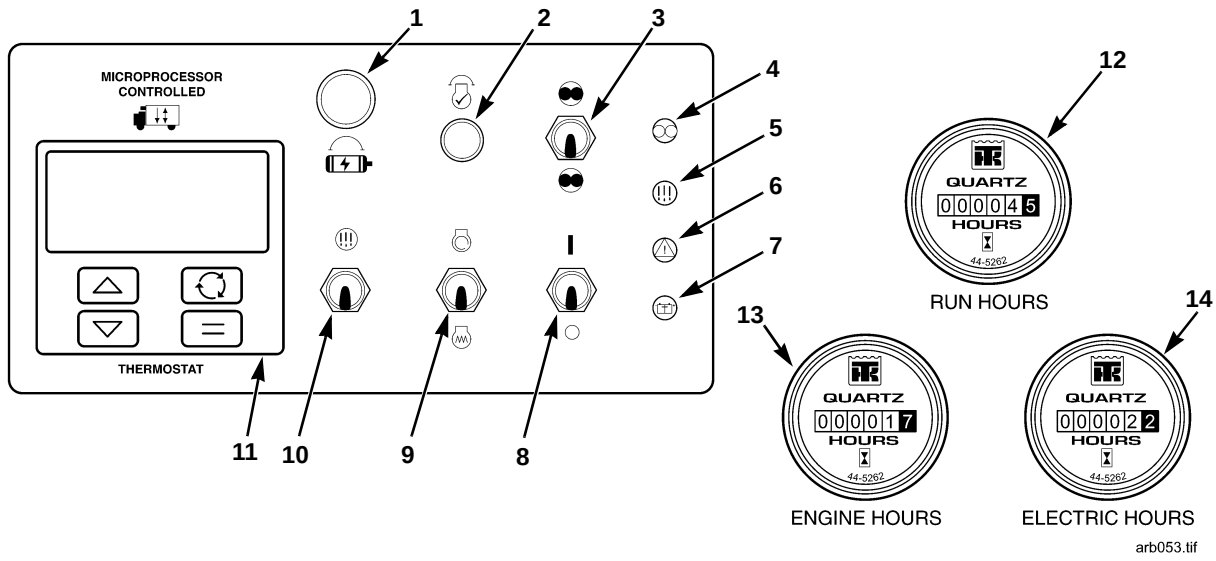


Figure 1: Roadside View



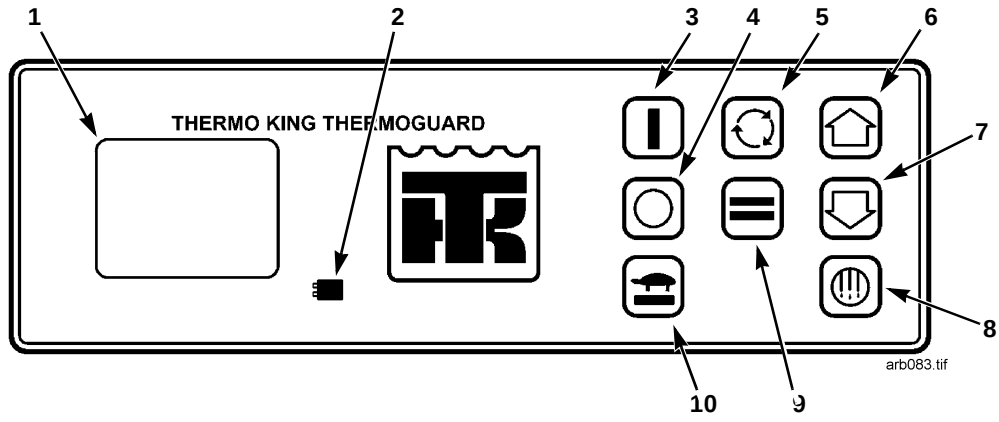
1.	Fuel Filter	9.	High Pressure Relief Valve
2.	Oil Filter	10.	Receiver Tank
3.	Engine	11.	Air Defrost Switch
4.	Muffler	12.	Drier
5.	Suction Pressure Regulator	13.	Condenser Coil
6.	Compressor	14.	Three-Way Valve
7.	Alternator	15.	Expansion Tank
8.	Nameplate		

Figure 2: Top View



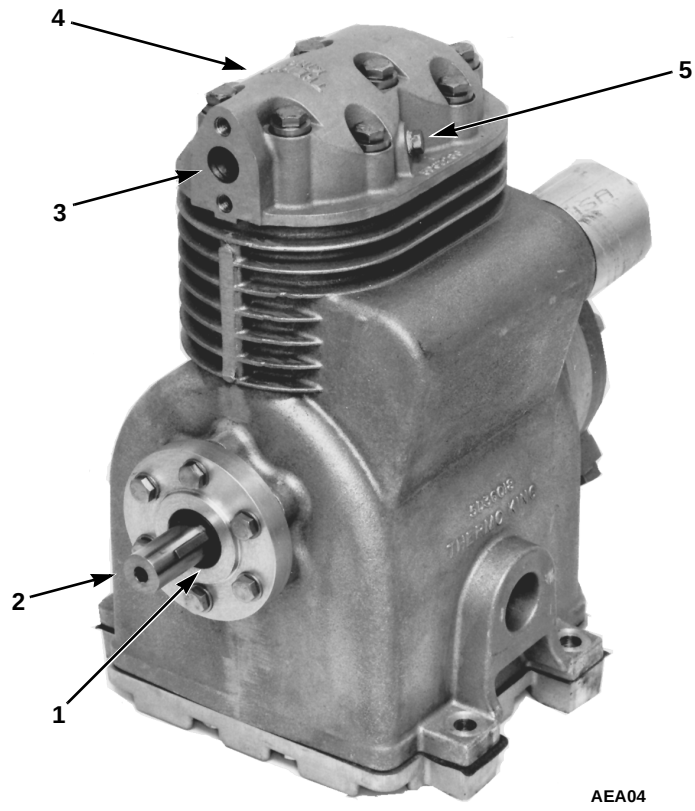
1.	Motor Reset (Model 50)	8.	On/Off Switch
2.	Engine Reset	9.	Preheat/Start Switch
3.	Auto Start/Stop - Continuous Run Switch (Optional)	10.	Manual Defrost Switch
4.	Start/Stop Light (Optional)	11.	Microprocessor Controller TG-V
5.	Defrost Light	12.	Run Hourmeter (Optional on Model 50)
6.	Engine Light	13.	Engine Hourmeter
7.	DC Alt Light	14.	Electric Operation Hourmeter (Optional on Model 50)

Figure 3: TG-V Control Panel



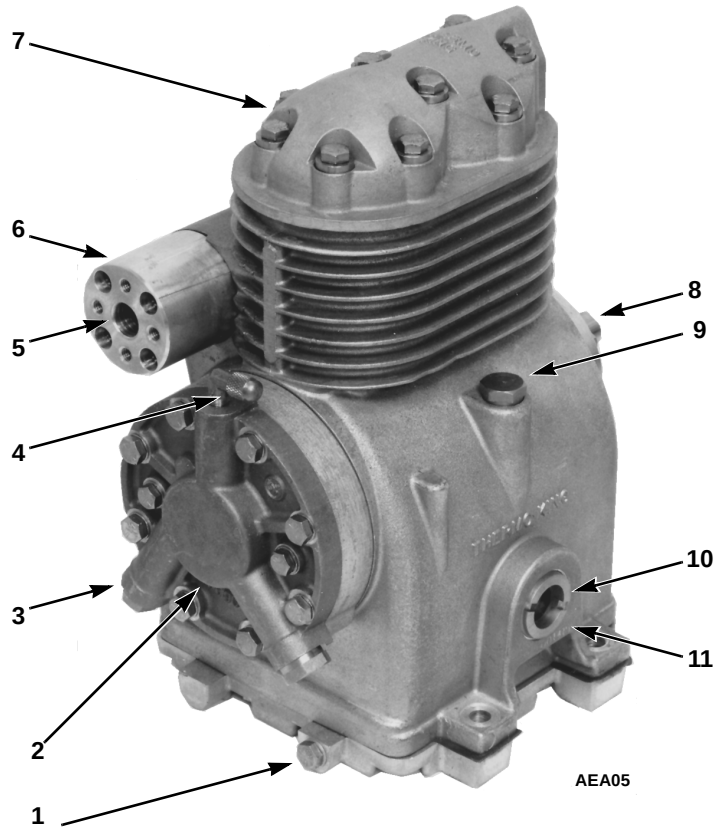
1.	Temperature Display	6.	**UP** Key
2.	Power Cord Indicator Light	7.	**DOWN** Key
3.	**ON** Key	8.	**DEFROST** Key
4.	**OFF** Key	9.	**ENTER** Key
5.	**SELECT** Key	10.	**LOW NOISE** Key

Figure 4: TG-V In-Cab Controller



1.	Oil Seal (Location Not Shown)	4.	Cylinder Head
2.	Crankshaft	5.	***NOTE: Apply Thread Sealant When Installing High Pressure Cutout.***
3.	Discharge Port		

Figure 5: X214 Compressor



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

Figure 6: X214 Compressor

Operating Instructions

WARNING: Do not operate the unit until you are completely familiar with the location and function of each control, gauge and indicator on the panels.

Unit Controls

TG-V Unit Control Box

Auto Start/Stop - Continuous Run Switch (Optional): This switch selects Continuous Run operation or CYCLE-SENTRY operation.

- Cont. Run position: The unit will be started manually with the On/Off switch and the Preheat/Start switch. After start-up, the unit operates continuously until the On/Off switch is turned Off or a protection circuit shutdown occurs due to a malfunction in the fuel, engine oil, engine coolant or refrigeration system.
- Auto Start/Stop position: All unit starting operations are performed automatically on demand. Starting functions such as glow plug preheat, fuel and throttle solenoid control and cranking are performed automatically when operation is required. The engine will start automatically for one or a combination of the following conditions:

  a. The Microprocessor Controller calls for heating or cooling.

  b. Manual Defrost initiated.

  c. Engine block temperature drops below 35 F (2 C).

  Once started, the engine will run until:

  a. Microprocessor Controller demands are satisfied,

  b. The block temperature reaches 90 F (32 C),

  c. The Defrost cycle is complete.

  The engine is then automatically stopped by the CYCLE-SENTRY control system.

Start/Stop Light (Optional): When this green light is On, the CYCLE-SENTRY system is functioning normally. A malfunction is indicated if the Auto Start/Stop-Continuous Run Switch is set to Auto Start/Stop and the light is off. In this situation, the unit will not run. The Engine Reset may be tripped.

Engine Reset: The Engine Reset is a pushbutton switch behind a flexible weatherproof cap. When this switch “opens”, the button pops out. It remains open until it is manually pushed in to reset the circuits.

When the Engine Reset is open (tripped), the diesel engine cannot be started. If the reset trips while the engine is running, the engine will shutdown. Four conditions can cause the engine reset to trip:

- Engine oil pressure drops below 7 to 13 psi (48 to 90 kPa) while the On/Off switch is switched to On. This includes any situation which causes the engine to stop or not start within a short period of time.
- Engine coolant temperature rises above 215 to 225 F (102 to 107 C).
- Engine oil pressure drops too low.
- The starter exceeds the cranking limit in CYCLE-SENTRY operation (optional).

  Some situations which may cause the Engine Reset to open are:

  a. Engine runs out of fuel.

  b. On/Off switch is left On accidentally without the engine being started.

  c. Engine does not start after cranking in CYCLE-SENTRY mode.

  d. High refrigerant pressure causes the high pressure cutout to stop the engine.

Defrost Light: When this orange light is On, the unit is operating in the Defrost mode.

Engine Light: When this red light is On, the Engine Reset switch has been tripped.

DC Alt Light: When this yellow light is On, there is no current output from the alternator.

On/Off Switch: This switch supplies power to the circuits of the unit.

- On position: This switch energizes the electrical system for the unit.
- Off position: This switch de-energizes the electrical system and the unit will not operate.

NOTE: If the unit is also equipped with an In-Cab Control Box. All On/Off switches must be in the On position before the unit will operate.

Preheat/Start Switch: When held on Preheat, this switch energizes the glow plugs in the diesel engine to aid in starting.

When held on Start, this switch energizes both the glow plugs and the starter which cranks the engine.

Manual Defrost Switch: When pushed, the Manual Defrost switch starts the Defrost cycle. However, the evaporator coil must be below 42 F (6 C) for the unit to go into Defrost. A thermal switch on the evaporator coil senses this temperature.

NOTE: The unit will remain in Defrost mode until the coil temperature rises to 52 F (11 C).

Run Hourmeter (Optional on Model 50): The Run Hourmeter records the total number of hours that the unit has been in operation.

Engine Hourmeter: The Engine Hourmeter records the total number of hours that the diesel engine has been in operation. This meter can be used to determine proper maintenance intervals.

Electric Operation Hourmeter (Optional on Model 50): The Electric Operation Hourmeter records the total number of hours that the electric motor has been in operation. This meter can be used to determine proper maintenance intervals.

Coolant Temperature Gauge (Optional): The Coolant Temperature Gauge indicates the temperature of the coolant in the engine block.

Oil Pressure Gauge (Optional): The Oil Pressure gauge shows the engine oil pressure. This pressure should rise immediately after the engine starts.

Suction Pressure Gauge (Optional): The Suction Pressure gauge indicates the pressure of the refrigerant gas returning to the compressor.

Ammeter (Optional): The Ammeter indicates whether the battery is being charged or discharged. The amount of discharge shows whether the glow plugs are functioning properly during preheat.

ThermoGUARD V Microprocessor Controller (TG-V)

WARNING: Do not operate the TG-V until you are completely familiar with the meaning of each display symbol, and the function of each control key.

The programmable TG-V displays temperature and alarm conditions. It also functions as a thermostat and a defrost timer for the unit.

The TG-V In-Cab Remote Control Box provides convenient on-the-road unit control from inside the truck cab. It includes the following:

Temperature Display: This digital temperature display indicates the temperature of the air returning from the cargo box to the evaporator.

Power Cord Indicator Light (Model 50): When this red light is On, the Electric/Diesel switch is in the Electric Standby position and the truck ignition is on.

OFF Key: Used to turn off the controller and stop the engine or standby motor.

ON Key: Used to turn on the condensing unit and the controller.

NOTE: The main unit On/Off switch must be set to On before the In-Cab Controller can be turned On. The unit will automatically start. Also, the In-Cab Controller must be On before the main unit can be started.

SELECT Key: Used to select the various displays which can appear on the screen.

UP Key: Used to increase setpoint temperature when the setpoint symbol is on the screen.

DOWN Key: Used to decrease setpoint temperature when the setpoint symbol is on the screen.

DEFROST Key: Used to start the Defrost cycle of the evaporator.

ENTER Key: Used to enter new information into the controller.

NOTE: The ENTER key must be pressed within 6 seconds after releasing the UP or DOWN key to complete the setpoint change.

LOW NOISE KEY: Used to lock out high speed operation to maintain low speed (low noise) operation.

With the unit switched off, the controller screens will be dark; nothing will be on the display. When the unit is switched On, all symbols and readouts will be displayed for about 10 seconds. Make sure that all display segments are operational.

Standard Display is set to *Return Air Temperature* at the factory. Each controller can be programmed to show return air or setpoint as the Standard Display.

When unit is switched off, it is normal for display to remain On for about 30 seconds.

With power off or battery disconnected, all settings are saved in the controller memory and become active when unit is switched On.

During the normal operation, the Standard Display is on the screen.

Return Air Temperature is factory Standard Display setting (can be changed). Other operating data can be displayed.

To view other operating data, repeatedly press and release the **SELECT** key.

The following data may be displayed:

- Discharge Air Temperature
- Setpoint Temperature
- Press **SELECT** key for next display.

The remote control box is replaced with an electric standby power receptacle on units that are equipped with the cab control box.

Remote Control Box Outside (Optional)

The switches in the remote control box energize relays on the option board to control the operation of the unit. The remote On/Off switch and the unit On/Off switch must both be in the On position for the unit to operate. Either switch will turn the unit off.

The remote control box mounts on the truck body beneath the unit to offer easier accessibility to unit controls. This box offers the following functions:

Preheat/Start Switch: When pressed to Preheat, the switch energizes the glow plugs to aid in starting. When pressed to Start, it energizes both the glow plugs and the starter motor.

On/Off Switch: The On/Off switch energizes the On relay, activating the unit electrical system. The control panel On/Off switch and the remote On/Off switch must both be On in order for the unit to operate. Either switch can stop the unit.

Manual Defrost: Pressing the Manual Defrost switch will initiate a Defrost cycle if the evaporator coil temperature is below 42.0 F(5.6 C).

Diesel/Electric Switch (Model 50 only): Switches the unit to electric motor standby power when placed in Electric position and power cord is connected to the box.

Other Controls

Defrost Termination Switch: A temperature sensitive switch is mounted on the evaporator coil. It is used to control Defrost. The switch closes when the evaporator temperature drops to 42 F (6 C). This enables Defrost.

Defrost Air Switch: The Defrost Air switch senses the air pressure difference between the evaporator coil inlet and outlet. The switch automatically places the unit on Defrost when the evaporator temperature is below 42.0 F (5.6 C) and frost builds up on the coil to a point where the air flow across the coil is restricted.

Unit Indicators

Remote Light Indicator Box (Optional): The optional Remote Light Display mounts on the truck for convenient indication of the unit's operating mode. The following conditions are indicated by the respective light(s) being On:

a. Cool (White). The unit is cooling.

b. Defrost (Tan). The unit is defrosting.

c. Heat (Amber). The unit is heating.

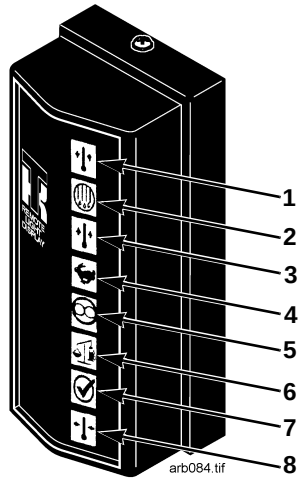
d. High Speed (Blue). When the blue light and white light are On at the same time, the unit is in high speed cool. When the blue light and amber light are On at the same time, the unit is in High Speed Heat.

e. CYCLE-SENTRY (Green). The unit is in CYCLE-SENTRY mode.

f. Fuel Saver (Light Blue). Not used.

g. Check Light (Orange). Not used.

h. In Range (Blue/Green). Not used.



1.	Cool Light
2.	Defrost Light
3.	Heat Light
4.	High Speed Light
5.	CYCLE-SENTRY Light
6.	Fuel Saver Light (Not Used)
7.	Check Light (Not Used)
8.	In Range Light (Not Used)

Figure 7: Remote Light Indicator Box

Hourmeters: The hourmeter records the number of hours the unit is in diesel operation for proper maintenance intervals. An electric hourmeter (hours in electric operation) and a total hourmeter (total operating hours) are optional equipment.

Digital Thermometer: A digital thermometer is built into each thermostat. The thermometer normally indicates the return air temperature.

Receiver Tank Sight Glass: This sight glass is used to check the amount of refrigerant in the system.

Compressor Oil Sight Glass: The compressor oil sight glass indicates the relative level of compressor oil in the compressor sump.

Engine Oil Dipstick: Use the engine oil dipstick to check the engine oil level.

Coolant Tank: This gauge indicates the engine coolant level. If the pointer is in the FULL (white) range, the coolant level is acceptable. If the point is in the ADD (red) range, add coolant to the expansion tank.

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

Unit Protection Devices

Engine Reset Switch: A thermal type manual reset switch protects the engine. The reset switch contains a heater coil that is attached to a sensor switch in the engine oil system, engine coolant system and the (optional) CYCLE-SENTRY system.

When the engine oil pressure is too low, when the starter exceeds the cranking limit on Auto Start/Stop operation, or when the engine coolant temperature is too high, the coil in the reset switch begins to heat up. In 20 to 40 seconds, the switch will open and shut down the unit. To reset the engine reset, press the engine reset button.

Overload Relay/Electric Motor Reset Switch (Model 50): The overload relay protects the electric standby motor. The overload relay opens the circuit from the linestarter to the electric motor if the motor overloads for any reason, (e.g., low line voltage or improper power supply) while the unit is on Electric Standby operation. To reset the electric motor, press the motor reset button which is located on the high voltage box.

Control System Circuit Breaker: The control system remote reset circuit breakers are located in the control box. They are designed to protect the 12 volt DC control circuit from overloads. To reset the circuit breakers, turn the unit On/Off switch to the Off position for 30 seconds.

Control Circuit Fuse: Located between the battery and the unit control circuits (typically inside the battery box). At about 60 amps, the fuse will melt and cut battery power to the unit.

Engine Coolant High Temperature Cutout: The engine coolant high temperature cutout is a temperature sensitive switch located in the engine cooling system.

The engine coolant high temperature switch will close and trip the engine reset if the engine coolant temperature is greater than 215 to 225 F (102 to 107 C).

Evaporator High Temperature Protection Switch (Model 50): A high temperature protective switch is located above the evaporator coil to interrupt the Heat cycle if the temperature above the coil exceeds 150 F (66.0 C) during electric standby operation.

Engine Low Oil Pressure Cutout: The engine low oil pressure cutout is a pressure sensitive switch located in the engine oiling system. This switch will trip the Engine Reset and stop the engine if the oil pressure drops below 8 to 12 psi (55 to 83 kPa).

Refrigerant High Pressure Cutout: The high pressure cutout is a pressure sensitive switch located in the compressor head. If the refrigerant discharge pressure exceeds the current setting, this switch opens the circuit to the fuel solenoid, stopping the engine. Within 30 to 50 seconds, the engine reset will also trip because of low oil pressure in the engine. For Model 50 units, this switch also shuts down electric motor operation.

Refrigerant High Pressure Relief Valve: This valve is designed to relieve excess pressure within the refrigeration system. Located on a high pressure line near the condenser, it is non-repairable and requires no adjustment. When pressure is released from the valve, it is directed away from anyone servicing the unit.

Preheat Buzzer (CYCLE-SENTRY Units): The preheat buzzer sounds when the CYCLE-SENTRY system causes the glow plugs to preheat.

Unit Operation

Pretrip Inspection

Pretrip inspections are a very important part of regularly scheduled preventive maintenance programs designed to minimize operating problems and breakdowns before they happen. While pretrips are not intended to take the place of regular maintenance inspections, the following suggested pretrip inspection should be performed before every trip involving refrigerated cargo.

Fuel: The diesel fuel supply must be adequate to guarantee the operation of the engine to at least the next check point.

Engine Oil: The engine oil level should be at the FULL mark on the dipstick. Never overfill.

Coolant: Check coolant level gauge for the correct amount of coolant. The indicator should be in the FULL (white) range. If the coolant level is in the ADD (red) range, add coolant to the expansion tank. The coolant should be a 50/50 mixture of ethylene glycol and water and provide protection to -30 F (-34 C).

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

Battery: The terminals must be tight and free of all corrosion. Electrolyte should be at full mark.

Belts: The belts must be in good condition and adjusted to the proper tension. Allow 1/2 inch (13 mm) deflection at the center of the span between pulleys.

Electrical: Check all electrical connections to make certain they are securely fastened. 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.

Gasket: The unit mounting gasket should be tightly compressed and in good condition.

Coils: The condenser and evaporator coils should be clean and free of debris.

Cargo Box: Inspect the interior and exterior of the box for damage. Any damage to the walls or insulation must be repaired.

Defrost Drain: Check the defrost drain hoses and fittings to be sure they are open.

Doors: Be sure doors and weather seals are in good condition, door latches securely and weather seals fit tightly.

Starting the Unit—Auto Start Diesel Operation

Auto Start is included with the cab control box.

1. Place the Diesel/Electric switch in the Diesel position and place the power receptacle On/Off switch in the On position.
2. Place the control box On/Off switch in the On position.
3. Press the **ON** key in the cab control box.
4. The unit should preheat and start automatically. If the unit fails to start, press the **OFF** key and place the On/Off switches in the Off position. Determine and correct the cause of the failure. Push in the reset button and repeat the starting procedure.

   NOTE: The Auto Start system, included with the cab control box option, functions like the CYCLE-SENTRY system except that once started the unit does not shut down on thermostat demand. The unit runs continuously until it is turned Off manually.

   The start sequence, once initiated, is the same for both systems. Refer to the CYCLE-SENTRY sections of this manual for further information on the start sequence, as it applies to the Auto Start system.

Manually Starting Units on Diesel Operation

1. Place the Diesel/Electric switch in the Diesel position and place the power receptacle On/Off switch in the On position.
2. Hold the Preheat/Start switch in the Preheat position for the required time.

Ambient Temperature	Preheat Time
32 to 60 F (0 to 16 C)	30 seconds
0 to 32 F (-18 to 0 C)	60 seconds
Below 0 F (-18 C)	90 seconds

3. Place the control box On/Off switch in the On position.
4. Press the **ON** key in the cab control box.
5. Hold the Preheat/Start switch in the Start position to crank the engine. Release when the engine starts. *Do not* release the switch prematurely when the engine is extremely cold.
6. Turn the control box On/Off switch to Off, and repeat steps 2 through 5 if the engine fails to start.

CAUTION: Never use starting fluid.

Starting the Unit—CYCLE-SENTRY Units on Diesel Operation

Selection of Operating Modes on CYCLE-SENTRY Equipped Units

The Thermo King CYCLE-SENTRY system is designed to save refrigeration costs. The savings vary with the commodity, ambient temperatures and truck insulation. However, not all temperature controlled products can be properly transported without continuous air circulation.

Since highly sensitive products will normally require continuous air circulation, CYCLE-SENTRY units come equipped with a selector switch for CYCLE-SENTRY or Continuous Run operation. Your selection of the operation mode for the proper protection of a particular commodity should use the following guidelines.

Examples of Products Normally Acceptable for CYCLE-SENTRY Operation

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

Examples of Products Normally Requiring Continuous Run Operation of Air Flow

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

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

Continuous Run Operation

With the selector switch in the Cont Run position, the CYCLE-SENTRY unit will operate in its regular cooling and heating modes. Refer to “Manually Starting Units on Diesel Operation” on page 38 or “Starting the Unit—CYCLE-SENTRY Units on Diesel Operation” on page 38.

CYCLE-SENTRY Operation

With the selector switch placed in the CYCLE-SENTRY position, 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, the unit start-ups may also be initiated by Defrost cycle initiation or engine block temperature switch demand.

If Defrost is initiated either manually, or automatically by the defrost timer, the unit will start and run in Defrost. When the Defrost cycle is complete, the unit will run in whichever operating mode the thermostat demands 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 30 F (-1 C). When the unit starts up because of low engine block temperature, the unit will run in whichever operating mode the unit thermostat is calling for until the battery is fully charged and the engine block temperature rises to 90 F (32 C).

After the unit starts from thermostat demand, Defrost initiation, or engine block temperature switch demand, a Battery Sentry switch monitors the voltage across the field of the alternator and will keep the unit running until the battery is recharged sufficiently. The unit runs in whichever operating mode the thermostat demands to properly maintain the compartment temperature. When the battery is sufficiently recharged, the unit will shut down on thermostat demand.

CAUTION: With the Auto Start/Stop - Continuous Run switch in the CYCLE-SENTRY position and the On/Off switches in the On position, The unit may start at any time without prior warning.

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

NOTE: A unit that is equipped with CYCLE-SENTRY should be manually started if it has been turned Off long enough for the engine to become cold soaked at temperatures below 30 F (-1 C). Place the Auto Start/Stop - Continuous Run switch in the Cont Run position and refer to "Manually Starting Units on Diesel Operation" on page 38. After this initial cold start, the Auto Start/Stop - Continuous Run switch can be switched to the CYCLE-SENTRY position. CYCLE-SENTRY sensors will then automatically maintain temperatures and provide reliable unit restarts on demand.

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

1. Place the Diesel/Electric switch in the Diesel position and place the power receptacle On/Off switch in the On position.
2. Place the CYCLE-SENTRY switch in the CYCLE-SENTRY position.
3. Place the control box On/Off switch in the On position.
4. Press the **ON** key in the cab control box. The CYCLE-SENTRY indicator light will come On. (This light must be On at all times while the unit is in CYCLE-SENTRY operation.) If a malfunction occurs preventing a restart, the fact that this light is Off is the only indication a malfunction has occurred.
5. Set each thermostat at the required temperature. *Do not* set a thermostat lower than required (lowering the thermostat setpoint does not make the unit cool faster).
6. If a thermostat calls for Cool or Heat, the glow plugs will automatically heat for the required amount of time depending on the engine temperature (5 seconds at 150 F [66 C] to 120 seconds at -20 F [-29 C]).
7. At the end of the preheat period, the engine will begin cranking. The glow plugs remain energized during the cranking period. If the engine RPM does not exceed 50 RPM during the first 4 seconds of cranking, or if the engine does not start after 30 seconds of cranking, the cranking cycle terminates.

   NOTE: If the engine fails to start, the unit reset switch will open, interrupting current to the control system about 40 seconds after cranking cycle terminates.
8. If the engine fails to start, place the control box On/Off switch in the Off position. Determine and correct the cause of the failure, then push in the reset button and repeat the starting procedure.

Starting the Unit—Electric Operation

1. Place the Diesel/Electric switch in the Electric position.
2. Make sure that an On/Off switch is in the Off position and that the electric standby power supply is turned off.

   CAUTION: Always turn Off the electric power supply when handling, connecting, or disconnecting high voltage power cords.
3. Connect the power receptacle to the power supply. Make sure that the power supply is the correct voltage, phase, and frequency.
4. Turn the high voltage power supply On.

   CAUTION: Do not start the electric motor unless the diesel engine is completely stopped.
5. Place the On/Off switches in the On position and press the **ON** key.
6. Set each thermostat setpoint at the required temperature. Do not set a thermostat lower than necessary. Setting the thermostat below the required setpoint will not make the unit cool faster.

7. If a thermostat is demanding Cool or Heat, the electric motor will start and the unit will operate. The unit will not operate if the box temperature is near the thermostat setpoint.
8. Check the fan rotation by holding a small piece of cloth or paper in front of the condenser grille. Correct fan rotation will draw the cloth or paper toward the grille, incorrect rotation will blow the cloth or paper away.
9. If the fan rotation is correct, leave the unit turned On.
10. If the rotation is incorrect, the phase of the power supply is wrong and must be corrected. Turn Off the power to the cable and reverse the position of any two power leads from the power cable plug. *Do not* disturb the green ground wire. (Refer this procedure to a qualified electrical repairman).

After Start Inspection

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.

Thermostat: Set the thermostat at, well above or well below the compartment temperature. Check to make sure that the mode of operation changes with the change in setpoint.

Pre-Cooling: With the thermostat set at the required temperature, allow the unit to run for one-half to one hour (longer if possible) before loading the truck. Pre-cooling will remove residual body heat and moisture from the truck interior and provide a good test of the refrigeration system.

Defrost: When the unit has finished pre-cooling the truck interior (evaporator coil temperature below 42 F [6 C]), initiate Defrost cycle with the **Manual Defrost** key. The Defrost cycle should end automatically.

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 the load temperature while loading. Especially note any off-temperature product.
3. Load 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. Set the thermostat at the required temperature setpoint.
3. Start the unit.
4. One-half hour after loading, Defrost each evaporator by momentarily pressing the Manual Defrost keys. If the evaporator coil temperature has dropped below 42 F (6 C), the unit will Defrost. The Defrost cycle should stop automatically.

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.

TG-V Thermostat

The TG-V is a programmable microprocessor controller that uses external relays. The TG-V module is replaced as an assembly, no internal repair is available.

For complete details, see the Microprocessor Controller TG-V Operating and Setup Manual TK 40284.

Features of the TG-V Thermostat include:

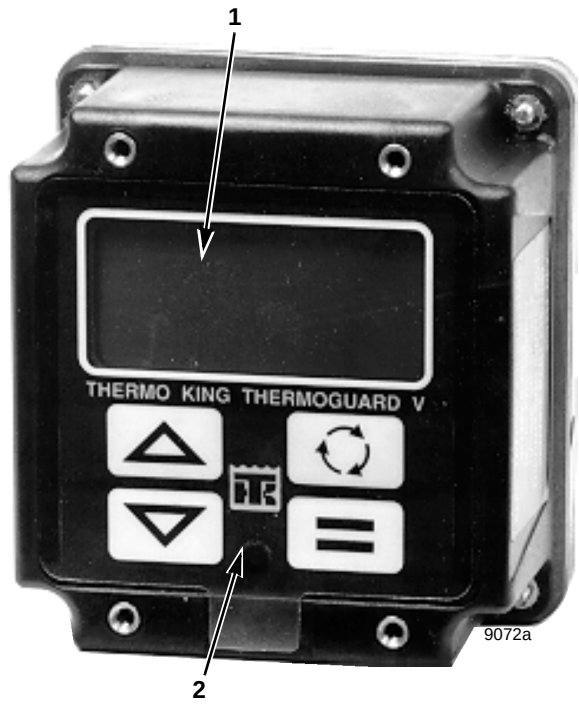
Thermometer: It displays the return air temperature, and can be programmed to display the optional discharge air temperature with 0.1 degree accuracy.

Thermostat: It provides temperature control from -20 to 80 F (-28 to 28 C), in 0.5 degree increments.

Defrost Control: When the evaporator coil is cold enough for frost to form, defrost is automatically initiated every 4 hours during pull-down until the return air temperature is in range. At in-range temperatures (between approximately 7 degrees above and 7 degrees between point), the controller is programmable for 2 to 16 hours in 2 hour increments. Defrost interval is set at the factory but can be reprogrammed by your Thermo King Dealer. It can also be programmed to terminate defrost at 30 or 45 minutes.

Fuel Saver: It can be programmed to delay high speed operation for optimum fuel economy.

Alarm: It can detect and display up to four alarm conditions including sensor, microprocessor, and defrost termination failures.



1. LCD
2. Keypad

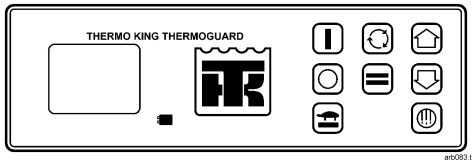
Figure 8: TG-V Thermostat

The keypad and the Liquid Crystal Display (LCD) allow the operator to operate the TG-V. The input and output terminals on the back of the TG-V monitor unit conditions and control unit functions.

Single Temp In-Cab TG-V Controller (optional)

The In-Cab TG-V Controller is a microprocessor based controller that is designed to be used in Thermo King Units.

For complete details, see the In-Cab TG-V Controller Operating and Setup Manual TK 40804-8-MS.



Single Temp In-Cab TG-V Controller

The early versions of the Single Temp In-Cab TG-V have the following part numbers:

- P/N 41-1544 - 12V No Modulation
- P/N 41-1545 - 12V Modulation
- P/N 41-1546 - 24V No Modulation
- P/N 41-1547 - 24V Modulation.

The software and alarm codes were updated in the first quarter of 2000. The updated versions of the Single Temp In-Cab TG-V have the following part numbers:

- P/N 41-3305 - 12V No Modulation
- P/N 41-3306 - 12V Modulation
- P/N 41-3307 - 24V No Modulation
- P/N 41-3308 - 24V Modulation
- P/N 41-3309 - Isuzu.

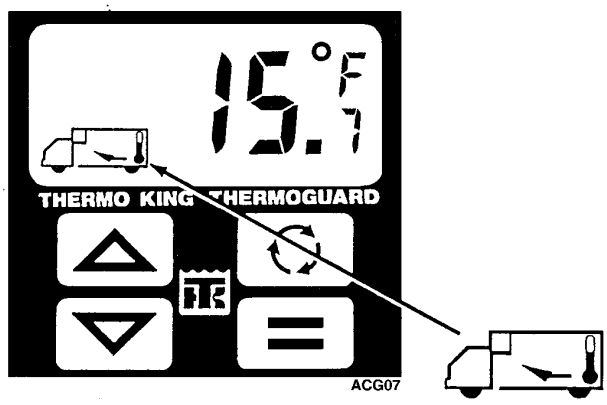
The face plate is P/N 91-8117 for all versions, except for Isuzu.

Interconnecting harness P/N 41-346 is used for all versions.

Display Symbols and Control Keys

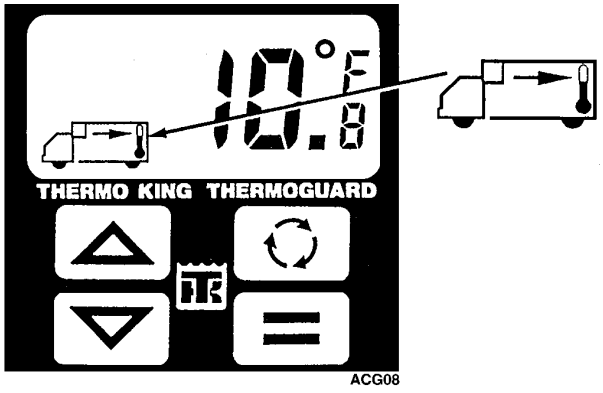
The following is a list of the display symbols and control keys on the TG-V. It is recommended that you become completely familiar with the meaning of each symbol and the function of each control key before operating the unit.

Display Symbols



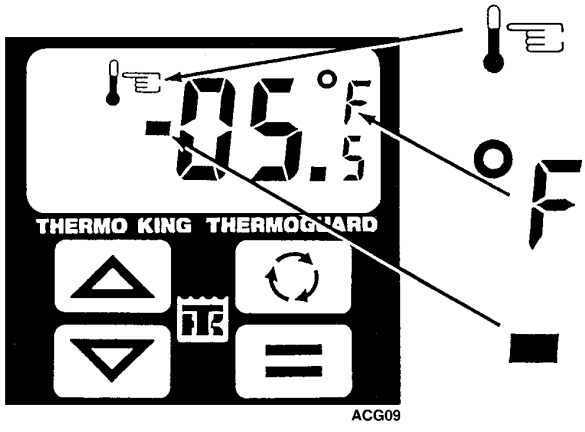
Return Air Symbol

(Arrow returning from thermometer to unit.) Indicates that the return air temperature is being displayed.



Discharge Air Symbol

(Arrow from unit pointing at thermometer.) Indicates that the discharge air temperature is being displayed (optional).



Setpoint Symbol

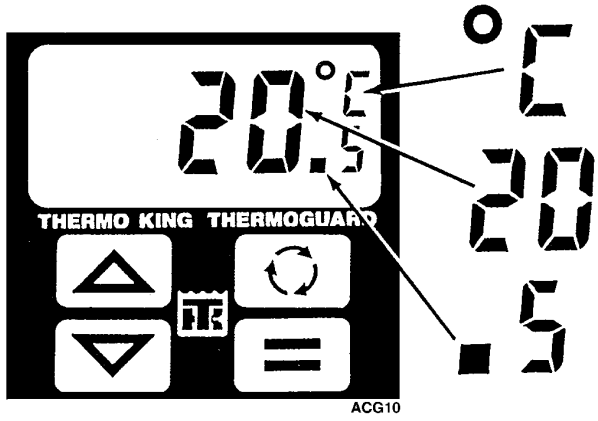
(Hand pointing to thermometer.) Indicates that the setpoint temperature is being displayed.

Fahrenheit Symbol

(Degree symbol and letter F.) Indicates that the temperature being displayed is in Degrees Fahrenheit.

Minus Sign

Indicates that the temperature being displayed is below zero.



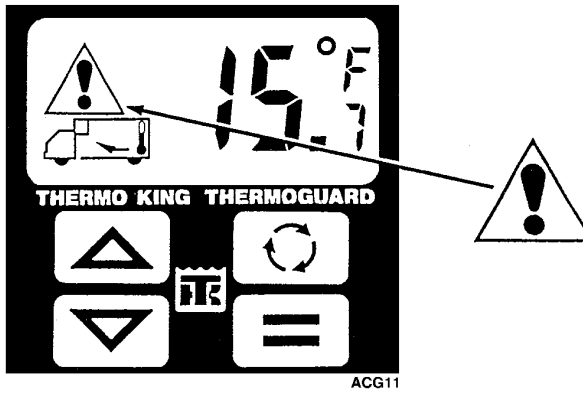
Celsius Symbol

(Degree symbol and letter C.) Indicates that the temperature being displayed is in Degrees Celsius.

Temperature

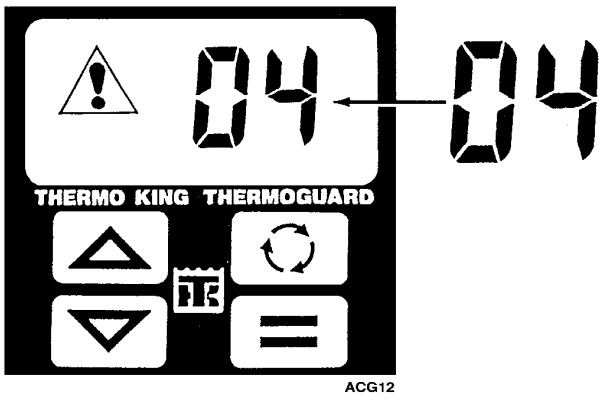
When a temperature symbol is displayed:

- Large numbers indicate the temperature in whole degrees.
- A decimal point and 1/2 size number indicates temperature in tenths of a degree.



Alarm Symbol

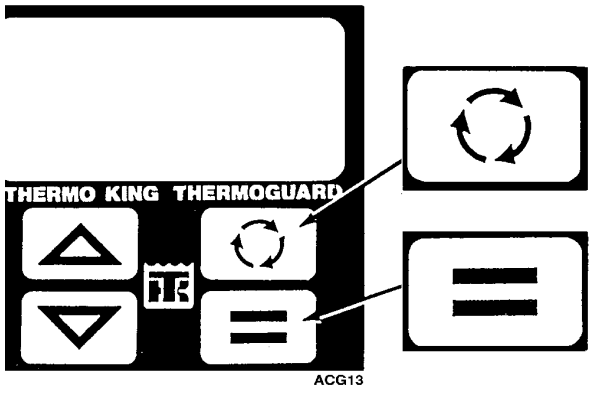
(Exclamation point within a triangle.) When this flashing symbol is displayed, an alarm (fault) condition has been detected by the controller.



Alarm Code

When an alarm has been sensed and an alarm screen has been selected by pressing the **SELECT** key, this two-digit code indicates the type of alarm.

Control Keys

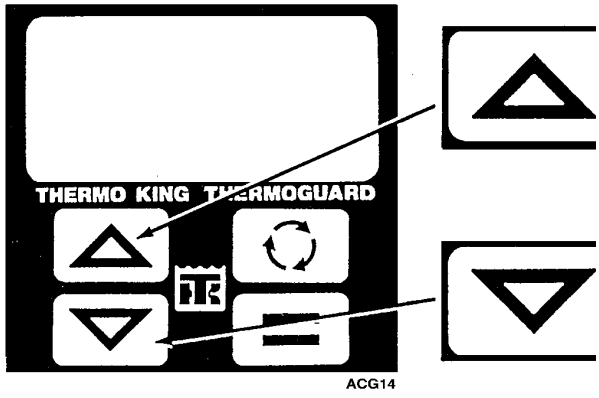


SELECT Key

(Cycling arrows) is used to select the various displays which can appear on the screen.

ENTER Key

(Equals sign) is used to enter new information into the controller.



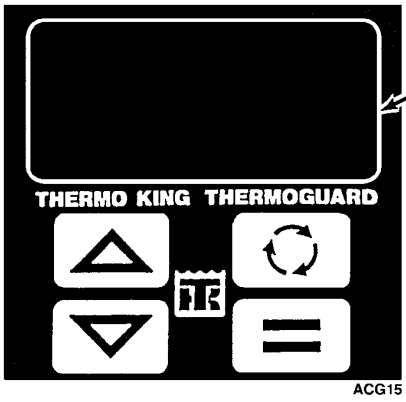
UP Key

(Arrow pointing upward) When the setpoint symbol is on the screen, this key is used to increase the setpoint temperature.

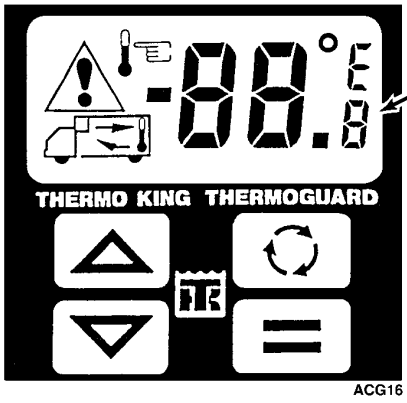
DOWN Key

(Arrow pointing downward) When the setpoint symbol is on the screen, this key is used to decrease the setpoint temperature.

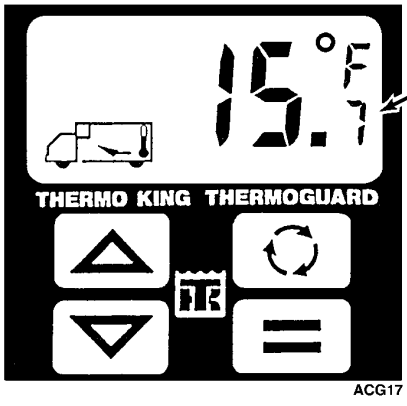
General Display Information



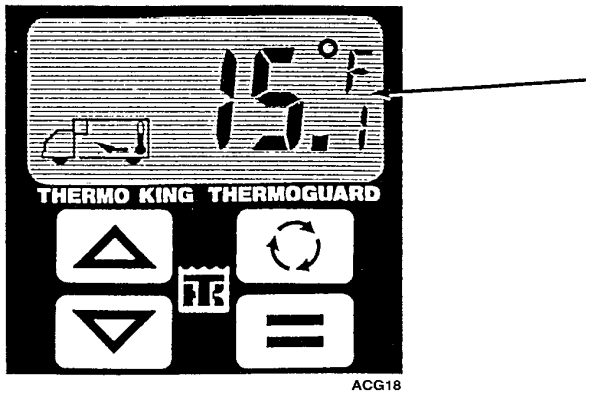
When the Thermo King unit is switched Off, the controller screen will be dark; nothing will be on the display.



When the Thermo King unit is switched On, all symbols and readouts will be displayed for about 5 seconds. Make sure that all display segments are operational.

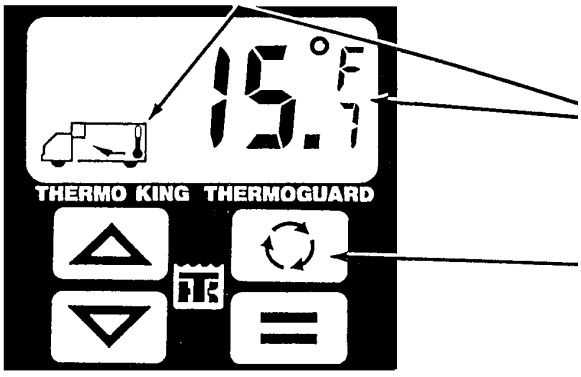


After 5 seconds the Standard Display will appear. This display remains on the screen during normal operation. The Standard Display is set to *Return Air Temperature* at the factory, however, the controller can be programmed to show Discharge Air, Return Air, or Setpoint as the Standard Display.



When the Thermo King unit is switched Off, it is normal for the display to remain On for about 30 seconds as it slowly fades.

NOTE: With the power Off or battery disconnected, all settings are saved in the controller memory and become active when the unit is switched On.



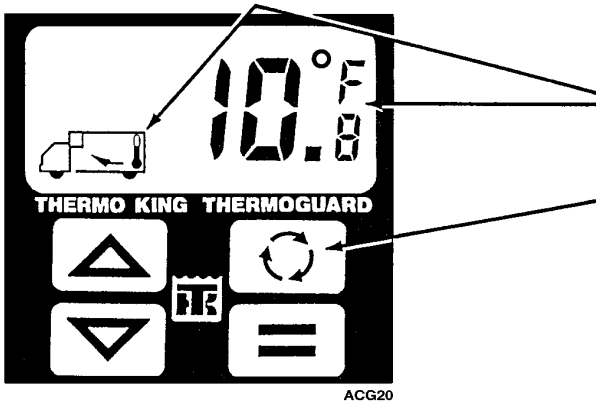
ACG19

Displaying Operating Data

During normal operation, the Standard Display is on the screen. *Return Air Temperature* is the factory Standard Display setting (this may be changed). Other operating data can also be displayed.

To view other operating data, repeatedly press and release the **SELECT** key.

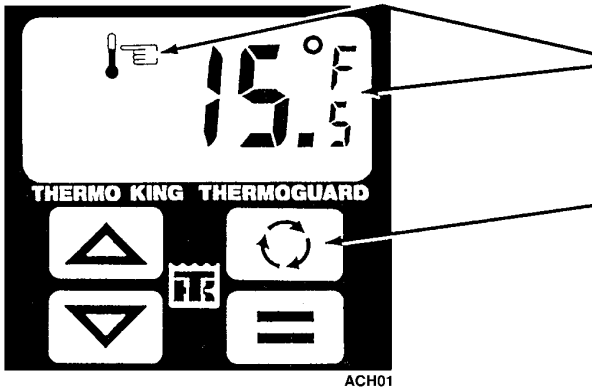
In addition to Return Air Temperature, the following data may be displayed:



ACG20

- Discharge Air Temperature (optional)

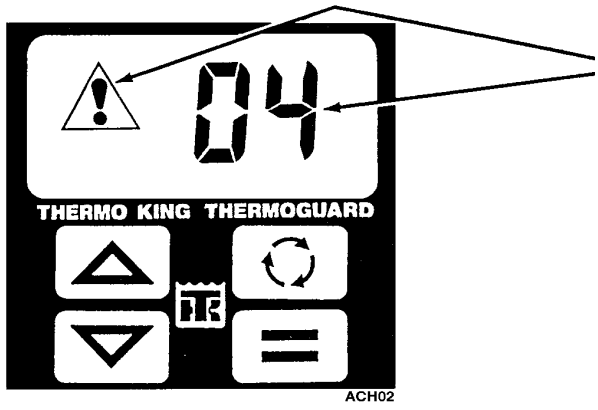
Press for next display.



ACH01

- Setpoint Temperature

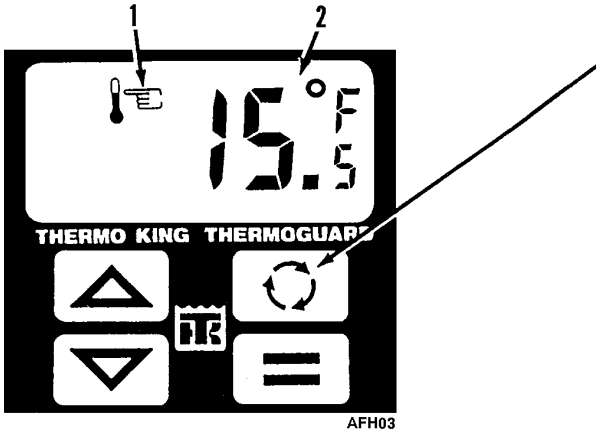
Press for next display.



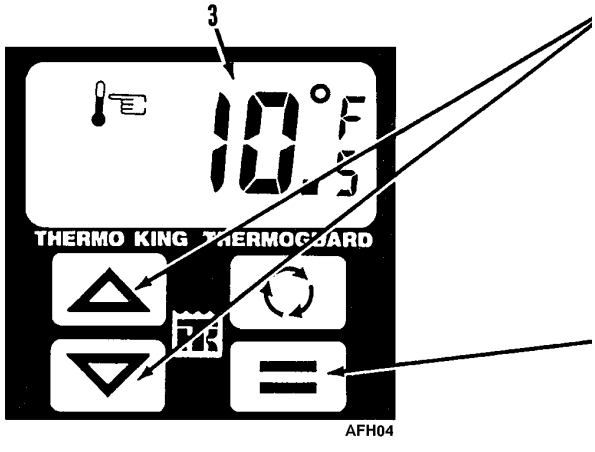
- Alarms

  (Can be displayed only when an alarm condition has been sensed by the controller).

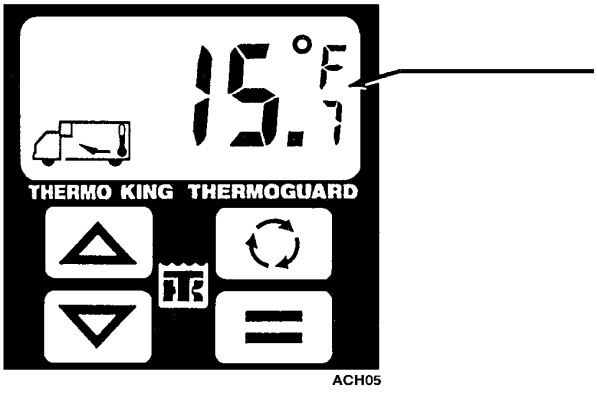
When viewing a display...If no keys are pressed, the Standard Display will automatically reappear on the screen in about 10 seconds.



AFH03



AFH04



ACH05

1. Setpoint Symbol
2. Setpoint Temperature
3. New Setpoint Temperature

Entering the Setpoint

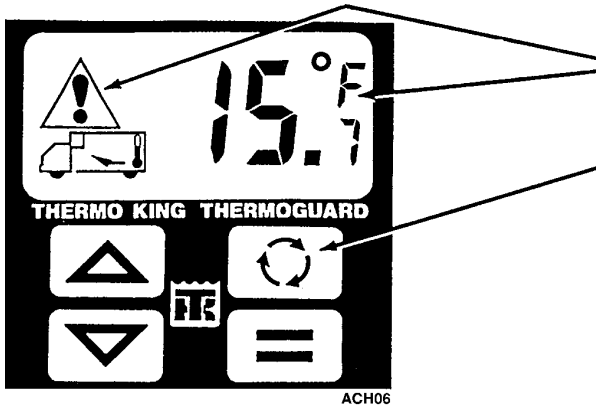
The setpoint temperature of the Thermo King unit can be easily and quickly changed. To change the setpoint:

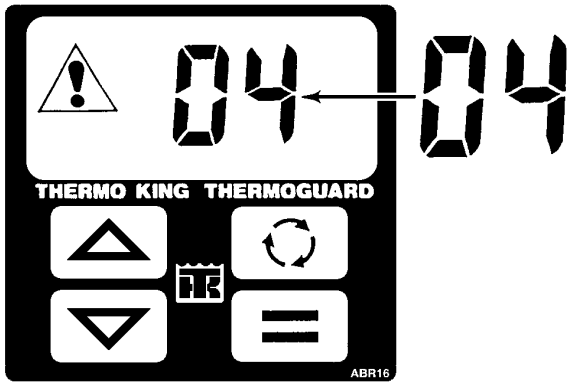
1. Press and release the **SELECT** key repeatedly until the setpoint symbol is on the screen.

2. Press the **UP** or **DOWN** key until the setpoint is at the correct temperature setting.
   - Pressing and releasing either key repeatedly will cause the temperature to change by .5 degree each key press.
   - Holding either key down will cause the temperature to scroll automatically, one degree at a time.

3. To enter the new setpoint into memory: Press and release the **ENTER** key *within 5 seconds*.
   - The display will blink once as the new setpoint is entered into memory.
   - The new setpoint will remain on the screen for about 5 seconds, then,
   - The standard screen will automatically appear.

CAUTION: If the ENTER key is not pressed within 5 seconds: the original setpoint will appear on the screen for 5 seconds, the standard screen will automatically appear, and the Thermo King unit will be controlled at the original setpoint.





Displaying and Clearing Alarm Codes

When the TG-V controller senses an alarm condition, a flashing alarm symbol appears on the display. A two digit alarm code is used to identify the type of alarm.

1. To display the alarm code, repeatedly press and release the **SELECT** key until the alarm screen is displayed.
   - If more than one alarm has been sensed, all alarm codes present will automatically alternate on the screen.
   - The following alarm codes are used:

     03 Return Air Sensor Failure
     The Return Air Sensor has failed or is disconnected.

     03A Return Air Sensor Failure
     The Return Air Sensor has failed or is disconnected (Zone 2).

     04 Discharge Air Sensor Failure (Optional)
     The Discharge Air Sensor has failed or is disconnected.

     14 Defrost Circuit Failure
     The unit is still in defrost after the end of the defrost time limit, indicating a defrost circuit failure.

     25 Battery Charging Alternator Failure
     Current output from the unit alternator is NOT being sensed.

     29 Defrost Initiation Failure
     This code indicates that the unit attempted to enter defrost three times in rapid succession indicating a shorted air switch, shorted manual defrost switch or other defrost circuit failure.

47Zone 2 Evaporator Defrost Circuit Failure
Zone 2 evaporator is still in defrost after end of the defrost time limit, indicating a defrost circuit failure (No. Rh circuit).

74 Cold Start or Checksum Error
Test In-Cab TG-V with tester P/N 204-83.

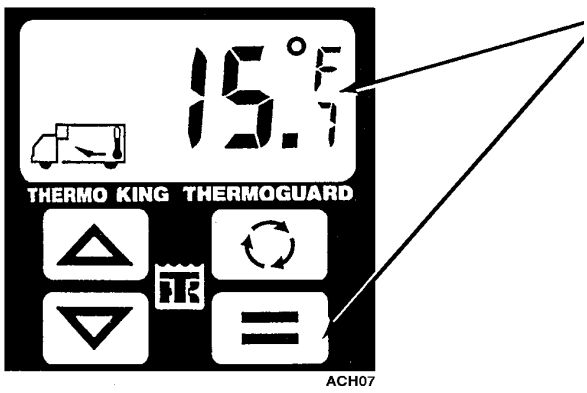
75 Microprocessor RAM Faulty
Test In-Cab TG-V with tester P/N 204-83.

76 Microprocessor EEPROM Faulty
Test In-Cab TG-V with tester P/N 204-83.

77 EPROM Faulty
Test In-Cab TG-V with tester P/N 204-83.

87 Field Test Error

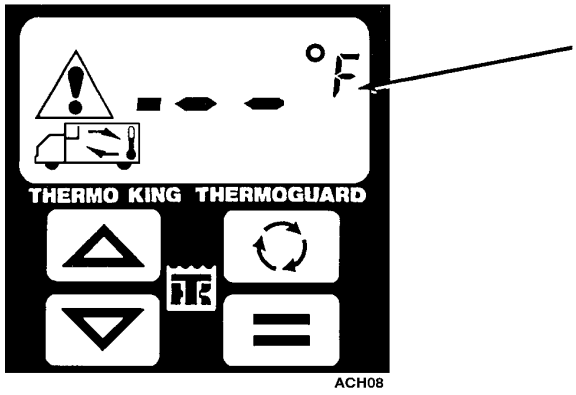
88 Microprocessor Failure
The TG-V has failed and must be replaced.



2. To clear the alarms, press the **ENTER** key while the alarm screen is showing. The alarms will clear and the Standard Display will appear on the screen.
   - Alarms may continue to appear as the unit operates if the alarm condition is not corrected.

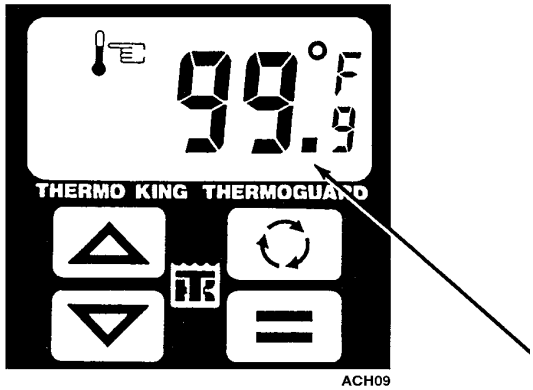
Additional Operating Information

Sensor Failure



ACH08

In addition to generating an alarm, the failure of a sensor will cause the display screen for that sensor to show a minus sign and dashes in place of temperature. The alarm symbol, the minus sign and the dashes will blink continuously.



ACH09

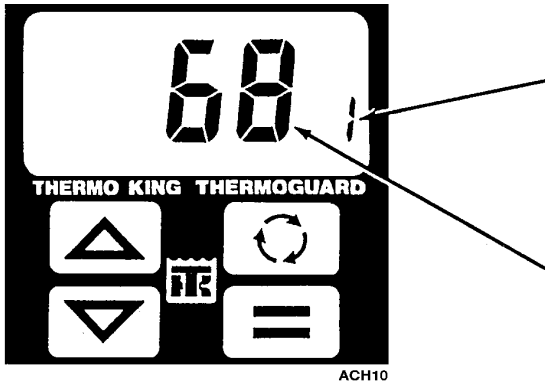
Temperatures Outside of Display Range

The Microprocessor Controller TG-V is capable of displaying temperatures ranging from -40 to 99.9 F (-40 to 37.8 C). A blinking temperature display of -40 or 99.9 F (-40 or 37.8 C) without an alarm symbol, indicates the unit is functioning normally but the temperature being sensed is outside of the display range of the controller.

Example: If the temperature in the cargo compartment were 110 F, the display would read 99.9 F (-37.8 C) and would blink continuously. The display would stop blinking once the temperature dropped below 99.9 F (-37.8 C).

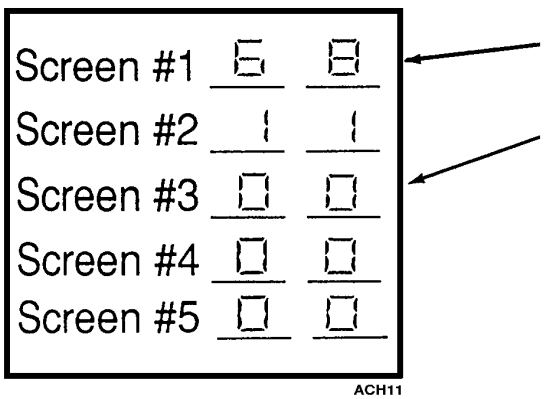
Guarded Access Mode

The TG-V controller is pre programmed at the factory to match the standard configuration and operating requirements of the unit.



Thermostat Set-Up Codes

Left Digit	Right Digit		Screen
	USA	EEC	
6	8	9	1
1	1	1	2
0	0	0	3
0	0	0	4
0	1	1	5



If the controller is being replaced, the programming set-up codes must be set to match the configuration of the unit.

The factory programming set-up codes can be found on the schematic and wiring diagrams for the unit. Special changes in the programming can be made for specific special applications.

Programming

Programming is done through the Guarded Access mode.

The Guarded Access mode consists of 5 screens numbered 1 through 5. Screen numbers are indicated by a 1/2 size digit.

The Microprocessor Controller is programmed by entering a two digit set-up code into each screen.

Set-up code 68 is the standard set-up code for Screen 1 on CD-II MAX (NAD) units.

Programming the controller requires the following:

- Choosing the desired set-up code for each screen.
- Entering the Guarded Access mode.
- Changing the set-up codes as required.

Choosing Set-up Codes

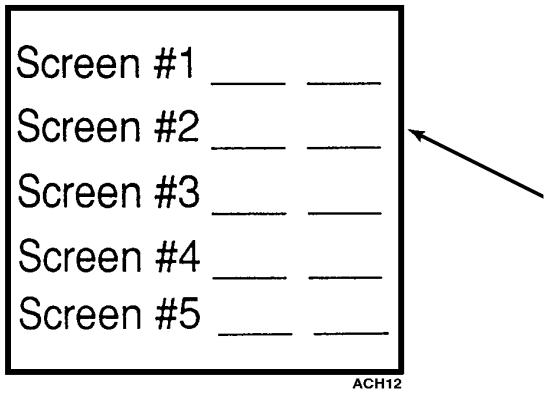
The standard set-up codes for the CD-II MAX are shown at the left.

NOTE: The set-up code for Screen 3 can be determined by checking the sensors themselves.

Each two digit set-up code can represent several operational settings of the Thermo King unit.

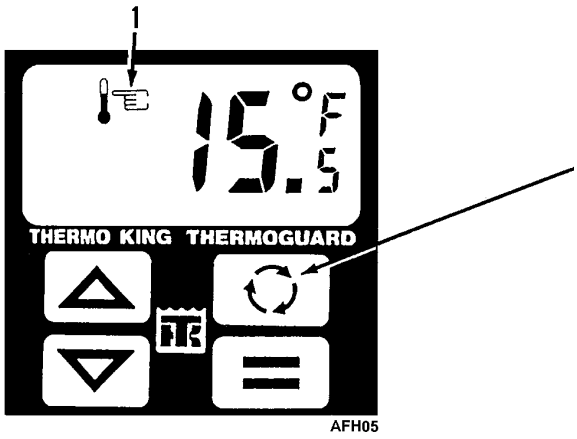
The factory programming set-up codes can be found on the schematic and wiring diagrams for the unit.

If the set-up codes are not available, they can be determined using information shown later in this chapter.



Before entering the Guarded Access mode or changing set-up codes:

1. Choose the set-up codes for each screen.
2. Write the set-up codes in the space provided or on a separate piece of paper.



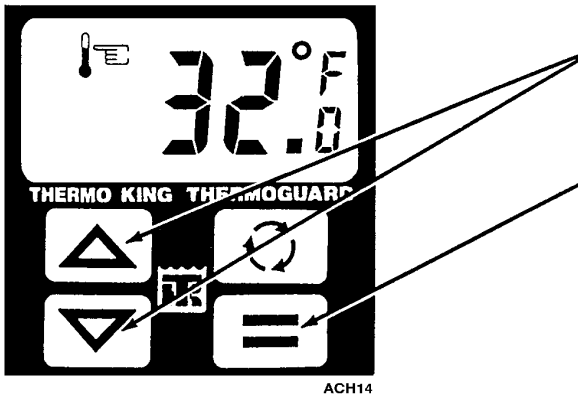
1. Setpoint Symbol

Entering the Guarded Access Mode

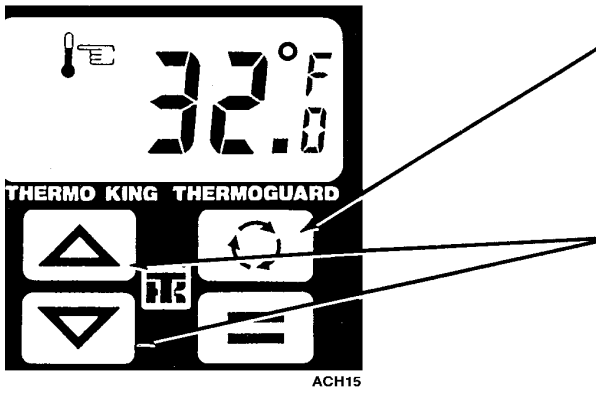
To get to the Guarded Access mode:

1. Press and release the **SELECT** key repeatedly until the setpoint symbol is on the screen.

   NOTE: Record the setpoint so that the unit may be returned to the original setting when programing is finished.



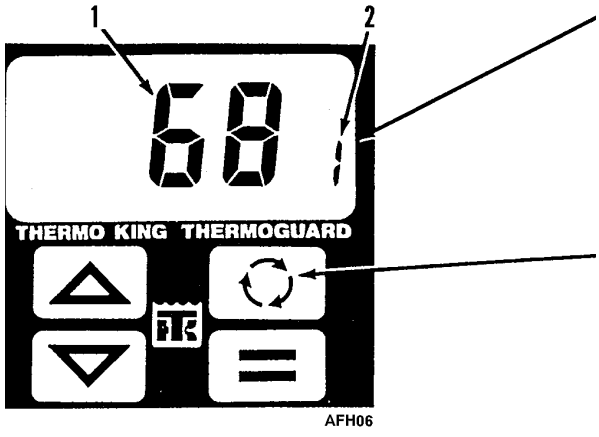
2. Press the **UP** or **DOWN** key until the setpoint is at exactly 32.0 F or 0.0 C.
3. Press and release the **ENTER** key within 5 seconds to enter the setpoint into the controller.



ACH15

4. Press the **SELECT** key until the setpoint symbol is again on the screen. However, this time, when the setpoint symbol comes on the screen, *Do Not* release the **SELECT** key, hold it down.

5. While holding down the **SELECT** key, press the **UP** key and the **DOWN** key *at the same time*.



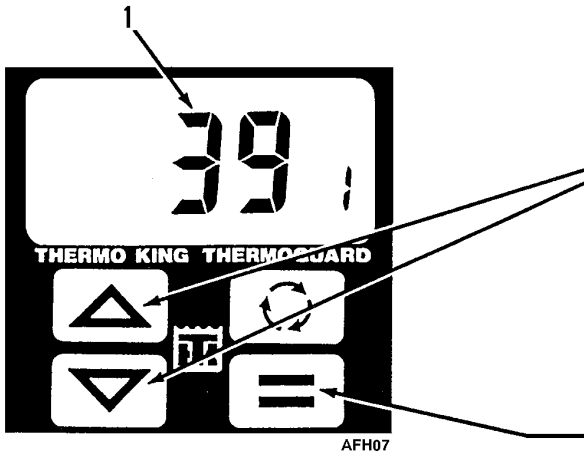
AFH06

1. Current Setup Code
2. Screen Number

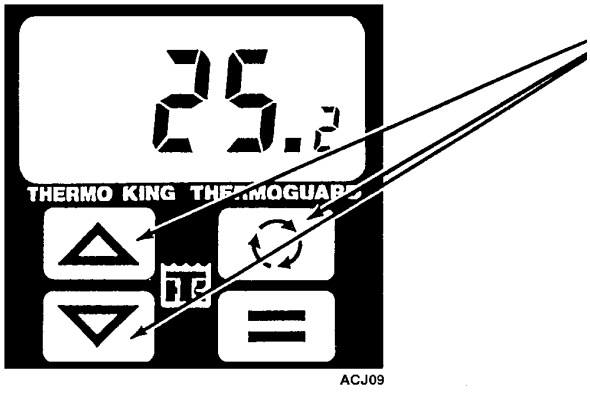
- Screen 1 in the Guarded Access mode will appear.

To select other Guarded Access screens, press and release the **SELECT** key until the desired screen is on the display.

If no keys are pressed, the Standard Display will automatically reappear on the screen in about 10 seconds.



1. New Set-up Code



Changing Set-Up Codes

To change the set-up code:

1. With a Guarded Access screen on the display, press the **UP** key or the **DOWN** key repeatedly until the desired code is on the screen.

   NOTE: Display digits cannot be set individually. The UP or DOWN key is used to "scroll" the display until the correct two digit code is on the screen.

2. To enter the new set-up code into memory:

   Press and release the **ENTER** key *within 5 seconds*.

   - The display will blink once as the new code is entered into memory.
   - The new code will remain on the screen for about 5 seconds and then,
   - The standard screen will automatically appear.

or

   - You may go to another Guarded Access screen by pressing and releasing the **SELECT** key within 5 seconds of entering the new code. To change the set-up code on other screens, repeat steps 1 and 2.

CAUTION: If the ENTER key is not pressed within 5 seconds: the original set-up code will appear on the screen for 5 seconds, the standard screen will automatically appear, and the controller will operate with the original set-up code for that screen.

NOTE: Remember to return the controller to the original setpoint when programming is finished.

Screen 1

The set-up code for Screen 1 represents a combination of the following seven settings:

1. **Save Elapsed Time**

   Elapsed time is the duration between the end of one Defrost cycle and the beginning of the next.

   The TG-V Microprocessor Controller has a built in defrost interval timer which can automatically initiate a Defrost cycle after a preset period of time has elapsed.

   When the Thermo King unit is switched Off, the defrost interval timer can be set to do one of two things:

   - It can save the time which has elapsed since the last defrost and continue on when the unit is restarted.
   - Or, it can reset and start timing again from the beginning.

   Example: Defrost interval time is set to 2 hours. The unit is switched Off after 1 hour (that is, a defrost interval of 1 hour has elapsed):

   - If the elapsed time *has* been saved; when the unit is turned back On, the timer could initiate defrost 1 hour later. The total interval is 1 hour of elapsed time plus 1 hour of time since the unit was turned On.
   - If the elapsed time *has not* been saved; when the unit is turned back On, the timer will reset and start timing again from the beginning. The timer could initiate defrost 2 hours from the time the unit was turned back On.

   The Microprocessor Controller should be set to save elapsed time:

   - In delivery applications where the unit will be turned On and Off before a normal defrost time has elapsed.
   - In units without an air switch.

   Elapsed time should *not* be saved in normal, over-the-road applications where the unit is run continuously and is not frequently turned Off and On.

   Settings:

   YES = Save elapsed time.

   NO = Do not save elapsed time.

2. **Defrost Terminate Time**

   If a Defrost cycle is not terminated automatically, the TG-V Microprocessor Controller terminates the Defrost cycle after the programmed period of time.

   Settings:

   30 minutes or 45 minutes.

3. High Speed Delay

   To save fuel when the cargo compartment temperature is in range, the TG-V Microprocessor Controller can delay high speed heat or high speed cool for 8 minutes.
   Settings:

   YES = Delay high speed operation for 8 minutes.

   NO = Do not delay high speed operation for 8 minutes.

   NOTE: In order for the High Speed Delay to operate, the 7K terminal must be used.

   NOTE: Low Speed heat is only available in Continuous Run operation. In CYCLE-SENTRY, the unit restarts and runs in High Speed Heat.

4. **High Speed Heat Lockout**

   To protect frozen foods, the TG-V can lockout high speed heat when the setpoint is below 15 F (-9.4 C).

   Settings:

   YES = Lockout high speed heat below 15 F (-9.4 C).

   NO = Do not lockout high speed heat below 15 F (-9.4 C).

5. **Fahrenheit/Celsius**

   The TG-V can display temperatures in either Fahrenheit or Celsius.

   Settings:

   F = Fahrenheit

   C = Celsius

   Directions for choosing the set-up codes for Screen 1 are on the next page.

6. **Discharge Sensor**

   When an optional discharge air sensor is connected to the TG-V, the discharge air temperature can be displayed.

   Settings:

   YES = Discharge sensor connected, display discharge air temperature.

   NO = Discharge sensor not connected, do not display discharge air temperature.

   NOTE: If the unit does not have a discharge air sensor, but the discharge sensor setting is set to "YES", the controller will display an alarm symbol and the alarm screen will show Alarm Code 04 (Discharge Air Sensor Faulty). Instead of showing a temperature, the discharge air screen will display dashes.

7. **Modulation Valve**

   The TG-V can control Thermo King units which are equipped with a modulation valve.

   Settings:

   YES = Unit has a modulation valve.

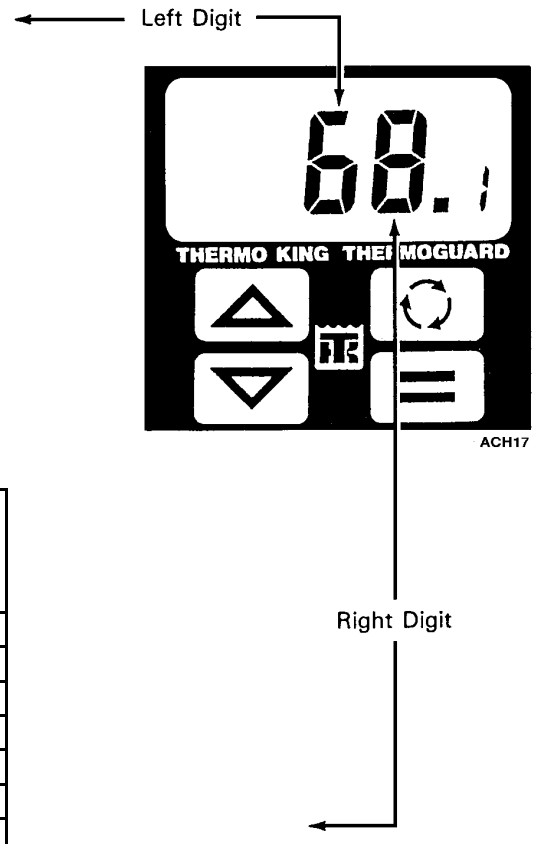
   NO = Unit does not have a modulation valve.

   NOTE: Units with a modulation valve must have a discharge air sensor connected to the controller.

   If the sensor is not connected, the controller will display an alarm symbol and the alarm display will show Alarm Code 04 (Discharge Air Sensor Faulty).

Set-up Code—Screen #1

Save Elapsed Time	Defrost Terminate Time	High Speed Delay	Code
No	30 min	No	0
No	30 min	Yes	1
No	45 min	No	2
No	45 min	Yes	3
Yes	30 min	No	4
Yes	30 min	Yes	5
Yes	**45 min**	**No**	**6**
Yes	45 min	Yes	7



Directions: To determine the two digit set-up code for Screen #1:

1. Select the code number that matches the correct combination of settings from the top table. This becomes the left digit.
2. Select the code number that matches the correct combination of settings from the bottom table. This becomes the right digit.

NOTE: Factory standard settings are in bold type.

High Speed Heat Lockout	Discharge Sensor	Modulation Valve	Fahrenheit /Celsius	Code
No	No	No	F	0
No	No	No	C	1
No	No	Yes	F	2
No	No	Yes	C	3
No	Yes	No	F	4
No	Yes	No	C	5
No	Yes	Yes	F	6
No	Yes	Yes	C	7
Yes	**No**	**No**	**F**	**8**
Yes	No	No	C	9
Yes	No	Yes	F	A
Yes	No	Yes	C	B
Yes	Yes	No	F	C
Yes	Yes	No	C	D
Yes	Yes	Yes	F	E
Yes	Yes	Yes	C	F

Screen #2

Defrost intervals are set with Screen #2. A defrost interval is the period of time between the end of one Defrost cycle and the beginning of the next.

During pull-down the defrost interval is 4 hours. Once the unit is in-range, the defrost interval becomes the interval set with this screen.

Defrost Time Interval Above Lockout

Sets the defrost interval for setpoint temperatures above 15 F (-9.4 C).

Settings:

2, 4, 6, 8, 10, 12, 14 or 16 hours.

Defrost Time Interval Below Lockout

Sets the defrost interval for setpoint temperatures below 15 F (-9.4 C).

Settings:

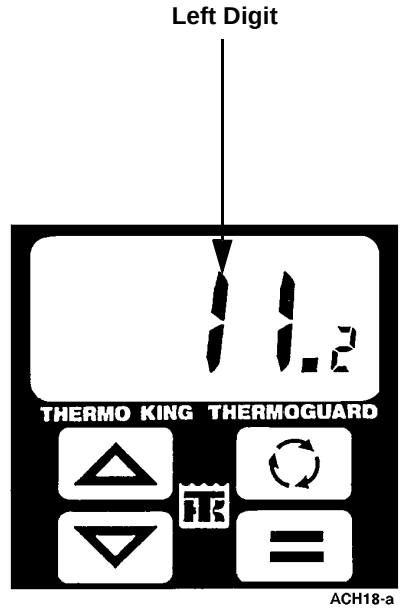
2, 4, 6, 8, 10, 12, 14 or 16 hours.

Directions for choosing the set-up codes for Screen #2 are on the next page.

NOTE: The 1 hour defrost interval is provided for checking the system and is not intended as a practical defrost interval.

Set-Up Code—Screen #2

Defrost Time Above Lockout	Code
2 Hours	0
4 Hours	**1**
6 Hours	2
8 Hours	3
10 Hours	4
12 Hours	5
14 Hours	6
16 Hours	7
1 Hour	8



Directions: To determine the two digit set-up code for Screen #2.

1. Select the code number that matches the correct setting from the top table. This becomes the left digit.
2. Select the code number that matches the correct setting from the bottom table. This becomes the right digit.

NOTE: Factory standard settings are listed in the wiring and schematic diagrams for each unit.

Defrost Time Below Lockout	Code
2 Hours	0
4 Hours	**1**
6 Hours	2
8 Hours	3
10 Hours	4
12 Hours	5
14 Hours	6
16 Hours	7
1 Hour	8

Screen #3

For accuracy, the Microprocessor Controller must be adjusted to match the unit sensors. That adjustment is done with Screen #3.

There are two types of sensors, graded and ungraded.

Graded sensors are measured and presorted at the factory into categories (grades) based on their electrical resistance. They are marked with grades 1 through 5. Graded sensors, regardless of grade number, are accurate to within ±.125 degrees.

Ungraded sensors are not sorted and therefore have a wider possible range of resistance. They do not have grading marks and are accurate to ±.6 degrees.

The TG-V Microprocessor Controller can be calibrated to work with either type of sensor.

For graded sensors, set the controller to match the grade of the sensor. Example: for a grade 4 sensor, the controller setting would be 4.

For ungraded sensors, set the controller to grade 0.

Directions for choosing the set-up codes for Screen #3 are on the next page.

Discharge Sensor Grade (Optional)

Matches controller operation to the grade of the discharge air sensor.

Settings:

Grades 0, 1, 2, 3, 4, or 5.

Return Sensor Grade

Matches controller operation to the grade of the return air sensor.

Settings:

Grades 0, 1, 2, 3, 4, or 5.

NOTE: An ungraded sensor can be partially graded by immersing the sensor in a good ice bath and then selecting various sensor grades until the return air (or discharge air) temperature reads 32.0 F (or 0.0 C). The sensor may then be accurate for freezing temperature but may not be accurate towards either extreme of the controller range.

NOTE: When return air and discharge air sensors are used with a modulation control valve, graded sensors must be used. Without modulation, the use of graded sensors is optional.

NOTE: The return air sensor is the primary control sensor and must be connected at all times.

Set-Up Code—Screen #3

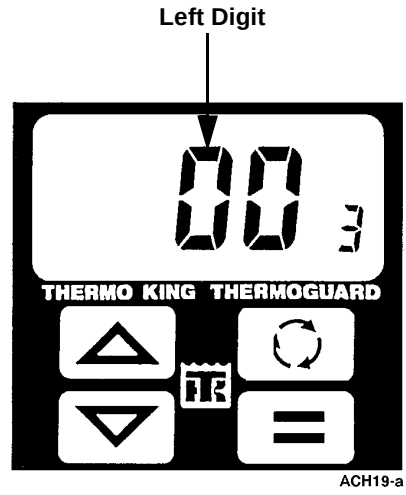
Discharge Sensor Grade	Code
0	**0**
1	1
2	2
3	3
4	4
5	5

Directions: To determine the two digit set-up code for Screen #3.

1. Select the code number that matches the discharge air sensor grade from the top table. This becomes the left digit.
2. Select the code number that matches the return air sensor grade from the bottom table. This becomes the right digit.

NOTE: Factory standard settings are listed in the wiring and schematic diagrams for each unit.

Return Sensor Grade	Code
0	**0**
1	1
2	2
3	3
4	4
5	5



ACH19-a

Screen #4

The “Standard Display” is set with Screen #4.

Standard Display

The Standard Display normally appears on the screen. The screen automatically returns to the Standard Display when viewing of other screens is complete and no keys are pressed for about 10 seconds.

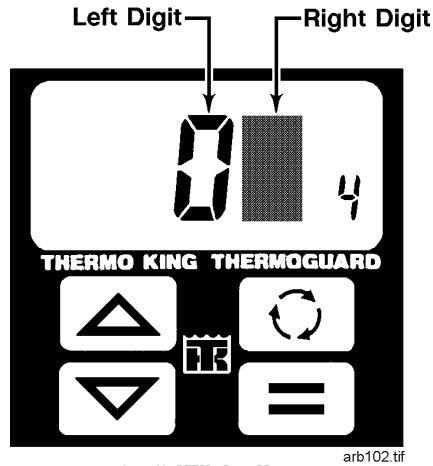
Settings:

- Return Air Temperature
- Setpoint Temperature
- Discharge Air Temperature (optional).

NOTE: This screen is available only when the Discharge Sensor setting (Screen #1) is set to YES.

- Alternate between Return Air Temperature and Setpoint Temperature (Return Air 30 seconds, Setpoint 5 seconds).
- Alternate between Discharge Air Temperature and Setpoint Temperature (Discharge Air 30 seconds, Setpoint 5 seconds). This screen is available only when the Discharge Sensor setting (Screen #1) is set to YES, and the discharge sensor is installed.

NOTE: This screen is available only when the Discharge Sensor setting (Screen #1) is set to YES.



w/o “dF” Indicator

NOTE: The Left Digit is always zero.

Directions: To determine the two digit set-up code for Screen #4.

- Select the code number that matches the correct Standard Display. The LEFT digit of the code number becomes the LEFT digit on the screen. The RIGHT digit of the code number becomes the RIGHT digit on the screen.

NOTE: Factory standard settings are listed in the wiring and schematic diagrams for each unit.

Defrost Model Display

The purpose of this modification is to allow the default display to include a periodic indication that the system is in the Defrost mode.

The new selections possible on Guarded Access Screen 4 are as follows:

Default Display	Screen 4 Selection	
	Left Digit Code	Right Digit Code
Return Air Temperature	0	0
Setpoint Temperature	00	1
Discharge Air Temperature	00	2
Alternate Return Air Temperature and Setpoint Temperature	00	3
Alternate Discharge Air Temperature and Setpoint Temperature	00	4

Screen #5

The set-up code for Screen #5 represents a combination of the following settings:

High Speed (Cool) Pull-Down

This feature provides faster temperature Pull-Down for critical cargos.

At start-up:

- In Continuous Run or CYCLE-SENTRY, to reduce the time needed to bring cargo box temperature down to setpoint (Pull-Down), the unit will operate in High Speed Cool until the return air temperature reaches setpoint.
- Once the return air temperature reaches setpoint:
    - Units operating in Continuous Run will switch to low speed cool for five seconds then to low speed heat. The unit will then cycle between Low Speed Heat and Low Speed Cool as necessary.
    - Units operating in CYCLE-SENTRY will switch to low speed cool for five seconds to allow Battery Sentry to check the charging current. If the battery is charged, the unit is not in defrost and the engine block is sufficiently warm, the unit will shut-down, restarting as necessary. If not, the unit will continue to run switching from low speed heat to low speed cool as necessary.

As operation continues:

- In Continuous Run or CYCLE-SENTRY, if setpoint has not been reached in eight minutes while running low speed cool, the unit will switch to high speed cool, driving the return air temperature back down to setpoint.
- If the unit has been running in low speed cool for less than eight minutes and the return air temperature reaches setpoint:
    - Units operating in Continuous Run will switch to low speed heat changing to low speed cool as necessary.
    - Units operating in CYCLE-SENTRY will shut down, restarting as necessary.
- In Continuous Run or CYCLE-SENTRY, if the return air temperature reaches 5.1 F (2.8 C) degrees above setpoint, the unit will immediately switch to high speed cool, unless the Fuel Saver 8 minute Delay to High Speed is active.

NOTE: High Speed Pull-Down will be inactive in units with modulation that are operating in Continuous Run above 15 F (-9C).

High Speed Pull-Down Fresh

The controller can initiate a High Speed Pull-Down to setpoint of fresh loads above 15 F (-9.4 C).

Settings:

YES = Enable High Speed Pull-Down to setpoint.

NO = Normal operation. Do not enable high speed pull-down to setpoint.

High Speed Pull-Down Frozen

The controller can initiate a High Speed Pull-Down to setpoint of frozen loads at or below 15 F (-9.4 C).

Settings:

YES = Enable High Speed Pull-Down to setpoint.

NO = Normal operation. Do not enable High Speed Pull-Down to setpoint.

2 Minute Low Speed Start (Continuous Run only)

This setting allows the engine to warm-up by running it in low speed for 2 minutes when the unit is first started. After 2 minutes, the unit will resume normal operation.

This setting functions only while the unit is operating in Continuous Run.

Settings:

YES = Enable 2 minute low speed start.

NO = Normal operation. Do not enable 2 minute low speed start.

Reduced Setpoint Range

Smaller truck units are not designed to operate with a setpoint range of -20 to 80 F (-28 to 28 C). For these units the setpoint range must be reduced to 0 to 80 F (-18 to 28 C).

This setting is programmed at the factory. Change it only when replacing the controller, and then only to the original factory setting for your unit.

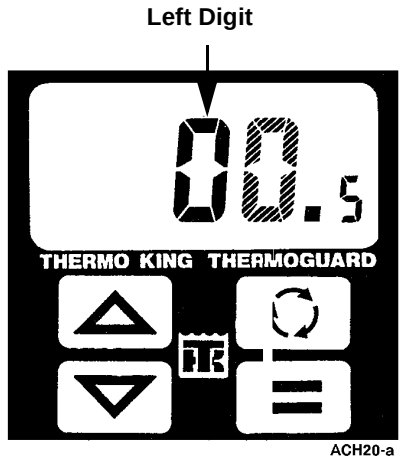
Settings:

YES = Reduce setpoint range to 0 to 80 F (-18 to 28 C).

NO = Do not reduce setpoint range.

Set-Up Code—Screen #5*

Code
0



ACH20-a

Directions: To determine the two digit set-up code for Screen #5:

1. Left digit code number is always 0 for this screen.
2. Select the code number that matches the correct combination of settings from the bottom table. This becomes the right digit.

NOTE: Factory standard settings are listed in the appropriate wiring and schematic diagrams for each unit.

High Speed Pull Down Fresh	High Speed Pull Down Frozen	2 Minute Low Speed Start*	Reduced Setpoint Range	Code
No	No	No	F	0
No	No	No	Yes	1
No	No	Yes	No	2
No	No	Yes	Yes	3
No	Yes	No	No	4
No	Yes	No	Yes	5
No	Yes	Yes	No	6
No	Yes	Yes	Yes	7
Yes	No	No	No	8
Yes	No	No	Yes	9
Yes	No	Yes	No	A
Yes	No	Yes	Yes	b
Yes	Yes	No	No	C
Yes	Yes	No	Yes	d
Yes	Yes	Yes	No	E
Yes	Yes	Yes	Yes	F

* Functions in Continuous Run only

In-Range Temperature Differential Setting

The In-Range Temperature Differential Setting is set with Screen 5. This setting determines the range used in monitering in-range and out of range conditions.

The following settings are available for Fahrenheit or Celcius readouts:

- Fahrenheit: 0.0 F (OFF), 6, 10, 14, and 18 degrees
- Celsius: 0.0 F (OFF), 3, 6, and 10 degrees

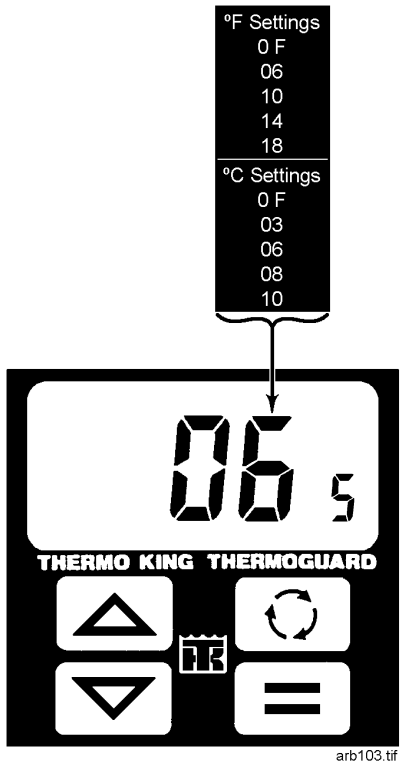


Figure 9: In-Range Temperature Differential Setting

Directions:

To determine the setting for Screen 5, choose the temperature differential desired for the in-range temperature interval.

Example:

To set an in-range temperature differential of 6 degrees above and below the setpoint, select the number 6.

NOTE: The settings available automatically correspond to the scale (F or C) chosen in Display 1.

Testing the TG-V Thermostat

Tools and Materials Required for Testing

1. Volt/ohm meter capable of accurately reading 1/100 volt increments.
2. Jumper Wires
3. Three Relays, Part No. 44-5847
4. One 12 Vdc Power Supply
5. Mercury Thermometer

TG-V Calibration

The TG-V thermostat is permanently calibrated, and no attempt should be made to recalibrate it. The thermostat module is a non-serviceable item and repairs should not be attempted. If the thermostat is found to be defective, replace it.

Ice-Water Bath Preparation

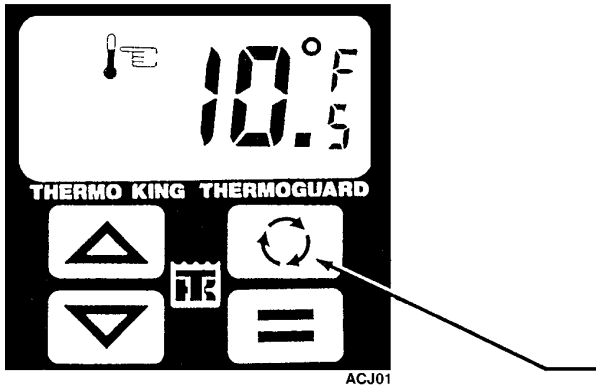
1. Fill an insulated container full of ice. Add enough water to cover the top of the ice during the test procedure.
2. Remove the sensor bulb from the unit or use a known good sensor for testing the thermostat module.
3. Stir the ice-water bath for one minute or until stabilized at 32 F (0 C).
4. Monitor the ice-water bath temperature with a mercury thermometer during testing to ensure test accuracy.

NOTE: Before testing a questionable thermostat module, it is a good idea to check the thermostat sensor first.

Sensor Test

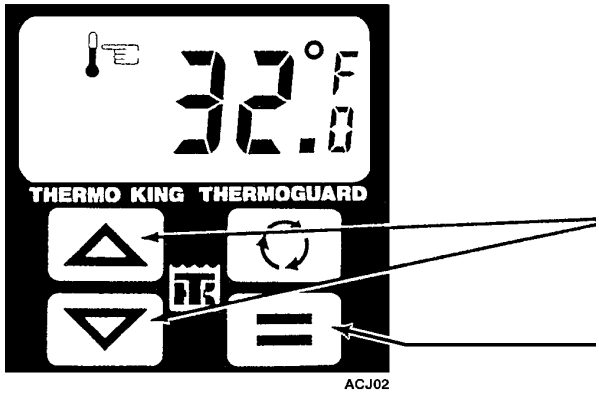
1. Visually check the bulb end, lead, and terminal end of the sensor. Make sure that it is not damaged.
2. Using an ohmmeter capable of reading at least 4000 ohms, check resistance between the sensor leads.
3. Sensor resistance should be approximately 3000 to 3500 ohms. Use the following method to give the sensor a more accurate test:
   a. Cool the sensor down to 32 F (0 C) and check the resistance—reading should be 3266 ± 3.4 ohms.
   b. Warm the sensor up to 70 F (21.1 C) and check the resistance—reading should be 3450 ± 6.9 ohms.
4. If the sensor does not meet specifications, replace it.
5. If the sensor does meet specifications, proceed to TG-V thermostat bench test.

Preparing TG-V Module for Bench Test



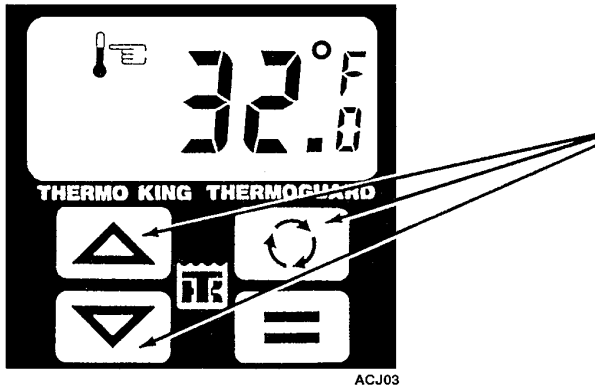
ACJ01

1. Place the unit On/Off switch in the On position. (If the thermostat module is out of the unit, this can be accomplished by connecting a 12 Vdc power source to the 8 and CH terminals, 8 is connected to positive (+) and CH is connected to negative (-).
2. Press and release the **SELECT** key repeatedly until the setpoint symbol is on the screen.



ACJ02

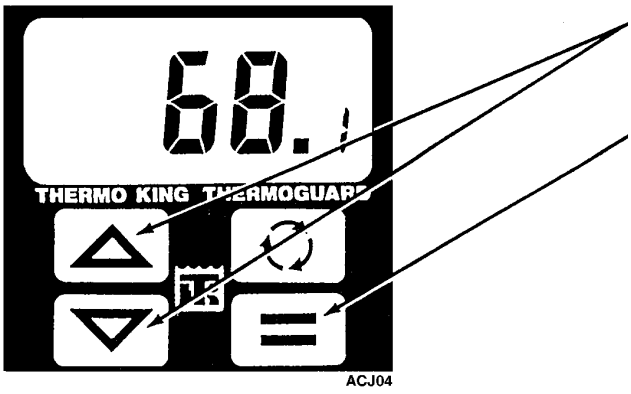
3. Press the **UP** and **DOWN** key until the setpoint is at exactly 32 F or 0 C.
4. Press the **ENTER** key (within 5 seconds) to enter this setpoint.



ACJ03

5. With the setpoint temperature at 32 F or 0 C, press the **UP** key, the **DOWN** key and the **SELECT** key *at the same time*.
   - Screen #1 in the Guarded Access Programming mode will appear.

   NOTE: Pressing the three keys at the same time can be difficult. If it does not work the first time, return to the setpoint screen with the setting at 32 F or 0 C and try again. It may take several attempts.



6. Press the **UP** or **DOWN** key until the set-up code on Screen #1 reads 68.

7. Press the **ENTER** key.

If no keys are pressed, the Standard Display will automatically reappear on the screen in about 10 seconds.

TG-V Module Bench Test

1. Place the main On/Off switch in the Off position.
2. Disconnect all of the wires from the thermostat module.
3. Connect a known good sensor (yellow jacketed) to the terminals labelled SN on the rear of the thermostat module.
4. To obtain accurate voltage readings during the thermostat module checkout, circuits 10T and 14T must be tested under normal load. This is provided by connecting two Bosch relays (Part No. 44-5847) as follows:

   Connect pin 86 of two relays to the negative (-) terminal of a 12 Vdc power source. Connect pin 85 of one relay to the 10T terminal to simulate the speed relay. Connect pin 85 of the second relay to the 14T terminal to simulate the heat relay.
5. Place the sensor bulb in a 32 F (0 C) ice bath.
6. Connect the positive (+) 12 Vdc power source on the 8 terminal. Connect the negative (-) power source to the CH terminal.
7. Check for voltage between 8 and CH. Make sure approximately 12 volts is present.

   NOTE: Due to the accuracy of the TG-V module, the digital readout may read a few tenths of a degree higher than 32 F (0 C).
8. Set the thermostat module setpoint to 24 F (4.4 C). The thermostat is now in high speed cool.
   a. Check for voltage between terminals 10T and CH. 12 volts should be present. The speed relay should be energized.
   b. Check for voltage between terminals 14T and CH. Zero volts should be present. The heat relay should be de-energized.
9. Set the thermostat module setpoint to 29 F (-1.7 C). The thermostat is now in low speed cool.
   a. Check for voltage between terminal 10T and CH. Zero volts should be present. The speed relay should be de-energized.
   b. Check for voltage between terminals 14T and CH. Zero volts should be present. The heat relay should be de-energized.
10. Set thermostat module setpoint to 33 F (0.6 C). The thermostat is now in low speed heat.
    a. Check for voltage between terminals 10T and CH. Zero volts should be present. The speed relay should be de-energized.
    b. Check for voltage between terminals 14T and CH. 12 volts should be present. The heat relay should be energized.
11. Set the thermostat module setpoint to 36 F (2.2 C). The thermostat is now in high speed heat.
    a. Check for voltage between terminals 10T and CH. 12 volts should be present. The speed relay should be energized.
    b. Check for voltage between terminals 14T and CH. 12 volts should be present. The heat relay should be energized.
12. Turn Off the power to the thermostat module.
13. Place a jumper wire from the 8 terminal on thermostat module to the 7K terminal on the thermostat module.
14. Turn On the power to the thermostat module.
15. Set thermostat module setpoint to 33 F (0.6 C). The thermostat module should now be in low speed heat. (12 volts present on terminal 14T, zero volts present on terminal 10T). Leaving the jumper from the 8 terminal to the 7K terminal in place, set the thermostat module setpoint to 36 F (2.2 C).

16. Check voltage on 14T and 10T terminals.
    a. Check for voltage on terminal 14T. 12 volts should be present. The heat relay should be energized.
    b. Check for voltage on terminal 10T. Zero volts should be present. The speed relay should be de-energized. The thermostat module is in the eight minute High Speed Lockout mode of operation.
17. At the end of eight minutes, the thermostat module should automatically switch to high speed heat. Check the voltage at terminal 10T after the eight minute interval. 12 volts should be present.
18. Connect pin 86 of the third relay to the 11 terminal in order to simulate the defrost relay. Connect pin 85 of this relay to the positive (+) terminal of the power source.
19. Place a jumper between the 12 terminal and the negative (-) terminal of the power supply. Place another jumper between the 12 terminal and the 11 terminal. The relay should energize.
20. Remove the jumper between the 12 terminal and the 11 terminal. The relay should remain energized.
21. Remove the jumper between the 12 terminal and the negative (-) terminal of the power supply. The relay should de-energize.

TG-V Terminal Voltage Chart

Voltages must be checked with the yellow jacketed sensor hooked across the SN terminals and the bulb placed in a 32 F (0 C) ice-water bath.

		HSC Setpoint 24 F	LSC Setpoint 29 F	LSH Setpoint 33 F	HSH Setpoint 36 F
	8	12 Vdc	12 Vdc	12 Vdc	12 Vdc
	CH	0 Vdc	0 Vdc	0 Vdc	0 Vdc
	29	0 Vdc	0 Vdc	0 Vdc	0 Vdc
	10T	12 Vdc	0 Vdc	0 Vdc	12 Vdc
	14T	0 Vdc	0 Vdc	12 Vdc	12 Vdc
Return Air Sensor	SN	—	—	—	—
	SN	—	—	—	—
	HFL	0 Vdc	0 Vdc	0 Vdc	0 Vdc
	HLO	0 Vdc	0 Vdc	0 Vdc	0 Vdc
	38	0 Vdc	12 Vdc	12 Vdc	0 Vdc
	7T	0 Vdc	0 Vdc	0 Vdc	0 Vdc
	SP	1.95 Vdc	2.00 Vdc	2.04 Vdc	2.07 Vdc
	12	12 Vdc	12 Vdc	12 Vdc	12 Vdc
	11	12 Vdc	12 Vdc	12 Vdc	12 Vdc
	HGV	0 Vdc	0 Vdc	0 Vdc	0 Vdc
	7K	0 Vdc	0 Vdc	0 Vdc	0 Vdc
MOD	(-)	0 Vdc*	0 Vdc*	0 Vdc*	0 Vdc*
	(+)	0 Vdc*	0 Vdc*	0 Vdc*	0 Vdc*
Disc	8B	0 Vdc	0 Vdc	0 Vdc	0 Vdc
	Sensor	—	—	—	—
	Sensor	—	—	—	—

See note below.

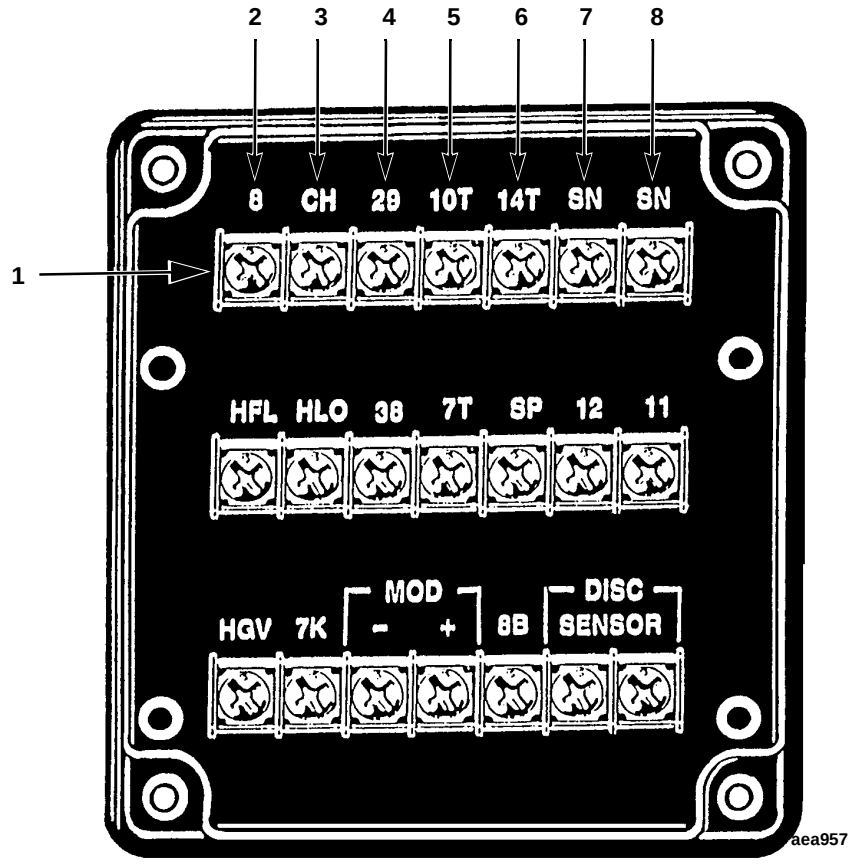
HSC - High Speed Cool

LSC - Low Speed Cool

LSH - Low Speed Heat

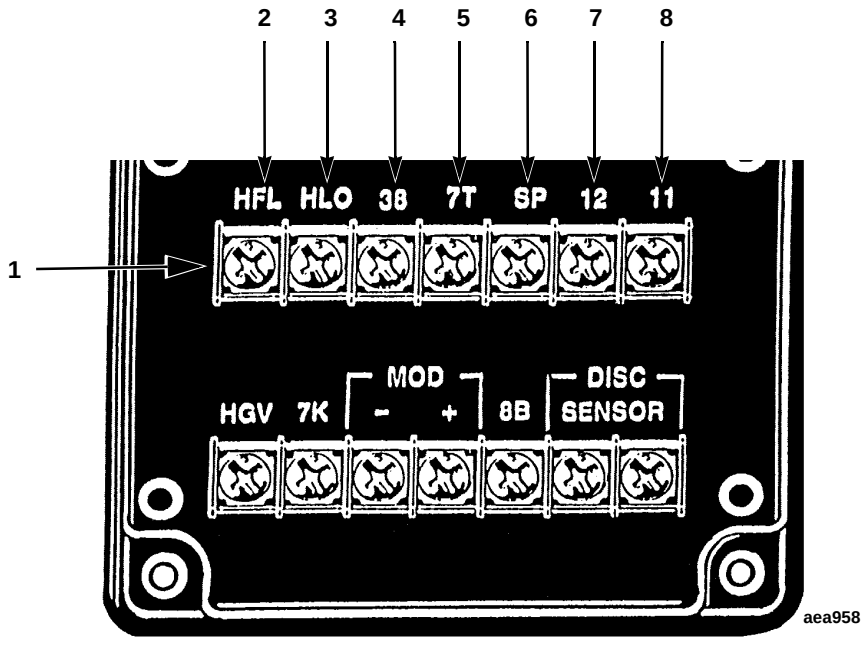
HSH - High Speed Heat

TG-V Terminal Identification



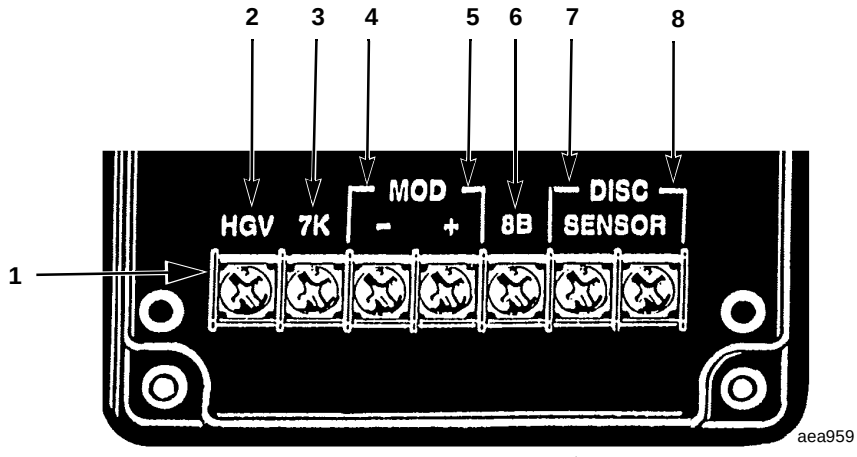
1. Basic Terminal Functions
2. (8) Supply Voltage From Unit To Thermostat Module
3. (Ch) Thermostat Module Ground Circuit
4. (29) Force To High Speed (Input) During Defrost
5. (10t) Applies Voltage To Speed Relay Coil When Calling For High Speed
6. (14t) Applies Voltage To Heat Relay Coil When Calling For Heat
7. (Sn) Connects One Lead Of The Return Air Sensor To Thermostat
8. (Sn) Connects Other Lead Of The Return Air Sensor To Thermostat

TG-V Terminal Identification



1. Specialized Terminal Functions
2. (Hfl) Force Heat Lockout
3. (Hlo) Heat Lockout Output
4. (38) In-range Output
5. (7t) Force High Speed Cool
6. (Sp) Setpoint Output
7. (12) Defrost Circuit
8. (11) Defrost Circuit

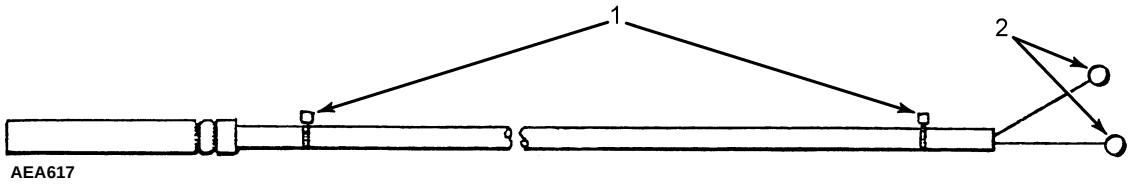
TG-V Terminal Identification



1. Specialized Terminal Functions
2. (Hgv) Hot Gas Bypass Valve
3. (7k) Accumulative Defrost Time And High Speed Delay Input
4. (-) Output To Modulation Valve Not Connected To Ch Ground
5. (+) Output To Modulation Valve
6. (8b) CYCLE-SENTRY Is In Operation (Input)
7. (Disc Sensor) Connects One Lead Of Discharge Air Sensor To Thermostat
8. (Disc Sensor) Connects Other Lead Of Discharge Air Sensor To Thermostat

Sensor Test

1. Visually check the bulb end, lead, and terminal end of the sensor. Make sure that it is not damaged.
2. Using an ohmmeter capable of reading at least 4000 ohms, check the resistance between the sensor lead terminals.
3. Sensor resistance should be approximately 3000 to 3500 ohms. Use the following method to give the sensor a more accurate test:
   a. Cool the sensor down to 32.0 F (0.0 C) and check the resistance. The reading should be 3266 ± 3.4 ohms.
   b. Warm the sensor up to 70.0 F (21.1 C) and check the resistance. The reading should be 3450 ± 6.9 ohms.
4. If the sensor does not meet specifications, replace it.



1.	Band Wraps—if Used, The Return Air Sensor Has Yellow Band Wraps And The Discharge Air Sensor Has Red Band Wraps.
2.	Sensor Lead Terminals

Figure 10: Sensor

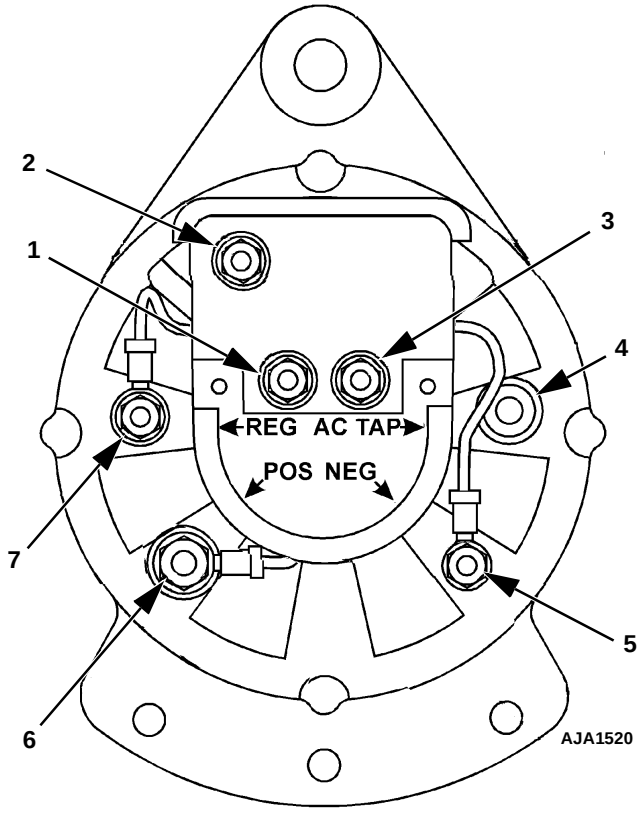
Alternator (Prestolite)

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.

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

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



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 11: Prestolite Terminal Locations

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. Set the unit for Continuous Run operation and place the On/Off switch in the Off position.
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 2 circuit.
5. Set the unit for continuous run operation and place the main On/Off switch in the On position.
6. Wait 20 seconds for the unloading timer to de-energize the unloading relay and check the voltage at the EXC terminal on the alternator. Battery voltage must be present. If not, check the EXC circuit.
7. Attach a clamp-on ammeter to the 2A wire connected to the B+ terminal on the alternator.
8. Connect a voltmeter between the B+ terminal and a chassis ground.
9. Start the unit and run it in high speed.
10. 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.

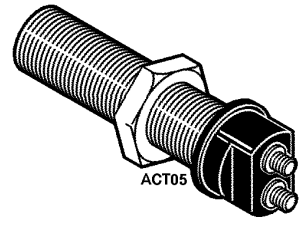


Figure 12: Flywheel (RPM) Sensor

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

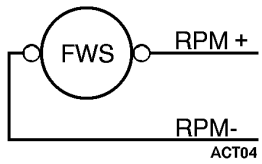


Figure 13: RPM+ and RPM- Wires

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.

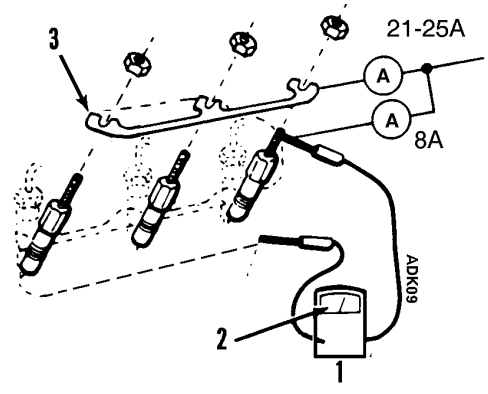
If the unit is not available, an alternate less reliable test may be performed as follows:

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 14: 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.

Engine Reset Switch

The engine is protected by a manual reset switch. The reset switch is attached to a two sensors. One sensor switch is in the engine oil system, the other is in the engine cooling system.

If either sensor switch is grounded due to an abnormal condition (low oil pressure, or high water temperature), the reset switch will trip and stop the engine in about 40 seconds.

The reset switch must be replaced if it is defective.

Conditions that cause the reset switch to trip:

- Engine coolant (water) temperature over 220 F (104 C).
- Engine oil pressure below 10 psig (69 kPa).
- Lack of fuel to the engine. The low oil pressure switch will cause the reset switch to trip after the engine stops.

NOTE: If the On/Off switch(es) are in the On position, if the CYCLE-SENTRY switch is in the Cont Run position, and if the engine is not running; the low oil pressure switch will cause the reset switch to trip.

- High pressure in the refrigeration system. The low oil pressure switch will cause the reset switch to trip after the high pressure cutout stops the engine.
- Reset switch becomes defective. The switch may get to a point where it will open due to vibration.
- A ground fault in the 20 or 20A wires to the sensor switches is also a possible cause.

NOTE: A ground or shorter circuit in the electrical system does not cause the reset switch to pop out.

Low Oil Pressure Switch (LOP)

The engine oil pressure should rise immediately after the engine is started. The LOP will trip the reset switch and stop the engine if the oil pressure drops below 10 ± 2 psig (69 ± 14 kPa). A continuity tester is needed to check the LOP.

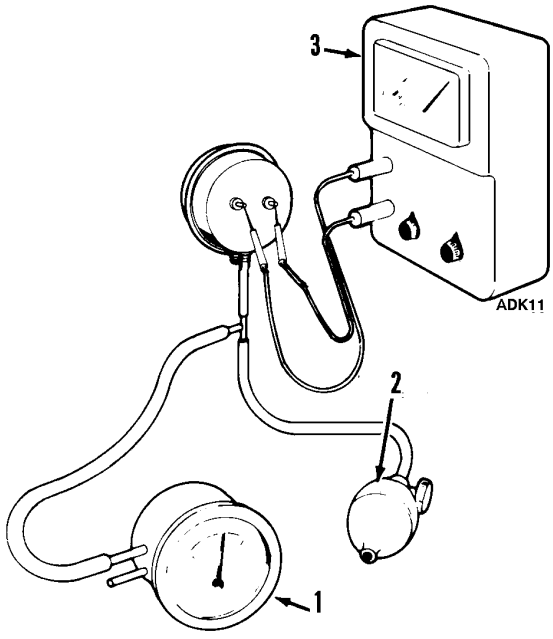
1. Remove the 20A wire from the LOP.
2. The continuity tester should indicate a complete circuit between the terminal and ground.
3. Start the engine. The tester should show an open circuit between the terminal and ground.

Repair consists of replacing the LOP.

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.

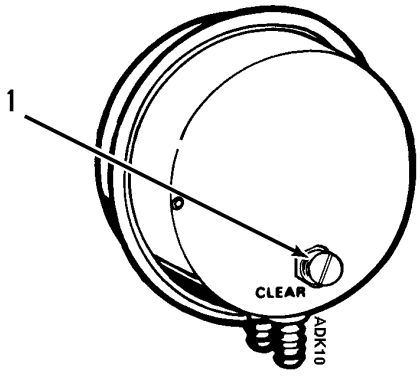
1. Remove plastic sensing tubing from both sides of the defrost air switch.
2. Disconnect one wire at switch terminal. Connect test light or continuity tester to the two terminals used on the switch.
3. Install test equipment (see Tool Catalog) onto the hose fitting on the side of the air switch stamped 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 15: 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 16: 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-II MAX Units Equipped with a Three-Phase Electric Motor and a Phase Converter That Operates on Single-Phase Power

MD-II MAX units that are ordered with the single-phase 220 volt electric standby option are equipped with a three-phase electric motor and a phase conversion system. This electric motor is the same 5/4.2 hp (3.7/3.1 kW) motor used in MD-II MAX units with a three-phase electric standby 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) on these single-phase units. 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 phase conversion system itself 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.

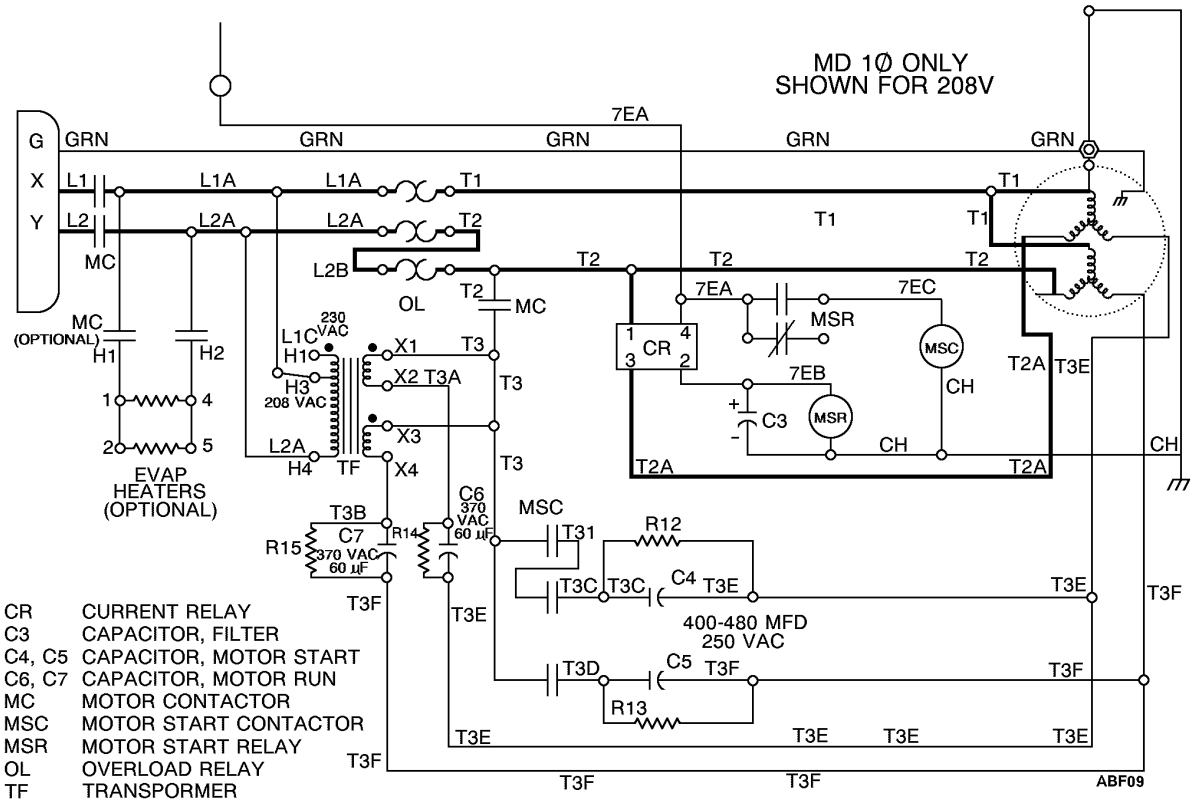


Figure 17: First and Second-Phase Connections

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

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.

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.

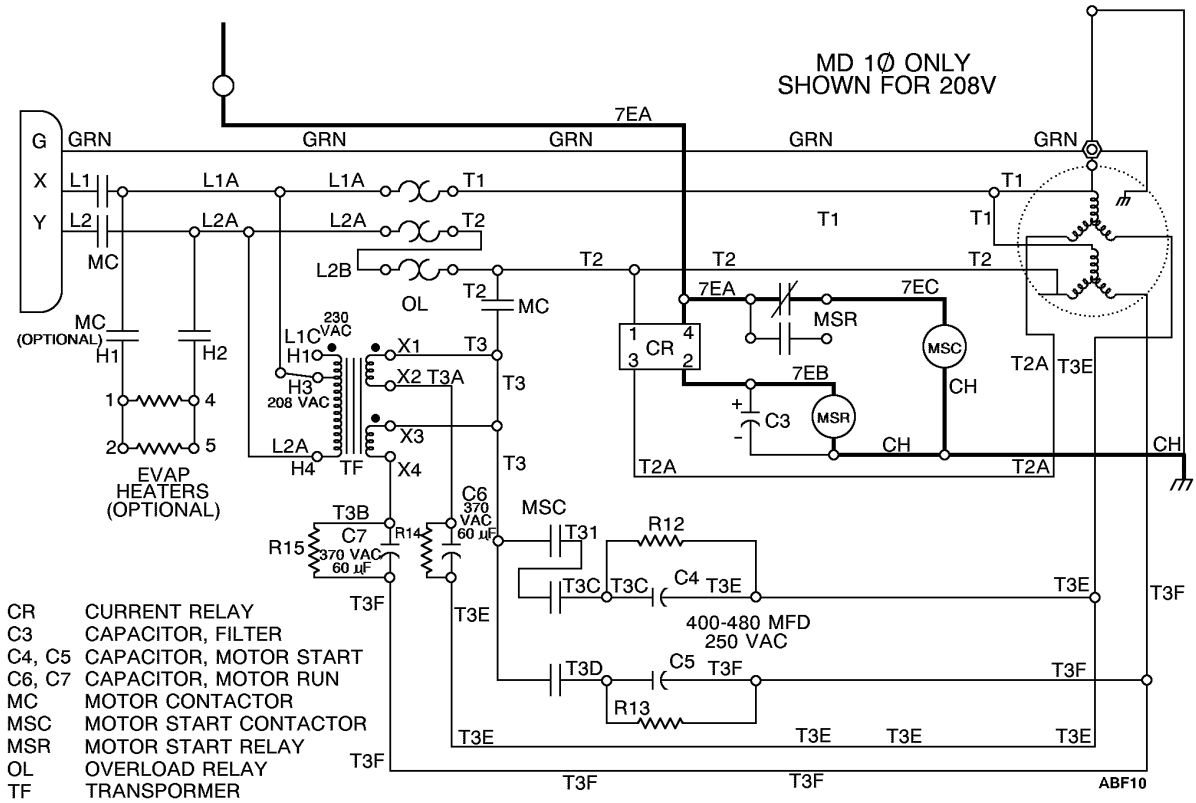


Figure 18: Motor Start Contactor Control Coil Circuit

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.

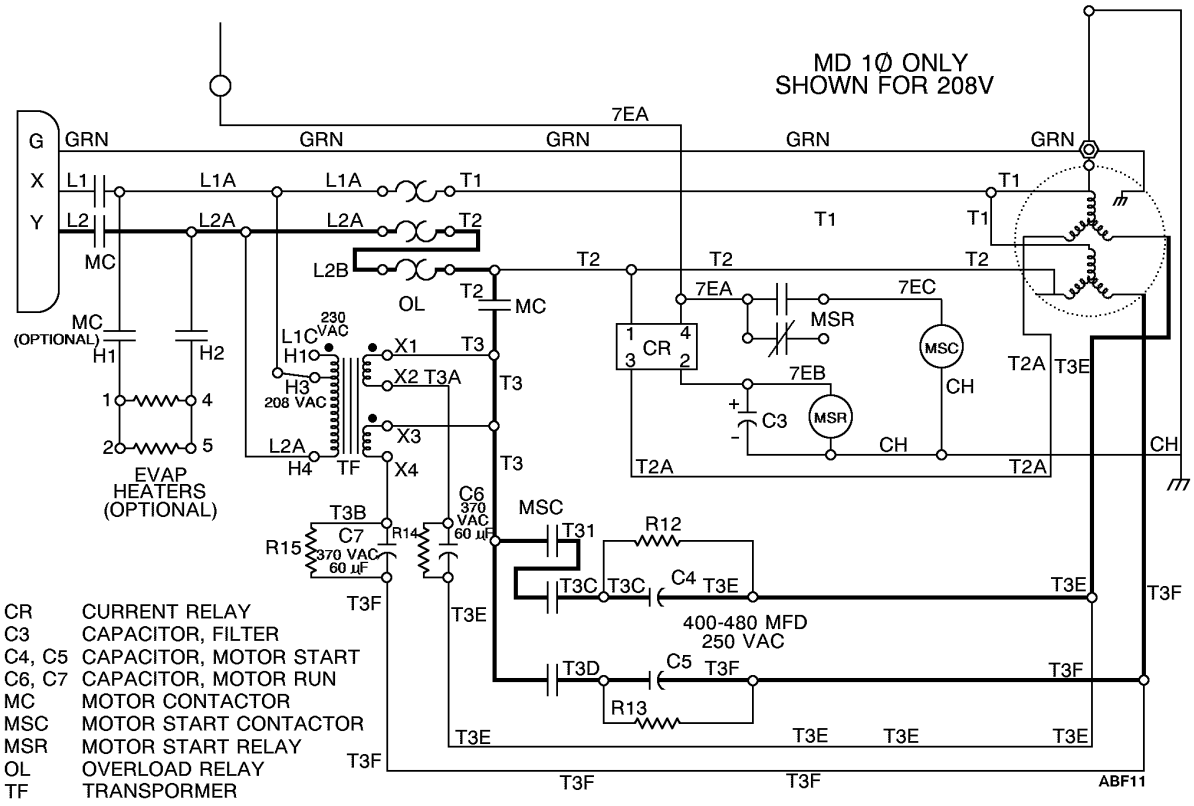


Figure 19: Third Phase Connection During a Start

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.

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).

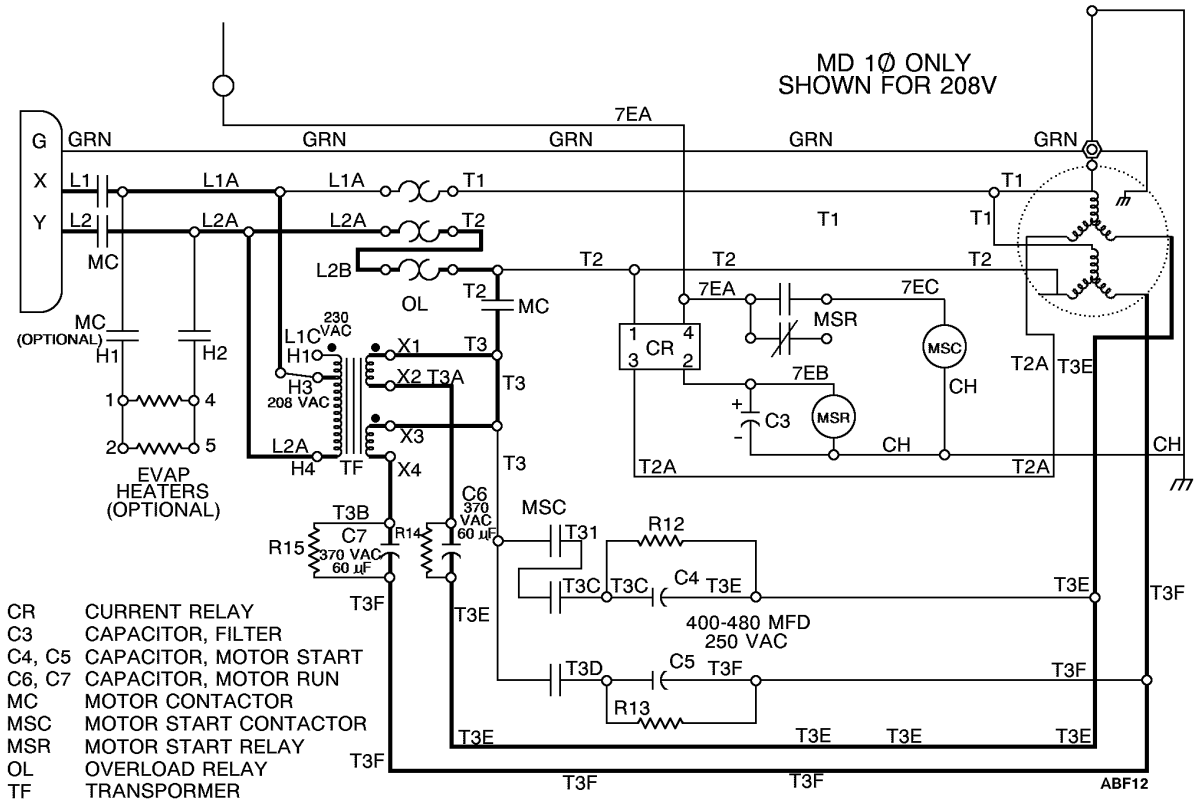


Figure 20: Third Phase Connection While Running Normally

L1 and L2 supplies power to the third windings in both sets of motor windings through the run transformer and the run capacitors.

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
L1-L2	
L2-L3	
L3-L1	

Wire	Start Current	Run Current
L1		
L2		
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.

    c. If the motor does not shift to run, check for a faulty motor start relay or a faulty motor start contactor.

    d. If the motor shifts to run, check for a faulty current relay or an overload on the motor.

    e. 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 MAX 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

In-Cab TG-V Controller

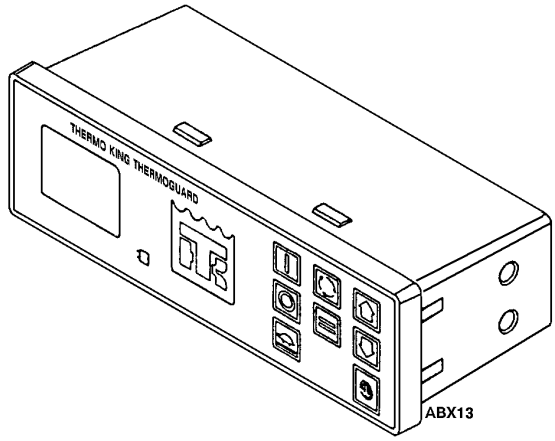


Figure 21: Single Temperature In-Cab TG-V Controller

(P/N 41-3305—12V No Modulation)

The In-Cab TG-V functions similarly to the standard unit mounted TG-V. However, the In-Cab TG-V Controller also has the following additional features:

- Alarm Codes for Single Temperature In-Cab TG-V.

Alarm Code	Fault Condition
03	Return Air Sensor Faulty
04	Discharge Air Sensor Faulty
14	Defrost Circuit Failure
19	Engine Low Oil Pressure/High Water Temperature
25	Battery Charging Alternator Failure
87	Field Test Error
88	Microprocessor Faulty

- Power Cord LED on Model 50 Units.
- Whisper (Low Speed) Push Button.

The operating manuals and the setup and operating manuals contain information about the control functions and how to customize the display screens. Manuals for the Single Temperature In-Cab TG-V Controller: Operating Manual (TK 40940) and Operating and Setup Manual (TK 40804).

The same interconnecting harness is used for the Single Temperature In-Cab TG-V and the Multi-Temp In-Cab TG-V.

A stand alone tester is available as P/N 204-831. It will test all In-Cab TG-V Controllers.

Field Test Procedure for Single Temperature In-Cab TG-V Controllers

Use tester P/N 204-831.

1. Connect the end of the tester marked “SINGLE” to the single temperature controller.

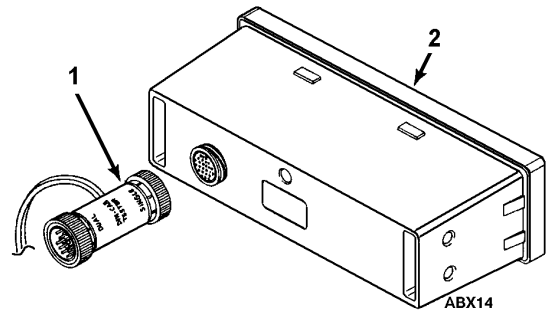


Figure 22: Connecting Tester to Controller

2. Power up the controller by connecting the tester leads to a 12 volt DC power supply.
3. Press the controller’s **On** key to display all segments.
   a. The Turtle icon must be displayed. If not, press the **Turtle** key. Alarm Code 19 will be recorded if the Turtle icon is not displayed.
   b. If the Alarm icon is displayed, press the **Select** key to display the alarm and press the **Enter** key to clear the alarm.
4. Press the **Select** key to display the setpoint(s) and adjust the setpoint(s) to 80 F.

   NOTE: The controller must be set to display temperatures in the Fahrenheit scale. The test WILL NOT work if the controller is displaying temperatures in the Celsius scale. Refer to the Controller Operating and Setup Manual for information about changing the displayed temperature scale.

5. With the setpoint of 80 F displayed on the screen, press the following keys simultaneously:
   - **SELECT** key
   - **UP** arrow key
   - **TURTLE** key.
6. The display will read “FT”.
   - All other icons will be Off.
   - The red, Power Cord LED will begin to flash On and off.
   - All icons will then turn On for a few seconds.
   - Then the display will count from 1 to 15.
   - The display will then read “PS” for pass, or “FC” for fail.
   - Press the **OFF** key to exit the test.

Connector Pins for Single Temperature In-Cab TG-V

Pin #	Circuit Code	Harness Wire Color Code	Circuit Description
1		WHT/BLK/RED	
2	HGV	WHT/VOIL	Hot Gas Valve (Modulation Only)
3	BATT+	WHT/ORG	Battery Positive
4	MV-	BLUE	Modulation Valve Negative (Modulation Only)
5	BATT-	YELLOW	Battery Negative
6	BATT+	WHT/BLK/ORG	Battery Positive
7	WS	WHT/BLK/YEL	Whisper Relay
8	14T	WHT/RED	Heat Relay
9		WHT/BRN	
10	ACC		Accessory Wire to Truck Ignition
11	PC	WHT/BLK/VOIL	Power Cord (Electric Standby)
12	8B	WHT/BLK/BLU	CYCLE-SENTRY Input
13	10T	VIOLET	High Speed Relay
14	38	WHT/BLK/BRN	In-Range Output
15		WHT/GRN	
16	INDL	WHT/GREY	Alternator Charging
17	8	WHT/BRN/RED	Power from On/Off Switch
18	SN	WHITE	Return Air Sensor
19	SN	GREEN	Return Air Sensor
20	BATT-	WHT/BLK	Battery Negative
21	11	BRN	Defrost Relay Circuit
22	12	WHT/YEL	Defrost Termination Switch
23	7T	WHT/BLK/GRN	Not Used
24	DSN	BLK	Discharge Air Sensor
25	PS	WHT/BLU	On Relay Coil
26	7K	GREY	Latching Circuit after 8D
27	29	ORANGE	Defrost Damper Circuit
28	DSN	RED	Discharge Air Sensor

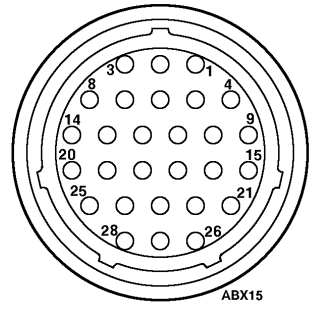


Figure 23: Connector on Back of Single Temperature In-Cab TG-V

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.

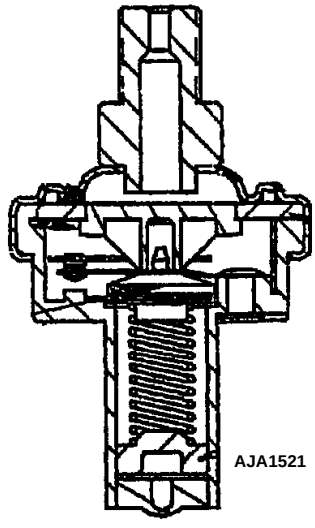


Figure 24: Engine Oil Pressure Switch

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.

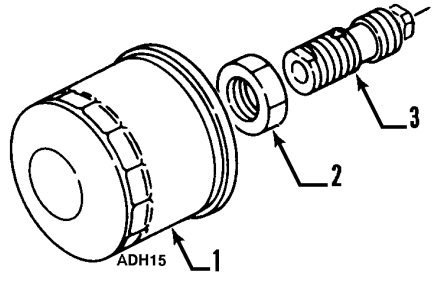
Add oil as necessary to reach the full mark. See Specifications chapter of this manual for correct type of oil.

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 25: Oil Filter Parts

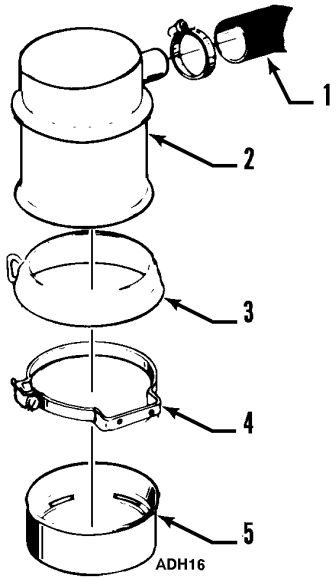
Crankcase Vent

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

Oil Bath Type

A heavy duty, oil bath air cleaner filters all of the air entering the engine. Excessive restriction of the air intake system reduces the flow of air to the engine affecting horsepower output, fuel consumption and engine life.



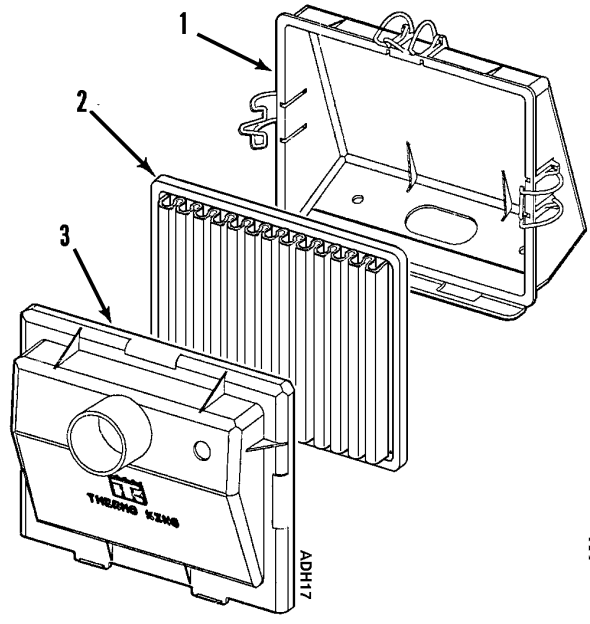
1.	Air Intake Hose
2.	Air Cleaner Filter
3.	Clamp Assembly
4.	Mounting Clamps
5.	Cup

Figure 26: Oil Bath Air Cleaner

The air cleaner removes abrasive material from the air entering the engine. The air cleaner must be kept clean and open so that the air can pass freely. If the oil has absorbed the maximum amount of dirt, it allows the dirt to enter the engine. Remove the oil cup, wash thoroughly and dry every 750 operating hours (500 hours under dusty conditions). Refill using the same weight oil used in the engine crankcase. Inspect the cleaner body and wash in solvent when it becomes dirty.

Dry Type (Optional)

A dry element 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 regular unit service intervals.



1.	Air Filter Box
2.	Air Filter
3.	Air Filter Cover

Figure 27: Dry Air Cleaner (Optional)

An air restriction indicator is installed in the air intake elbow. Visually inspect the restriction indicator periodically to assure the air filter is not restricted. Service the air filter when the yellow diaphragm indicates 22 in. (559 mm) of vacuum. Press the reset button on the bottom of the restriction indicator after servicing the air filter.

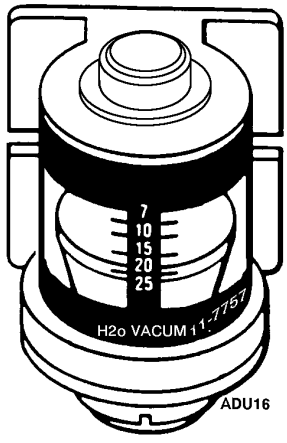


Figure 28: Air Restriction Indicator

Engine Cooling System

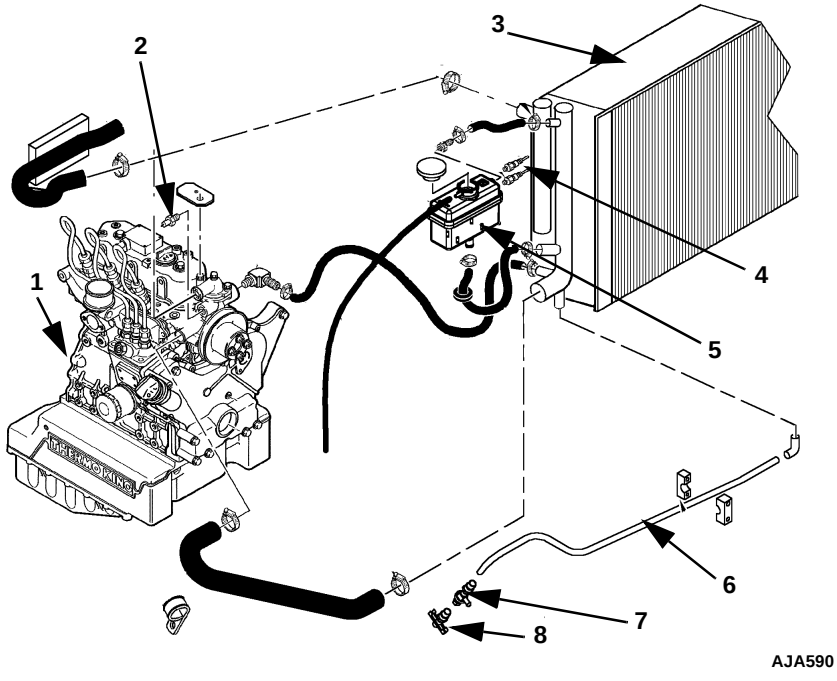
General Description

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 29: Engine Cooling Components

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.

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 engine block 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 block drain and install a commercially available radiator and block flushing agent, and operate the unit in accordance with instructions of the flushing agent manufacturer.
   c. Open the engine block and accumulator 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.

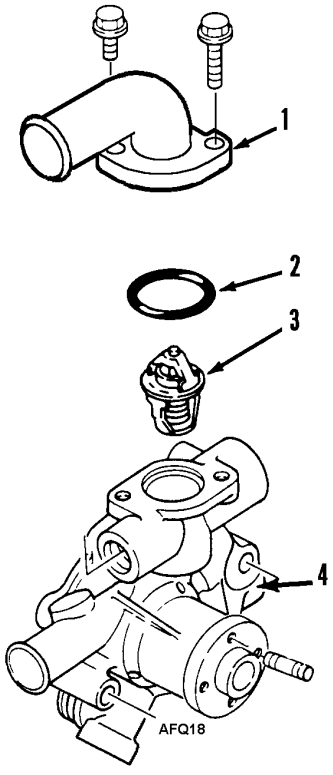
Bleeding Cooling System

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 30: 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:

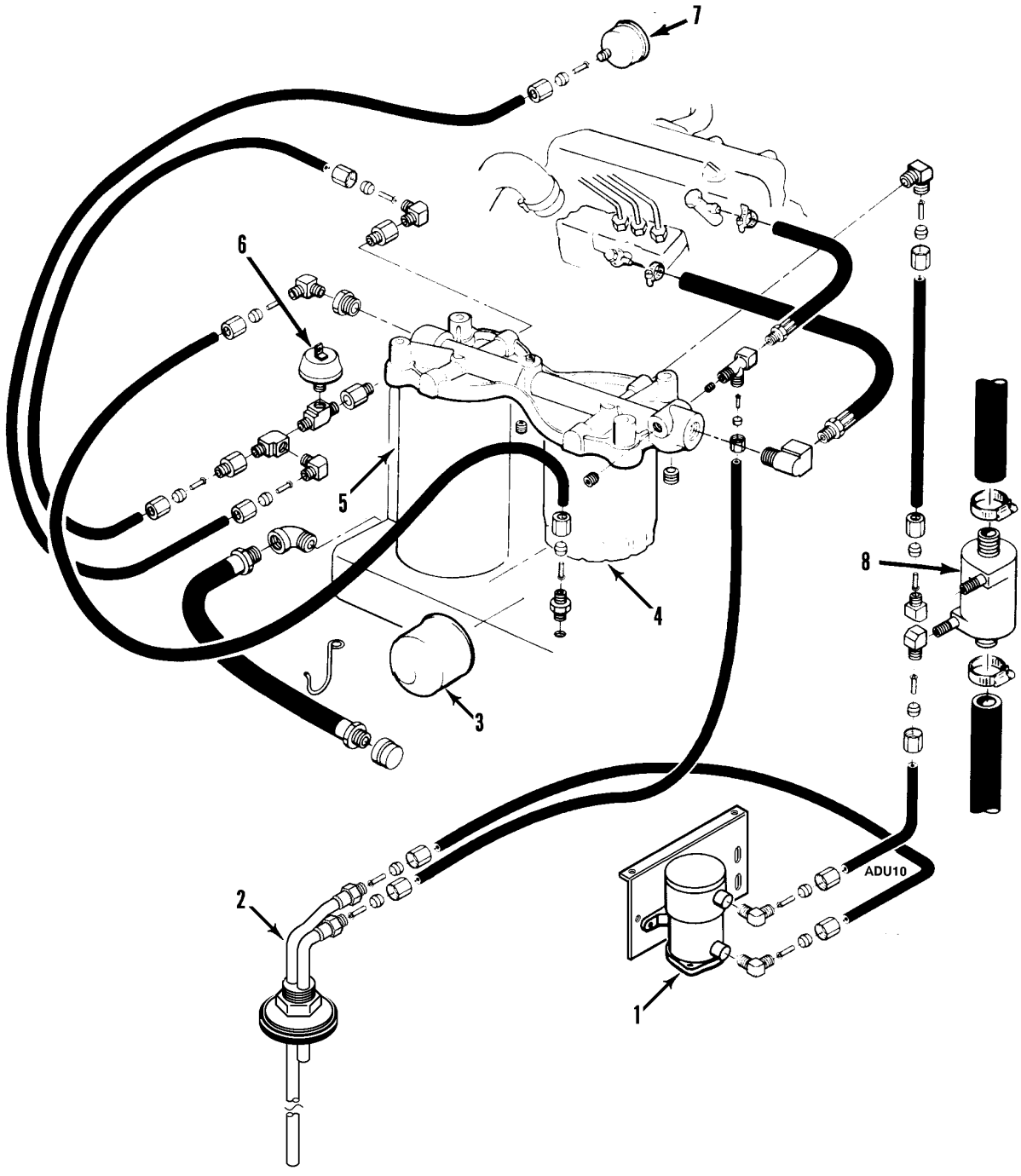
- Fuel tank (may be the truck fuel tank)
- Electric Fuel pump
- Fuel filter
- Injection pump
- Injection nozzles.

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.



1.	Fuel Pump	5.	Bypass Oil Filter
2.	To Fuel Tank	6.	Oil Pressure Switch
3.	Oil Filter	7.	Oil Pressure Gauge (Optional)
4.	Fuel Filter	8.	Diesel Fuel Heater (Optional)

Figure 31: Fuel and Oil System Components

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.

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

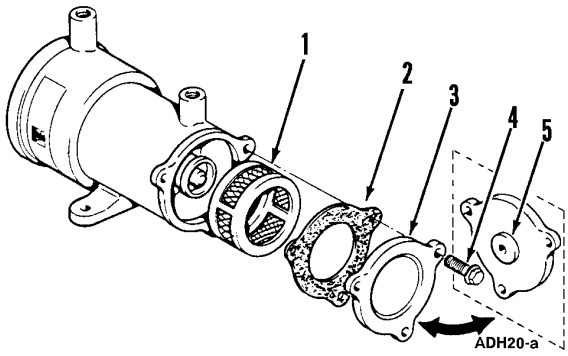
Place the cover gasket on the bottom cover and install the filter and cover assembly. Replace the three screws.

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 32: 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.

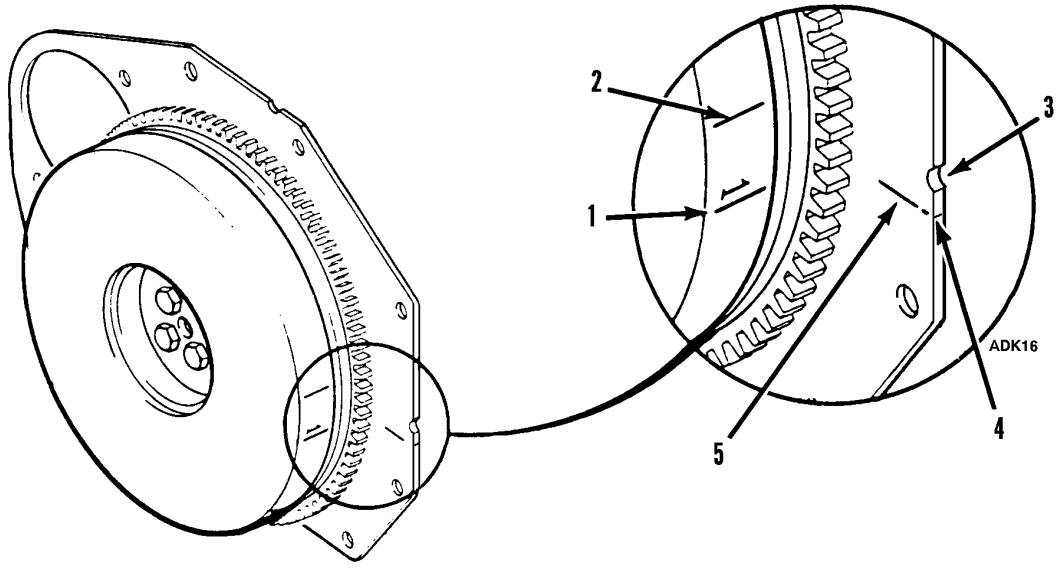
Make the engine speed adjustments with the engine fully warmed up.

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 33: 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.

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.

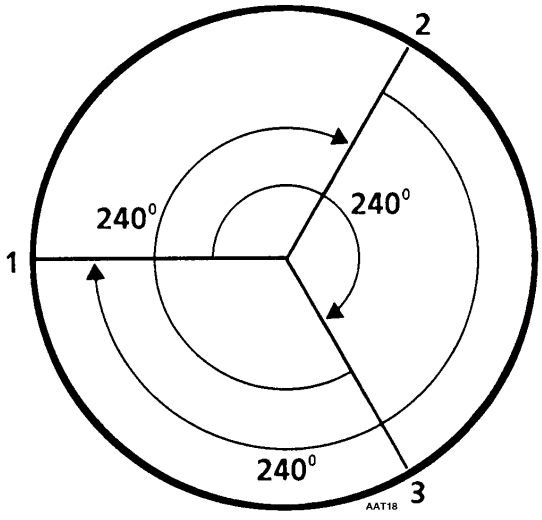


Figure 34: Individual Cylinder Timing and Firing Order

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 degrees to TDC mark on number 3 cylinder, and adjust both valves.

   c. Turn the crankshaft 240 degrees 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.

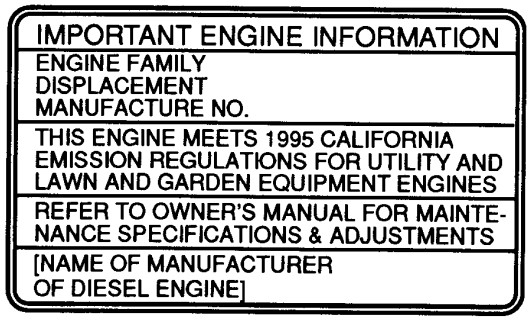


Figure 35: Emission Control Label

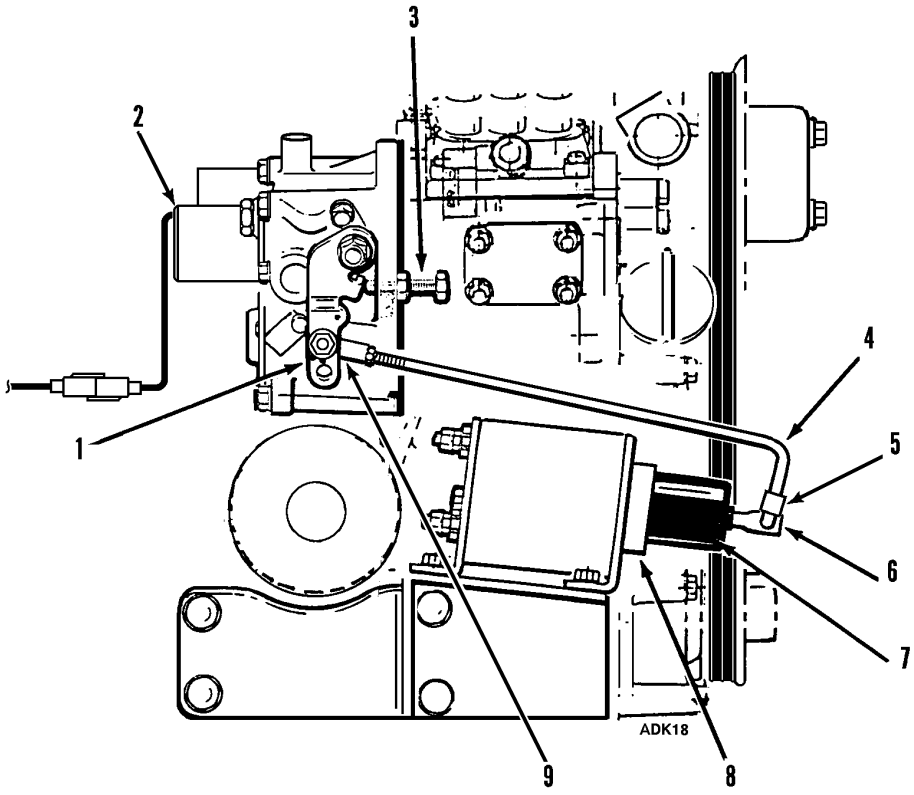
Integral Fuel Solenoid

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

Operation of the TK 3.74 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.

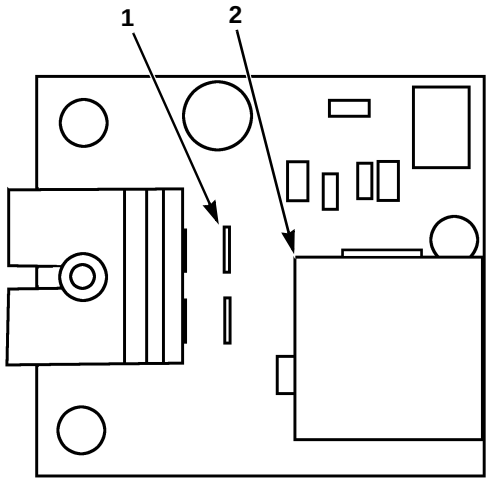
When the fuel solenoid is energized, current is applied to the coil creating an electro-magnetic field, which pulls the When in the "pulled-in" position, the plunger releases tension on the governor linkage. The governor linkage then moves the fuel injector rack, thus controlling the fuel flow and placing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

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



1.	Throttle Lever (P/N 11-6129)	6.	Eye Bolt (P/N 55-2762)
2.	Fuel Stop Solenoid (P/N 41-1386)	7.	Boot (P/N 91-3095)
3.	Low Speed Adjustment Screw	8.	Throttle Solenoid (P/N 44-9181)
4.	Rod (P/N 11-7817)	9.	Ball Joint (11-6820)
5.	Clevis Pin (11-4266)		

Figure 36: Integral Fuel Solenoid Components



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

Figure 37: Fuel Solenoid Timer

Electrical Changes

The fuel solenoid timer and fuel solenoid relay are located on a PC board. This improves reliability and simplifies the wiring. The PC board is mounted on the side of the control box to the left to the multi-temp relay board

The size of the capacitor has been changed to increase the pull-in time from 1 second to 2 seconds. This minimizes the chance that the pull-in coil would fail to open the fuel valve. The integral fuel solenoid contains two coils: the pull-in coil, and the hold-in coil. The pull-in coil draws approximately 30 to 40 amps at 12 volts. The hold-in coil draws approximately 1 amp at 12 volts.

The pull-in coil must be energized to move the injection pump governor linkage to the fuel on position. Once the injection pump governor linkage has been moved to the fuel on position, the hold-in coil will keep it in fuel on position until the 8D circuit is de-energized. The pull-in coil must be de-energized after the 2 second pull-time.

The timer now turns off instantly because the capacitor discharges through the hold-in coil in the fuel solenoid (8D circuit). This minimizes the chance that the timer would fail to energize the fuel solenoid relay after the unit had been turned off momentarily. The earlier timer required the unit to be turned off for at least 3 seconds to discharge the capacitor.

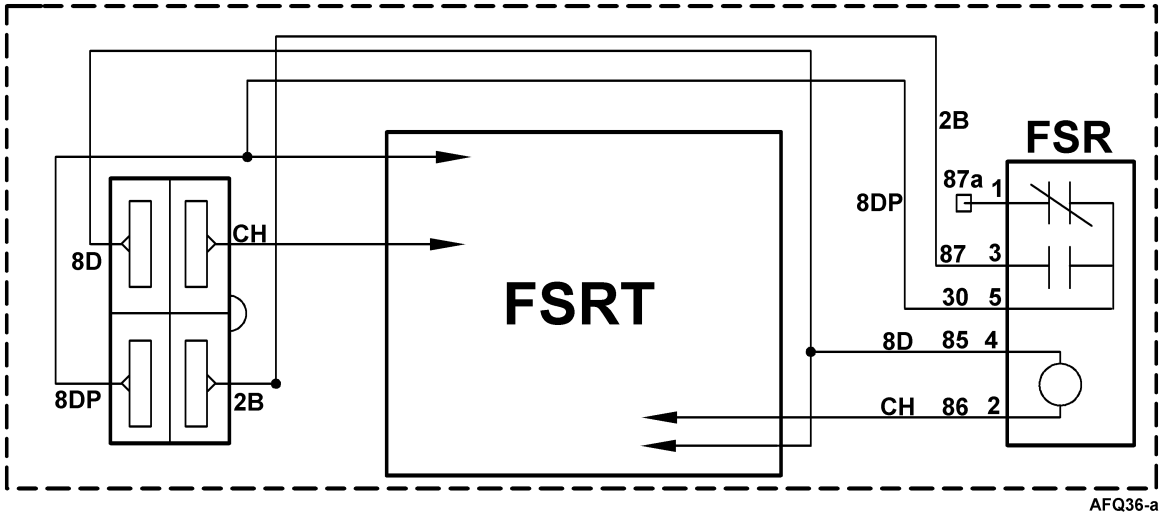


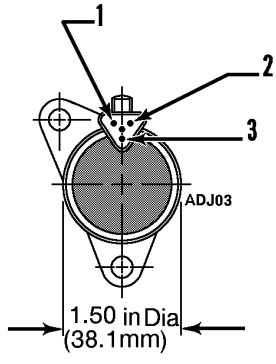
Figure 38: Wiring Diagram of Fuel Solenoid Timer Starting 4th Quarter 97

Troubleshooting the Integral Fuel Solenoid System

NOTE: The fuel solenoid pull-in coil will require 30 to 40 amps to turn on the fuel. The unit's battery must be in good condition. If the battery has enough power to crank the engine over, it has enough power to energize the fuel solenoid pull-in coil.

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

1. Disconnect the 20 wire from the reset switch so the reset switch will not trip.
2. Disconnect the 8S wire from the starter solenoid.
3. Disconnect the fuel solenoid wire connector from the fuel solenoid.
4. Turn the unit ON and check the voltage on the 8D pin in the fuel solenoid wire connector from the main wire harness. Refer to the following illustration to identify the pins in the wire connector and in the fuel solenoid.



1.	Pull Coil 8DP Color: White
2.	8D Hold Coil Color: Red
3.	Common—Ground Color: Black CH

Figure 39: Fuel Solenoid Pin Identification

   a. If battery voltage is not present on the 8D circuit, check the 8D circuit for an open or a short.

   b. If battery voltage is present on the 8D circuit, go to step 5.

5. Check the CH pin in the fuel solenoid wire connector for continuity to a good chassis ground.

   a. If there is no continuity between the CH pin in the fuel solenoid wire connector and a good chassis ground, check the black (CH) wire that goes from the fuel solenoid connector to the CH terminal on the throttle solenoid for an open circuit.

   b. If this black (CH) wire is not open, check the other CH wire connected to the CH terminal on the throttle solenoid for an open circuit.

   c. If there is continuity between the CH pin in the fuel solenoid connector and a good chassis ground, go to step 6.

6. Place a jumper wire between the CH pin in the fuel solenoid and a good chassis ground.
7. Test the pull-in coil by momentarily placing a jumper between the 8DP pin in the fuel solenoid and the 2 terminal at the control circuit. The fuel solenoid should make a definite click when the pull-in coil is energized and should click again when the pull-in coil is de-energized.

   NOTE: The pull-in coil will draw 18 to 25 amps so do not leave the jumper connected to the 8DP pin for more than a few seconds.

   a. If the pull-in coil does not energize, check the resistance of the pull-in coil by placing an ohmmeter between the 8DP pin and the CH pin in the fuel solenoid. The resistance of the pull-in coil should be -3 to -4 ohms. If the resistance of the pull-in coil is not in this range, replace the fuel solenoid.

   NOTE: If the pull-in coil fails, make sure to replace the fuel solenoid relay with a Potter-Brumfield relay P/N 44-9111.

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

8. Test the hold-in coil.

   a. Energize the hold-in coil by placing a jumper between the 8D pin in the fuel solenoid and the 2 terminal at the control circuit.

b. Momentarily energize the pull-in coil by placing a jumper between the 8DP pin in the fuel solenoid and the 2 terminal at the control circuit. The fuel solenoid should make a definite click when the pull-in coil is energized, but should not click when the pull-in coil is de-energized.

c. De-energize the hold-in coil by removing the jumper from the 8D terminal. The fuel solenoid should make a definite click when the hold-in coil is de-energized.

d. If the hold-in coil does not function properly, check the resistance of the hold-in coil by placing an ohmmeter between the 8D pin and the CH pin in the fuel solenoid. The resistance of the hold-in coil should be approximately 24 ohms. If the resistance of the hold-in coil is not in this range, replace the fuel solenoid.

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

9. Reconnect the fuel solenoid wire connector to the fuel solenoid.

10. Remove the fuel solenoid relay from its socket and make sure the unit is turned On.

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

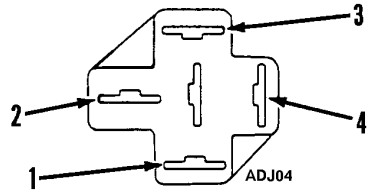
    a. If battery voltage is not present on the 8D circuit, check the 8D circuit for an open or a short (minimum voltage is 10 volts).

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

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

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

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



1.	86 Terminal—8DC Circuit
2.	30 Terminal—2B Circuit
3.	85 Terminal—8D Circuit
4.	87 Terminal—8DP Circuit

Figure 40: Relay Socket Terminal Identification

13. Test the relay.

    a. Use a jumper to connect the 85 terminal on the relay to the 2 terminal at the control circuit.

    b. Use another jumper to connect the 85 terminal on the relay to the 2 terminal at the control circuit.

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

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

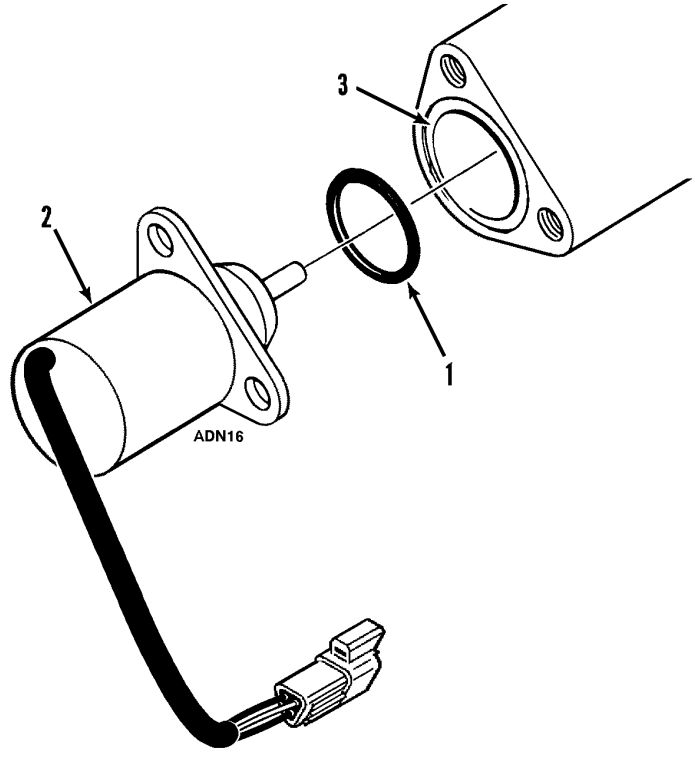
14. Remember to reconnect the 20 wire to the reset switch.

Fuel Stop Solenoid Replacement

1. Disconnect the 20 wire from the reset switch to prevent the reset switch from tripping.
2. Disconnect the fuel stop solenoid wire connector and remove the old fuel solenoid.
3. Connect the fuel stop solenoid wire connector to the new fuel solenoid.
4. Turn the unit on to energize the fuel stop solenoid.

NOTE: The fuel stop solenoid must be energized when it is being installed. If it is not, the plunger and the linkage may not line up correctly and the fuel solenoid will not function properly.

5. Place the o-ring in the groove in the end of the fuel injection pump. Make sure that the o-ring is positioned correctly during installation to avoid damage and leaks.
6. Install the new fuel stop solenoid.
7. Turn the unit Off and make sure to connect the 20 wire to the reset switch.



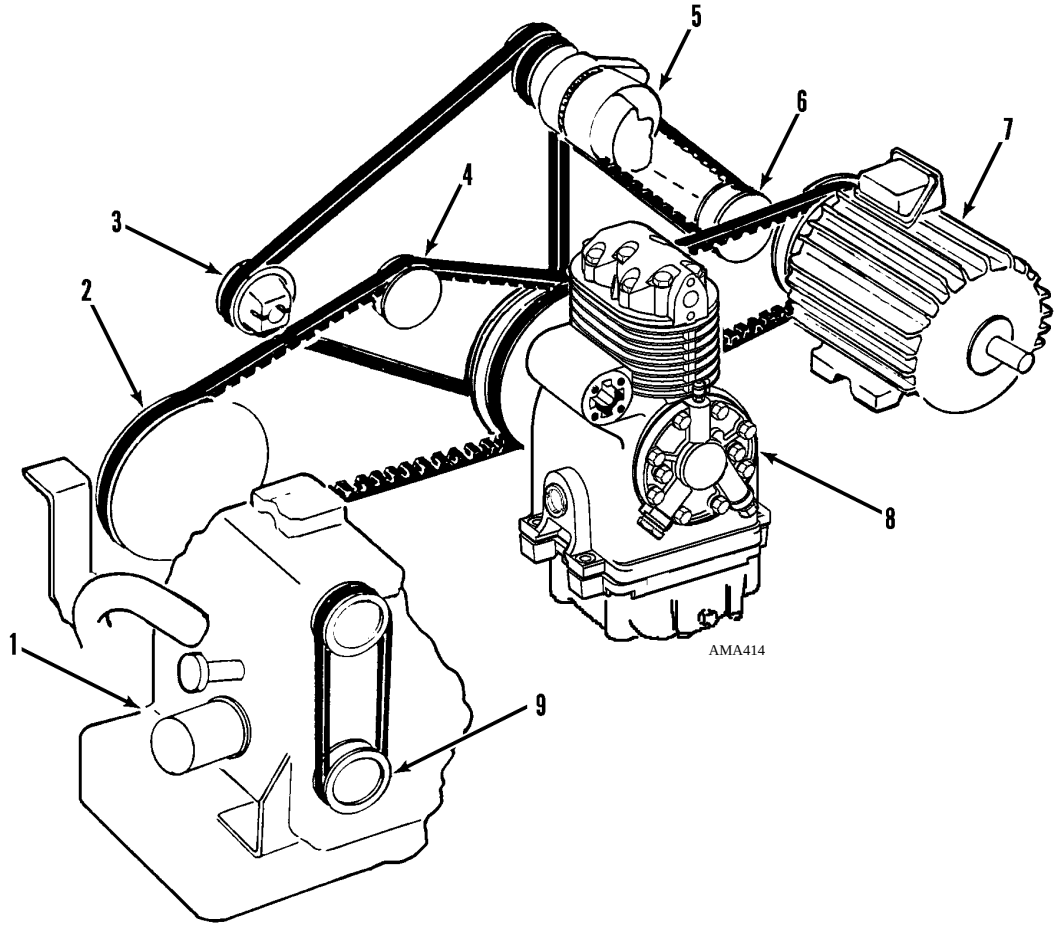
1.	O-ring
2.	Fuel Stop Solenoid
3.	Fuel Injection Pump Groove

Figure 41: Fuel Stop 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 42: 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.

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.

Engine/Compressor Belt

Install and adjust the new engine/compressor belt and the new compressor/electric motor/jackshaft.

Tighten the belt tension adjuster by hand until it is all the way down and locked into the belt tension stop.

Tighten pulley bolt.

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

Gauge tension on new belts should be 75 ± 3 lbs (34 ± 1.4 kg). Gauge tension on used belts should be 70 ± 3 lbs (32 ± 1.4 kg).

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

NOTE: DO NOT overtighten the compressor drive belt. Belt tension should allow belt to be deflected 1/2 in. (13 mm) at center of span without any engine movement. Over-tensioned belts cause severe overload on the bearings. Use only approved Thermo King Service Parts replacement belts. They are specially designed for the Thermo King units.

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 lbs (33 ± 1.4 kg). Gauge tension on used belts should be 67 ± 3 lbs (30 ± 1.4 kg).

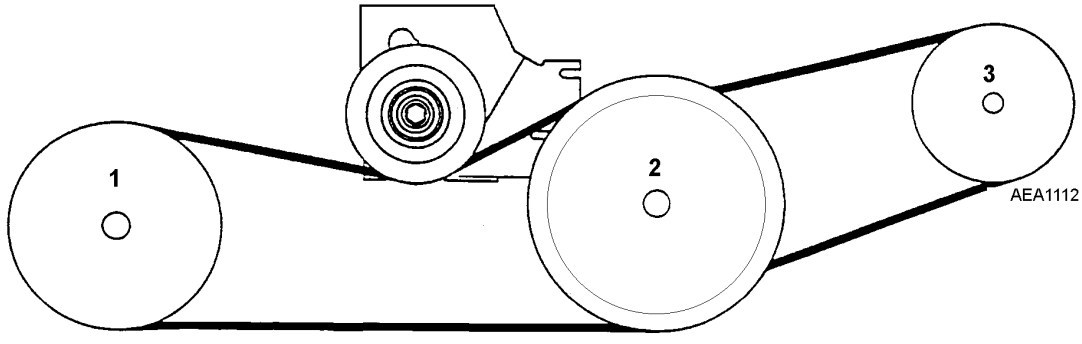
This tension allows 1/2 in. (13 mm) deflection in the center of the span.

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.

IMPORTANT

The Belts Must Be Adjusted To The Proper Tensions!



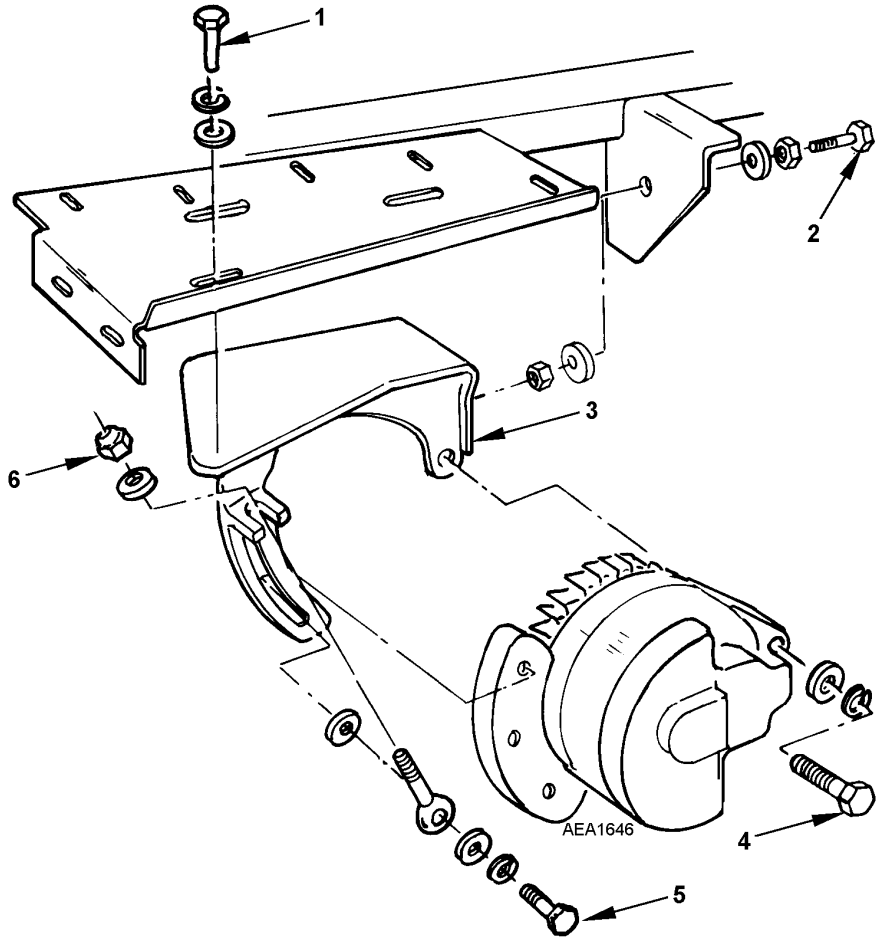
1.	Engine	3.	Jackshaft or Electric Motor
2.	Compressor		

Figure 43: Belt Layout

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 44: 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.

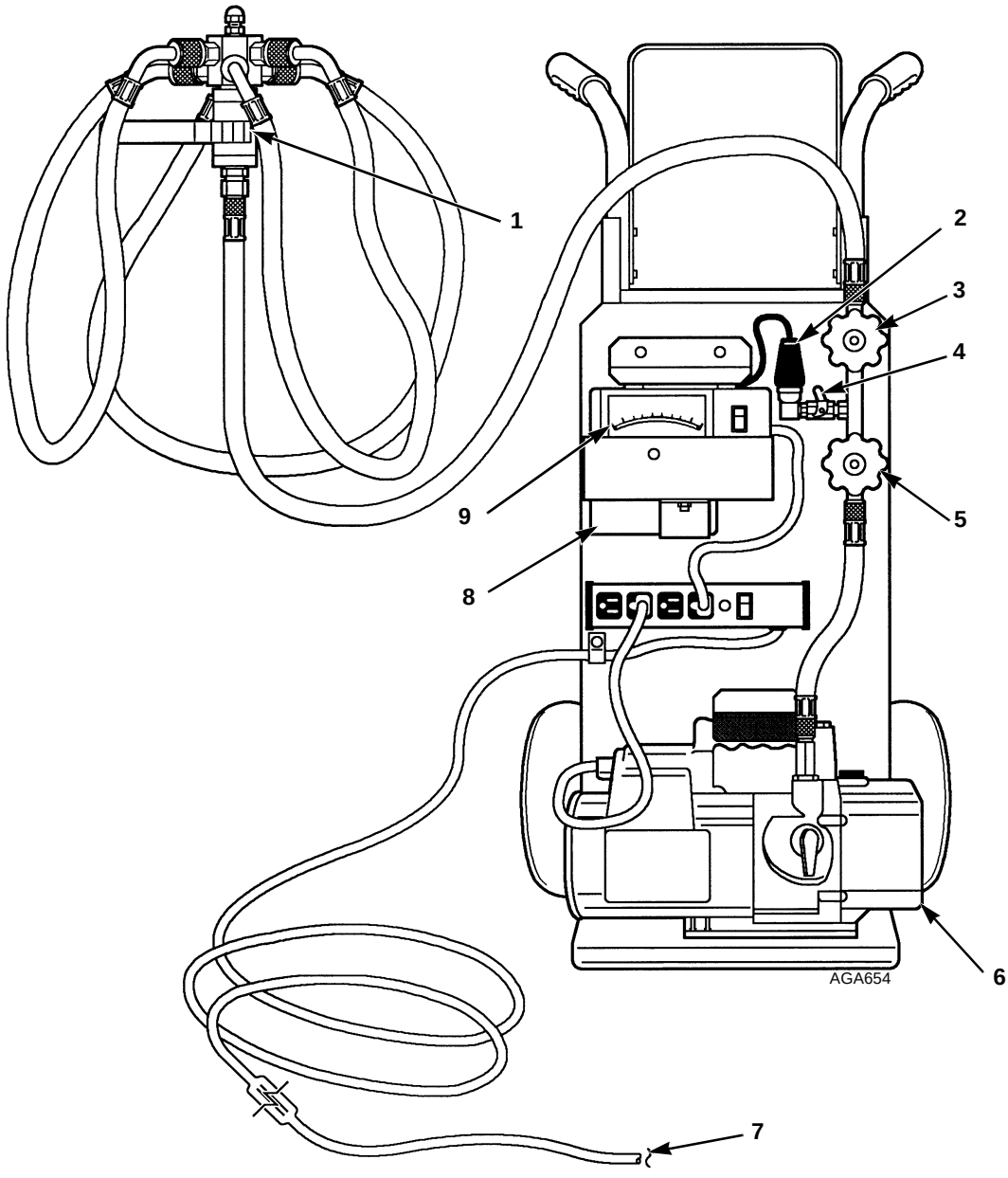
See the diagram of the Thermo King Evacuation Station and note the location of the valves.

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.

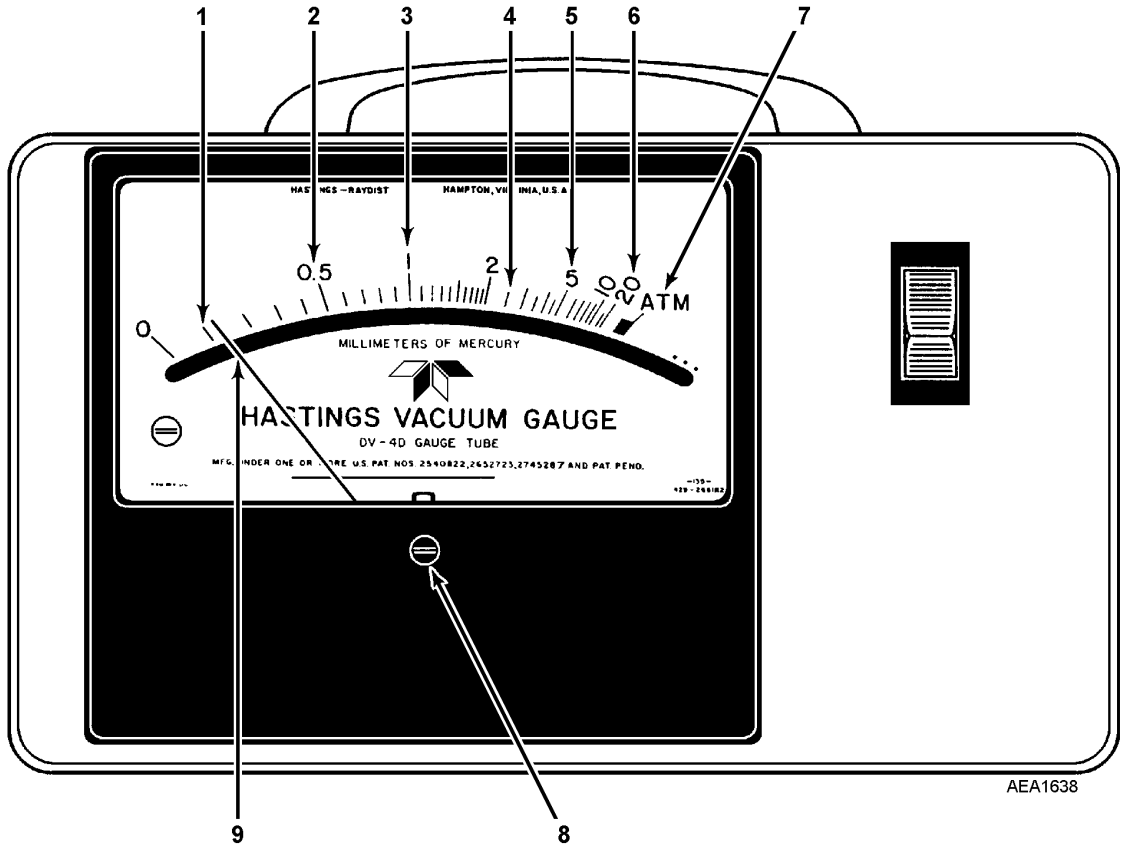
Valve #3 (V-3): Is in the open position during unit evacuation. When closed, V-3 isolates the micron gauge and the vacuum pump from the other evacuation hoses.

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 45: 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 46: 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.

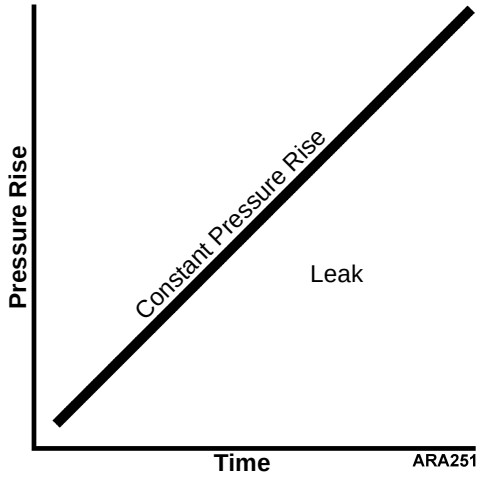


Figure 47: Leak

- 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.

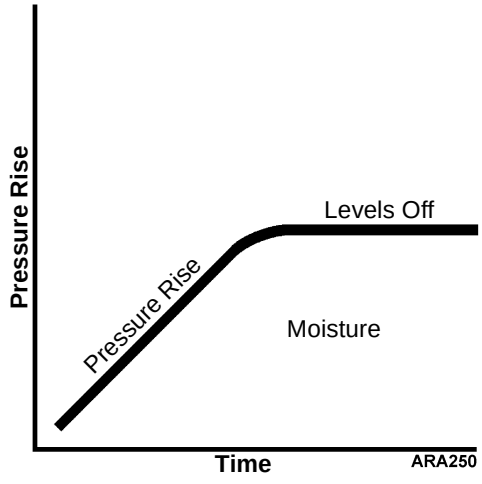


Figure 48: Moisture

- 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.

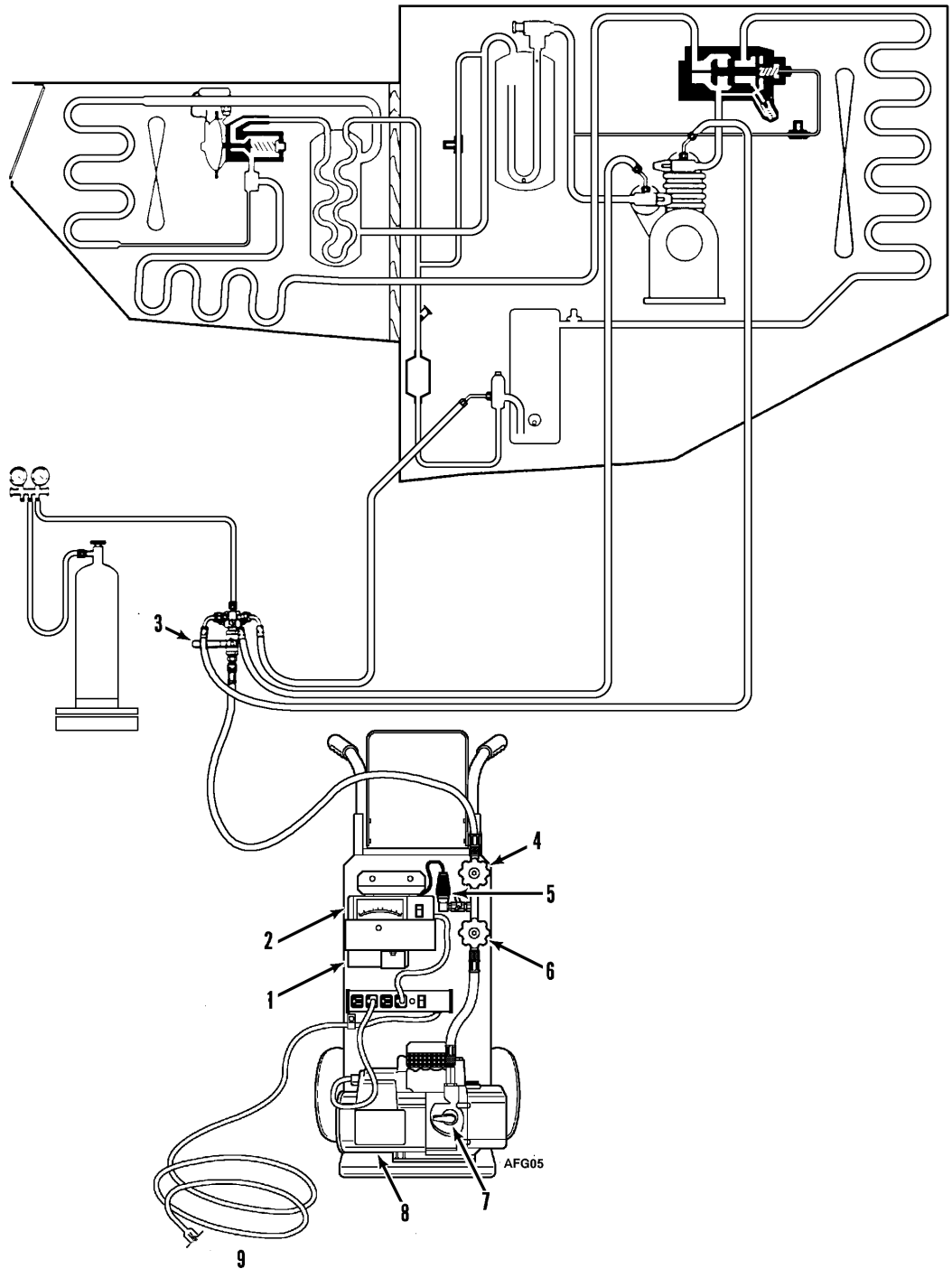
Unit Charging

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

Figure 49: 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.

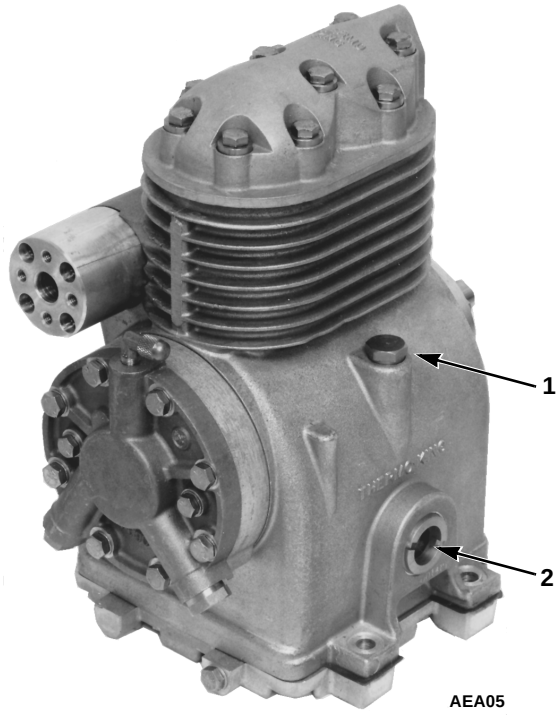
To check compressor oil level with an ambient air temperature above 50 F (10 C):

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 50: 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 Cool 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.

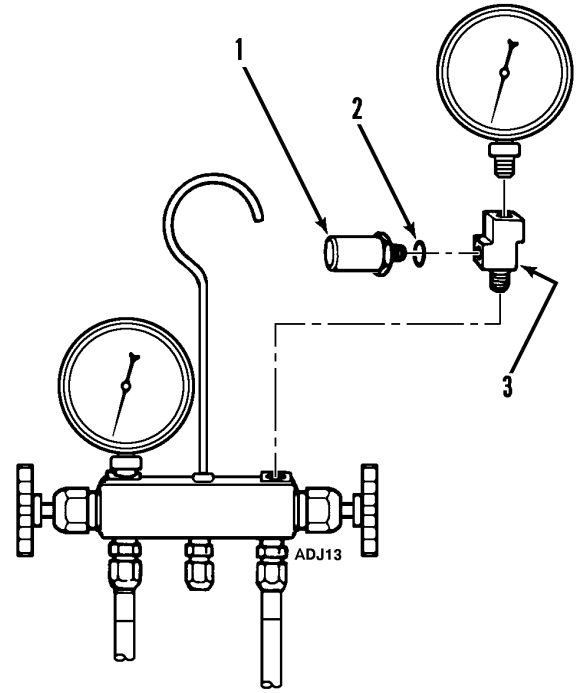
NOTE: Use refrigeration compressor oil ONLY. R-134a and R-404A systems use a special Ester oil TK No. 203-413.

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 51: 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.

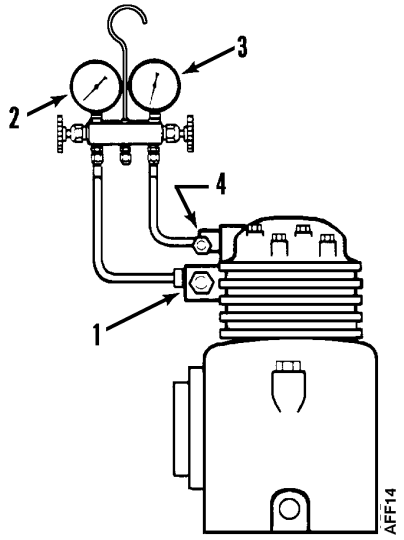
4. Failure of the HPCO system to stop compressor operation should be investigated first by checking the control circuit operation and secondly by HPCO switch replacement.

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 Cool 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 52: 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.

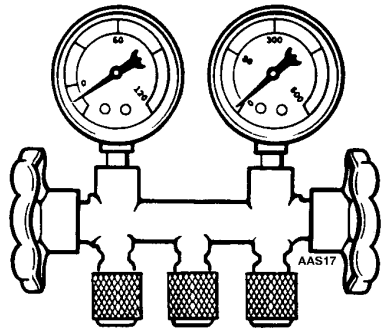


Figure 53: Compound Gauge Indicating 20 in. Vacuum

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

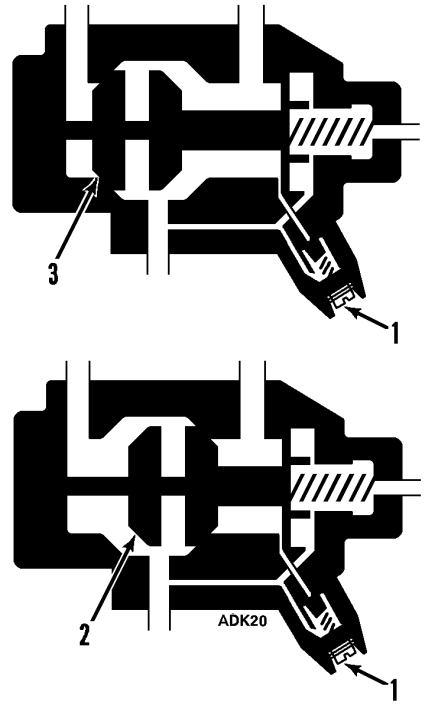
The condenser pressure bypass check valve is built into the three-way valve. This check valve controls the bypass flow of refrigerant gas between the condenser inlet line and compressor discharge line.

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 54: 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.

Commissioning Unit

The following procedure should be followed after any of these conditions:

- The compressor has been replaced
- There has been a large oil loss in the system
- There has been a complete clean up or flush of the refrigeration system.

1. Set the thermostat to the highest setpoint.

   If the ambient temperature is above set point range, jump power from the 2 circuit to HGS and RHGS to allow the valves to open.

2. Run the unit for ten minutes to allow for wetting of the system.
3. Set the thermostat for Cool (remove jumpers if installed in the previous step).

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

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.

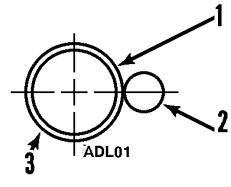
Expansion Valve Assembly

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.

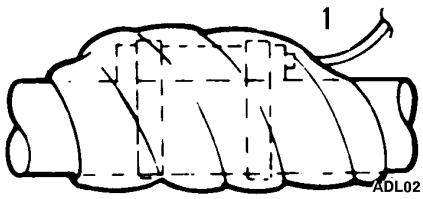
Installation

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 55: Location of Expansion Valve Bulb



1.	Top View

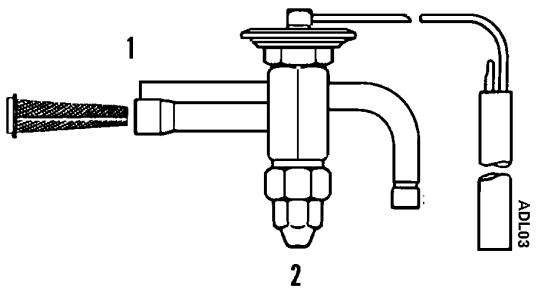
Figure 56: Completely Wrap Bulb with Tape

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 57: 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

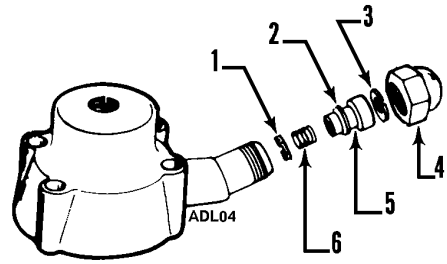
1. Place the receiver tank in the unit and install the mounting bolts and nuts loosely. Position the receiver tank so the sight glass is clearly visible and the outlet tube lines up.
2. Solder the condenser inlet tube.
3. Solder the filter drier line to the receiver tank outlet valve.
4. Tighten the 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 58: 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

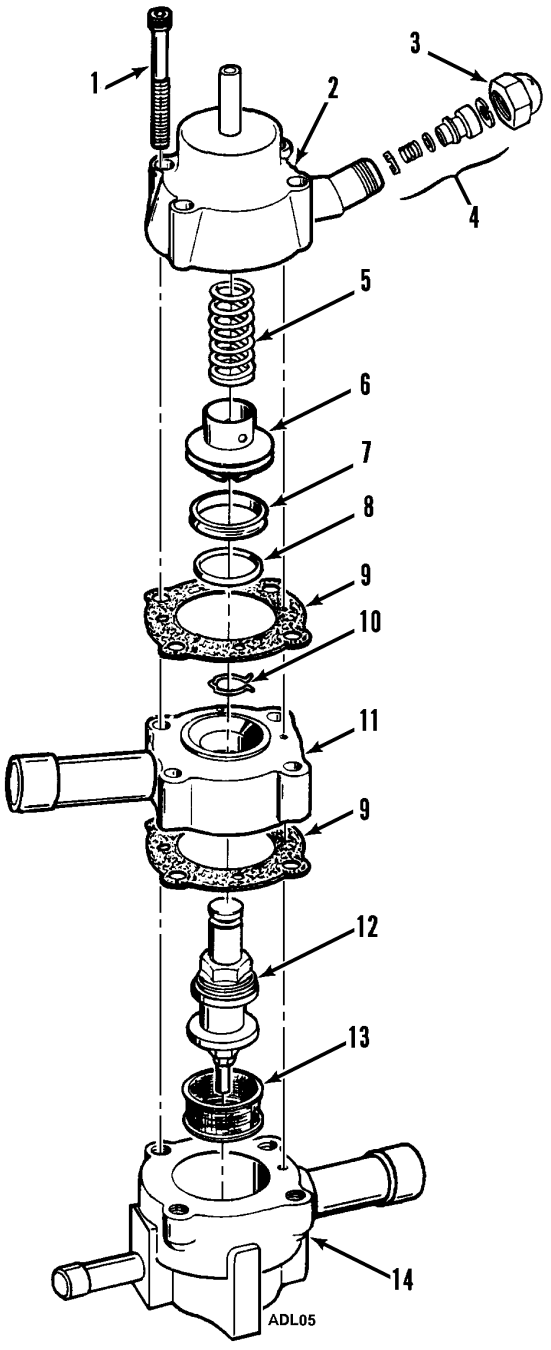
1. Remove the refrigerant charge.
2. Clean the exterior surface of the valve.
3. Remove the 1/4 in. copper line from the three-way valve to the pilot solenoid.
4. Loosen the four 1/4 in. Allen head screws (*do not remove*); use tool (see Tool Catalog) to break the gasket at each side of the center section.

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 59: Three-way Valve Assembly

Installation

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

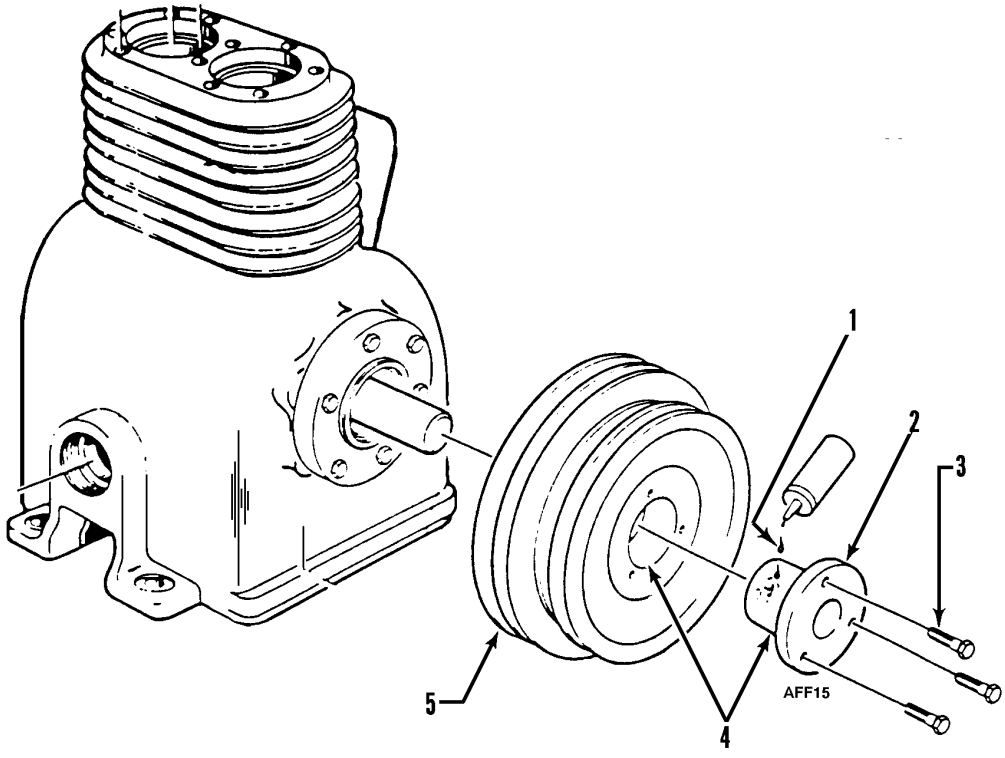
After cleaning and inspecting all parts, reassemble the valve. Clean solder off the condenser line and condenser head with sandpaper and tubing brush.

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.

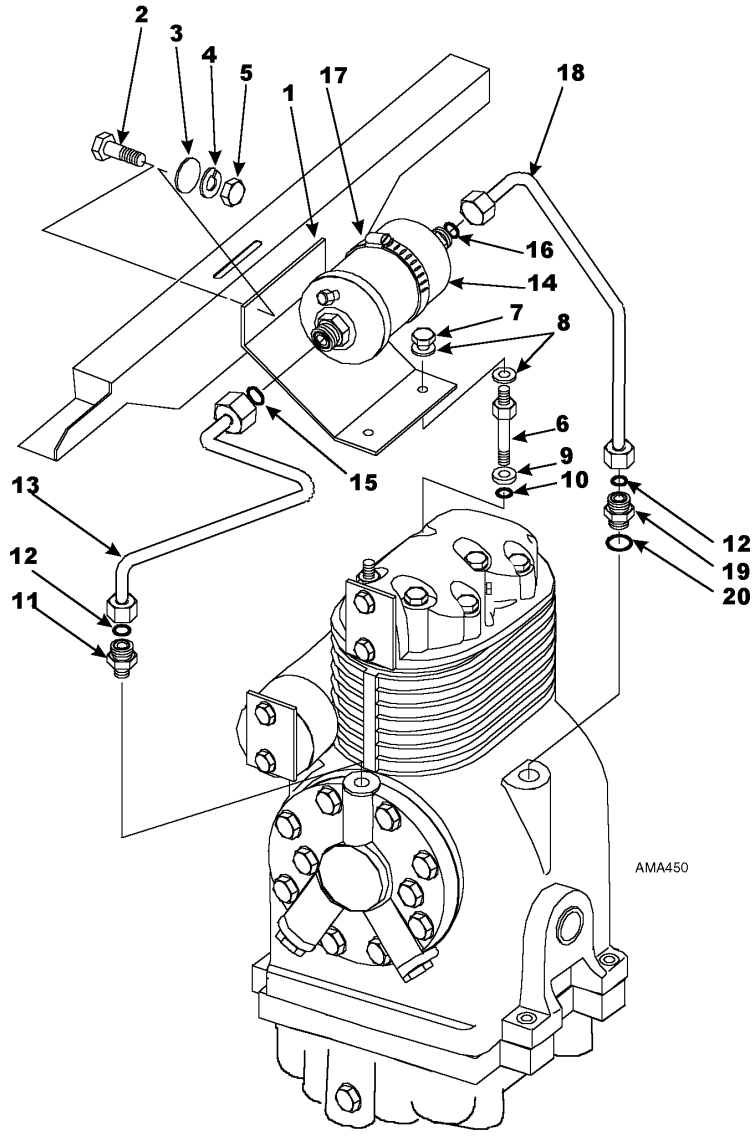


1.	Apply Anti-Seize Lubricant to the Tapered Surface of the Bushing Only.
2.	Bushing
3.	Torque Evenly to 7 to 10 ft-lb (23 to 14 N•m)
4.	Clean All Rust and Paint Off These Tapered Surfaces Before Installing.
5.	Pulley

Figure 60: 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 61: 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.

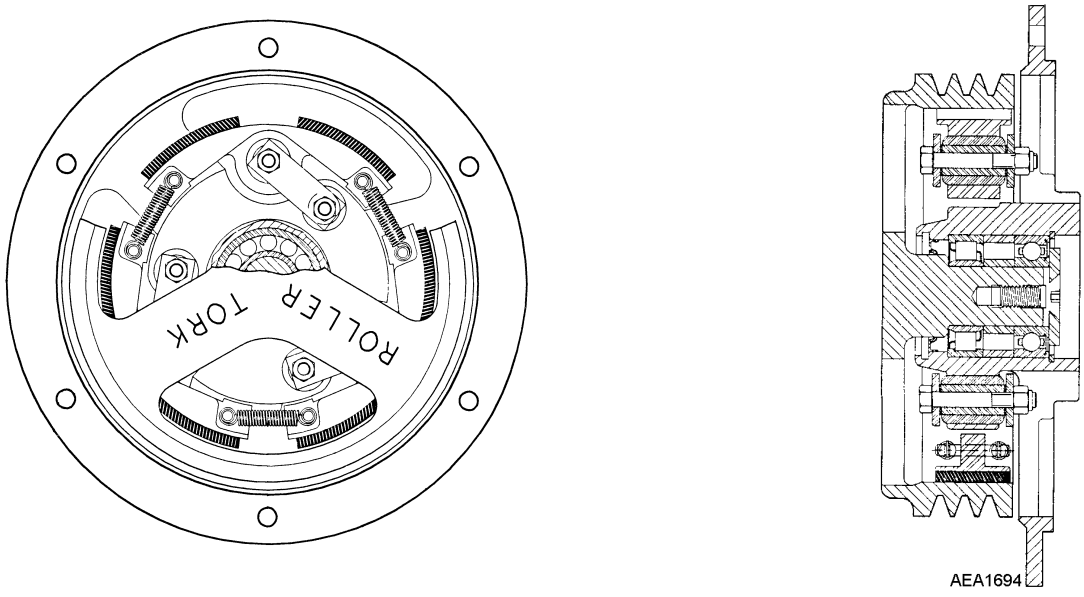
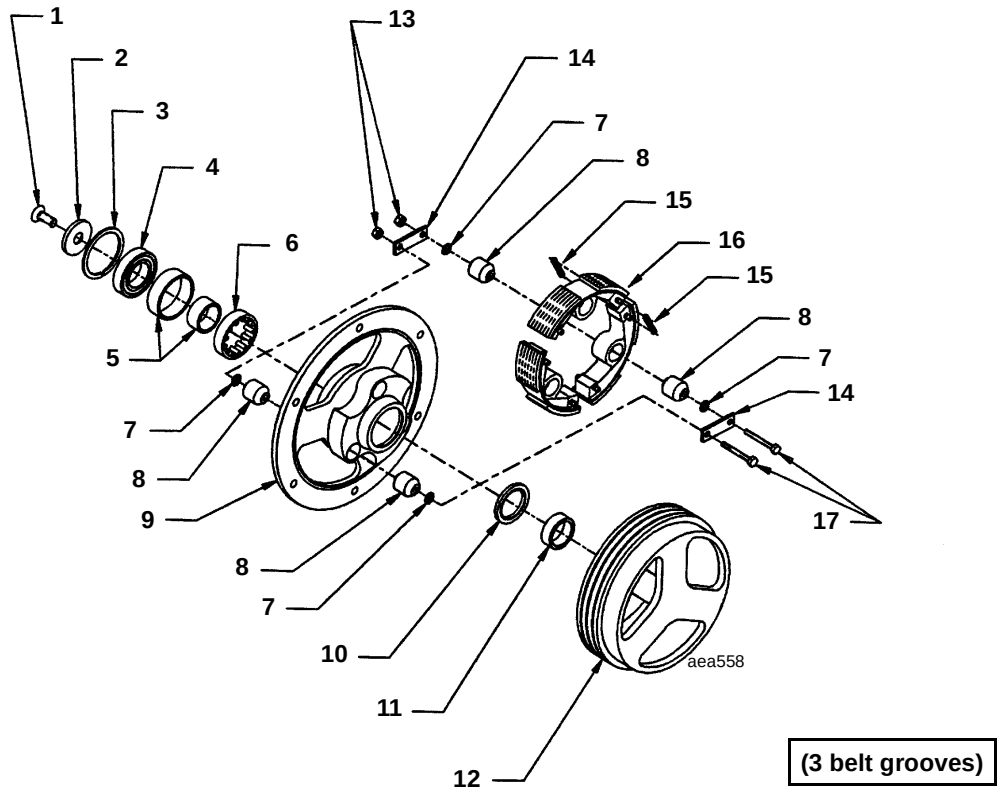


Figure 62: Front View and Cross Section



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 63: 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.

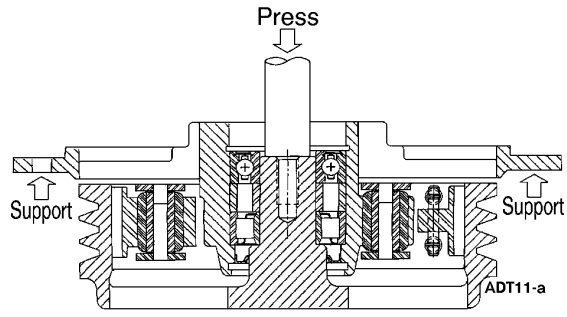


Figure 64: Housing Removal

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.

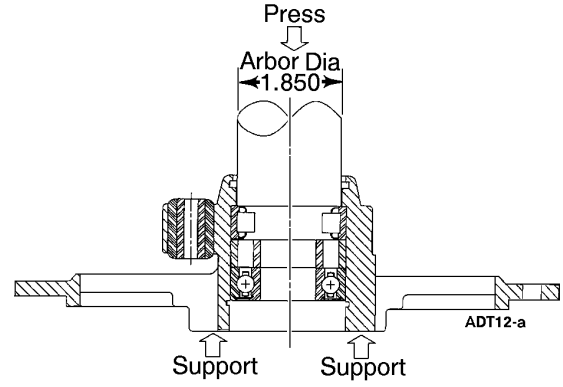


Figure 65: Bearing Removal

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.

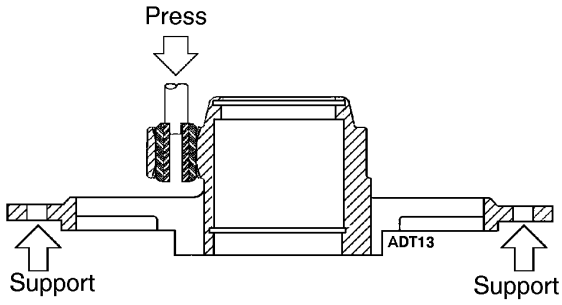


Figure 66: Bushing Removal

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.

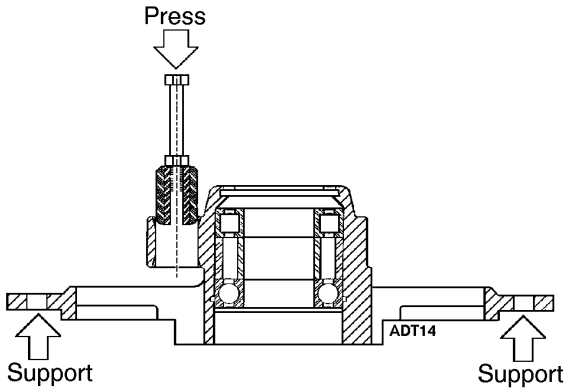


Figure 67: Bushing Insertion

   ****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.

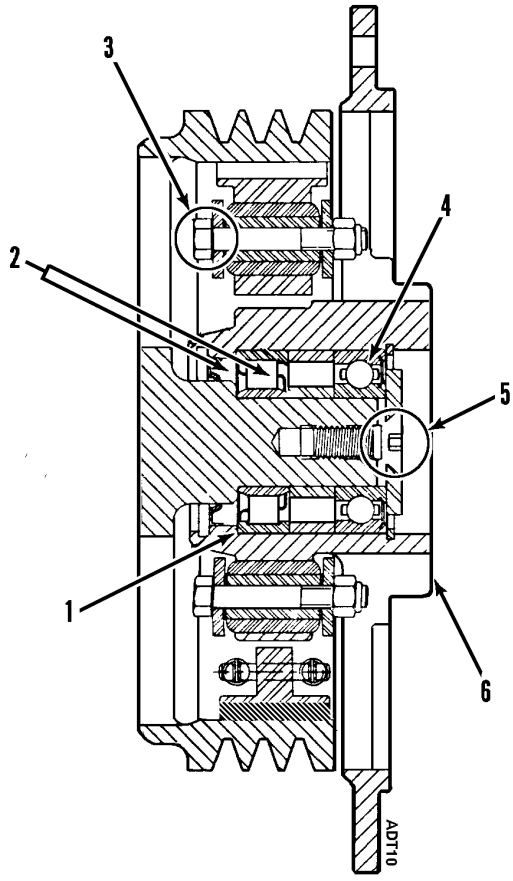
4. Apply a *small* amount of Loctite™ (see Tool Catalog) to O.D. of roller bearing and press into hub bore from the flange end until seated against the step in bore.

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).

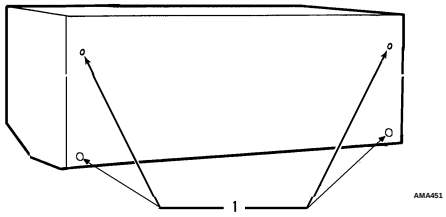


1.	Roller Bearing, Pack with Mobil™ (see Tool Catalog) grease
2.	Pack These Areas with Mobil™ (see Tool Catalog) grease at Assembly
3.	HEX HD Cap Screw (6X), 1-4/28 UNF X 1.75 Long. Torque to 110 ± 5 in-lbs (12.5 ±.6 N•m) ***NOTE: Shoes must be disengaged while tightening 6 bolts and MUST be held tightly 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 68: 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 69: Check Bolts For Tightness

Lift Points

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

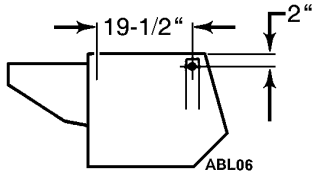


Figure 70: Lift Points

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

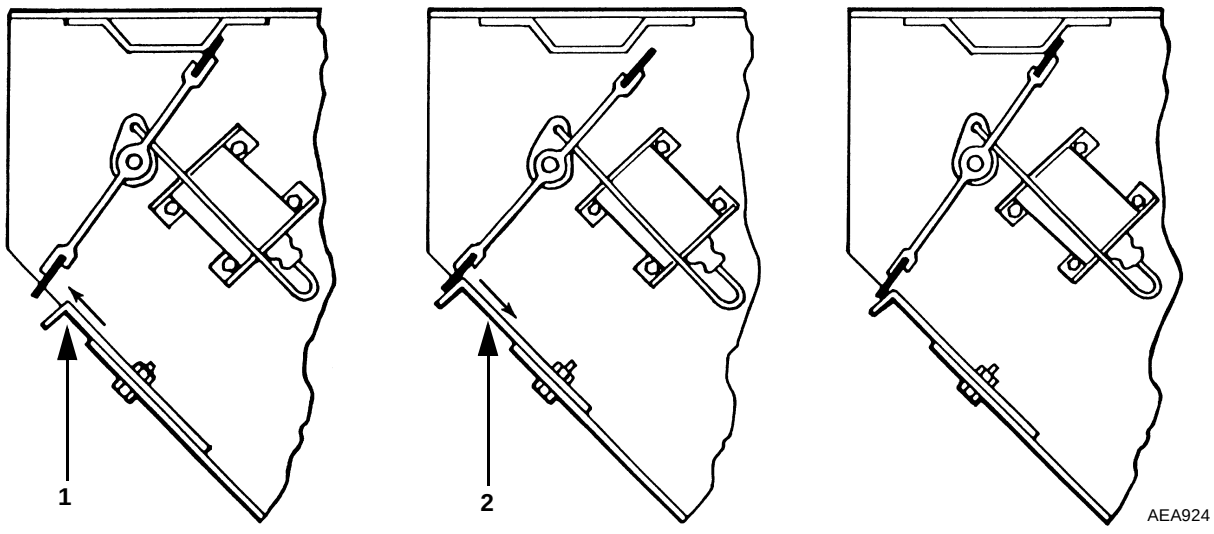
Clean the condenser coil during scheduled maintenance inspections by blowing compressed air from the back side of the coil out toward the front of the unit (direction opposite normal air flow). Inspect the coil and fins for damage and repair if necessary.

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 71: Defrost Damper Adjustment

Jackshaft Assembly

The MD-II MAX 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

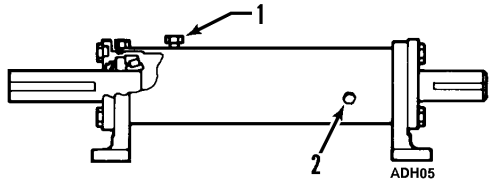
1. Remove jackshaft assembly from the unit and remove the pulleys.
2. Remove the level and fill plugs and drain oil reservoir.
3. Remove bearing retainer cap from fill plug end of the jackshaft assembly.

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.

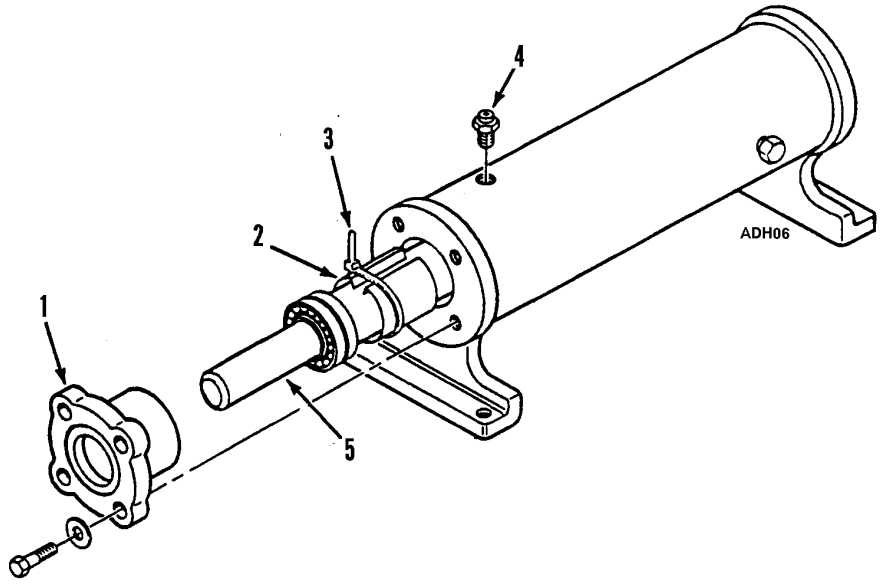
NOTE: The oil sling retainer is pulled out by the bearing assembly on shaft.

5. Remove the retainer cap from level plug end of assembly.
6. Use a punch and hammer to remove the seals and bearing cups from bearing retainer caps.
7. Use a bearing splitter or similar tool to remove the bearing cones from the shaft.
8. Clean all parts in clean solvent and then examine the bearing cups and cones for damage.



1.	Fill Plug and Vent	2.	Oil Level Plug

Figure 72: Jackshaft Assembly



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

Figure 73: Installing Oil Sling Retainer

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

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.

Disassembly

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

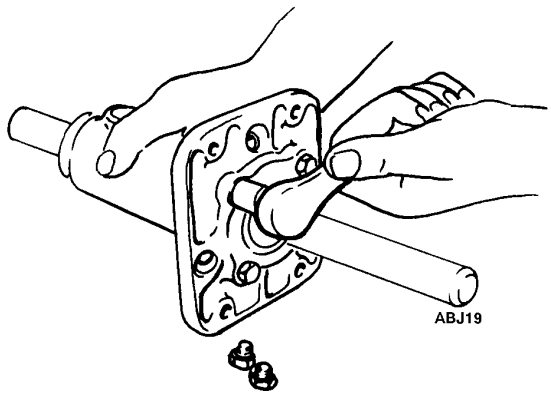


Figure 74: Removing Bearing Retainer Bolts

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

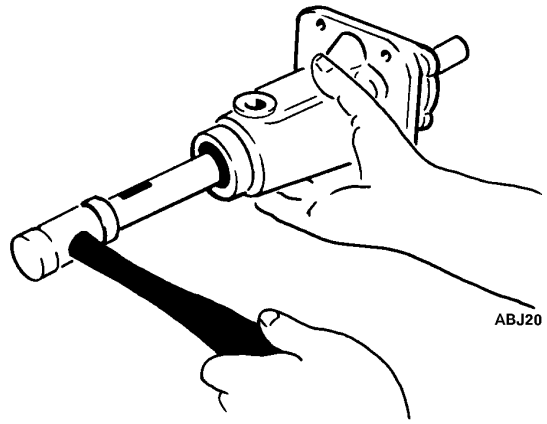


Figure 75: Removing Shaft

4. Using a punch, remove the oil seal from the evaporator end of the assembly. With the seal removed, clean the housing in solvent.

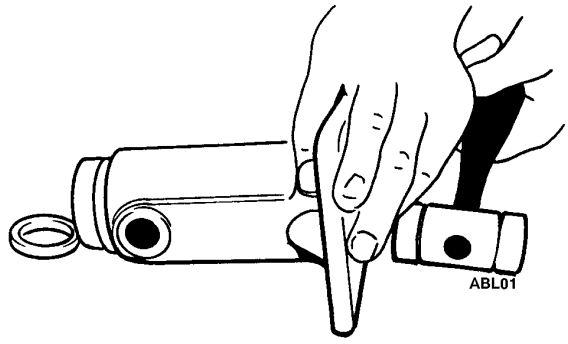


Figure 76: Removing Oil Seal

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.

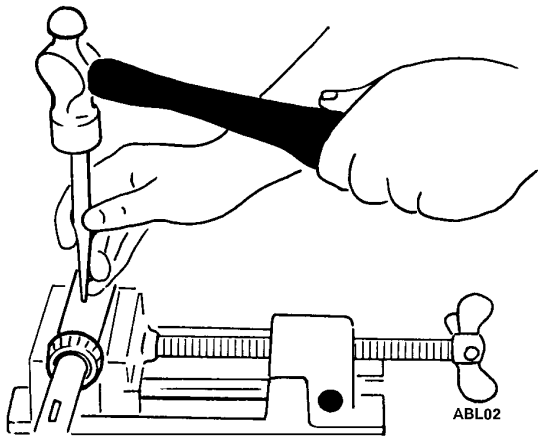


Figure 77: Removing Roll Pin

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.

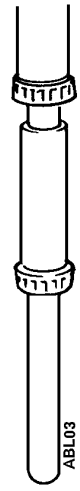


Figure 78: Installing Bearings

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.

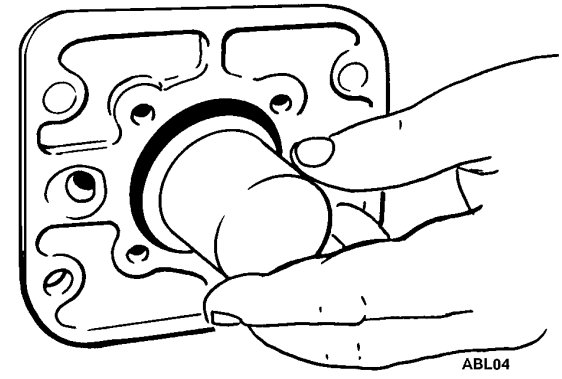


Figure 79: Installing Splash Guard

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

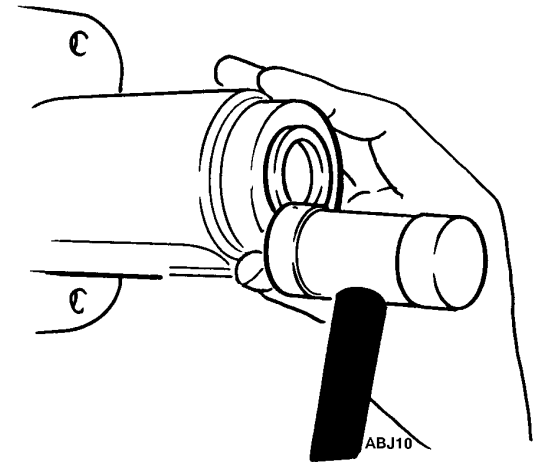


Figure 80: Installing Oil Seal

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.

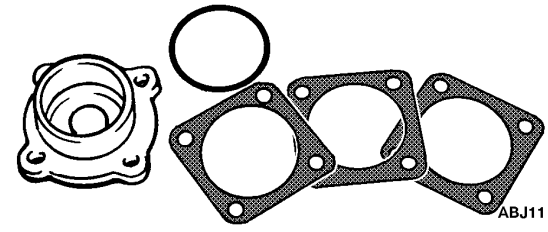


Figure 81: Shims and O-ring

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).

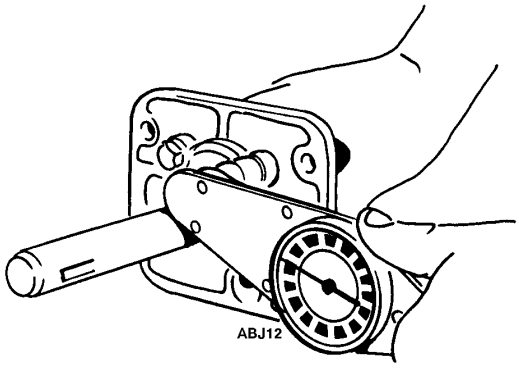


Figure 82: Torquing Retainer Plate Bolts

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

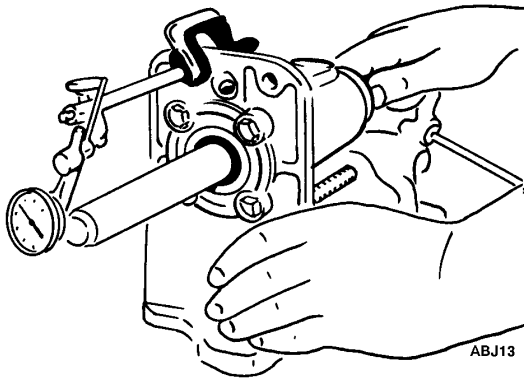


Figure 83: Checking End Play

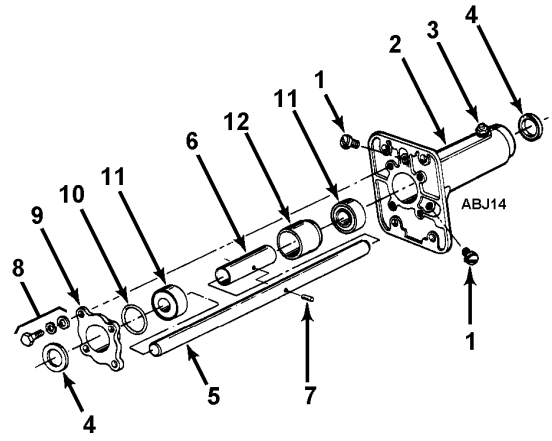
8. After the correct end play is obtained, add grease for the bearings.

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

CYCLE-SENTRY Diagnosis

Condition	Possible Cause	Test Procedure
Unit will not energize the run relay when required	Defective run relay	Test run relay
	Open 7A circuit from selector switch to run relay	Test 7A circuit
	Defective selector switch	Test circuit from 7M to 7A on switch in the start-stop function
	Defective load temperature thermostat	Check load temperature thermostat in Continuous Run mode
	Open D7 or D8 diodes	Test D7 and D8 diodes
	Defective CYCLE-SENTRY IV module	Test CYCLE-SENTRY module
	Open 53 circuit from run relay to CYCLE-SENTRY module	Test 53 circuit
Preheat relay will not energize when required	Defective preheat relay	Test preheat relay
	Open 52A circuit from preheat relay to CYCLE-SENTRY module	Test 52A circuit
	Open D7 or D8 diodes	Test D7 or D8 diodes
	Defective CYCLE-SENTRY module	Test CYCLE-SENTRY module
	Open CH circuit to CYCLE-SENTRY module	Test CH circuit
	Open 7A circuit from selector switch to the preheat relay	Test 7A circuit
	Open 2A circuit to preheat relay (after 9-89)	Test 2A circuit
Unit will not automatically crank, but will preheat automatically	Defective CYCLE-SENTRY module	Test CYCLE-SENTRY module
	Open 52 circuit from start relay to starter	Test 52 circuit
	Open 8S circuit from start relay to starter	Test 8S circuit
	Defective start relay	Test start relay
	Defective starter	Test starter
Unit will not automatically crank, but will preheat automatically (continued)	Open 8 circuit to starter relay (after 9-89)	Test 8 circuit
	Open 7A circuit to starter relay	Test 7A circuit
Unit disengaged starter before engine is running	Defective CYCLE-SENTRY module	Test CYCLE-SENTRY module
	Low battery condition	Test battery under load
	Defective starter	Test starter in Continuous Run mode

Condition	Possible Cause	Test Procedure
Unit does not disengage starter when engine is started	Defective starter	Test starter in Continuous Run mode
	Defective RPM sensor	Test 52A circuit
	Open or grounded FS-1 or FS-2 circuit from RPM sensor to CYCLE-SENTRY module	Test FS-1 or FS-2 circuit
	Defective CYCLE-SENTRY module	Test CYCLE-SENTRY module
Unit turns On and reset switch trips	Unit fails to start (normal indication)	Test for normal starting in Continuous mode
	Open 52 circuit from start relay to CYCLE-SENTRY module	Test 52 circuit
	Open 8S circuit from start relay to starter	Test 8S circuit
	Defective CYCLE-SENTRY module	Test CYCLE-SENTRY module
Standard 4-mode unit has no low speed cool in automatic start-stop mode (unit shuts Off after High Speed Cool	Defective thermostat	Test thermostat
	Open diode D6	Test D6 diode
Standard 4-mode unit will not initiate start from defrost	Open 29 circuit	Test 29 circuit to PC board
	Open D11 diode or R9 resistor, or 29T circuit on PC board	Test D11 diode or R9 resistor and 29T circuit on PC board to thermostat
	Defective thermostat	Test unit thermostat
Unit will not initiate start if engine temperatures drop below 60.0 F (15.5 C)	Defective block temperature thermostat	Test block temperature thermostat
	Open 8B circuit to block temperature thermostat	Test 8B circuit
	Open 7A circuit from block temperature thermostat to run relay	Test 7A circuit
Unit will not stop when load temperature thermostat is satisfied	Defective block temperature thermostat switch	Test block temperature thermostat switch
	Defective load temperature thermostat	Test load temperature thermostat in Continuous Run mode
	Engine temperature below 120 F (49.0 C)	Check engine temperature after warm up
	Battery not charged	Charge battery
	Defective battery sentry	Replace battery sentry
	Charging system faulty	Correct charging system

Electric Standby (Optional) Diagnosis

Condition	Possible Cause	Remedy
Unit switch On—indicator lights do not come On	Battery discharged	Charge or replace battery
	Remote switch off	Turn On switch (optional)
	Circuit breaker or safety switch open	Push in button. Replace switch if defective
	Electric motor reset switch tripping	Check for short circuit in unit wiring (high voltage)
	Fuse link blown	Replace fuse link
	Dirty battery terminals	Clean and retighten terminals
Unit switch On—indicator lights come On but electric motor does not run	Diesel/Electric switch on Diesel	Move switch to Electric position
	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
	Defective low oil pressure switch	Replace low oil pressure switch
	Overload relay tripping	Check for shorted motor windings or wires
	Defective motor	Replace motor
	Batteries discharged	Charge ore 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
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
	Poor ground on PC board	Test ground circuit on PC board
	Defective thermostat relay	Check operation of thermostat relay

Condition	Possible Cause	Remedy
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
	26 wire open	Locate open and repair
	Defective high temperature switch or sensor	Replace switch or sensor
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 repalce regulator
	Battery defective	Replace battery
	Alternator defective	Repair or replace alternator
	Loose belt	Tighten belt
	Dirty battery terminals	Clean and retighten

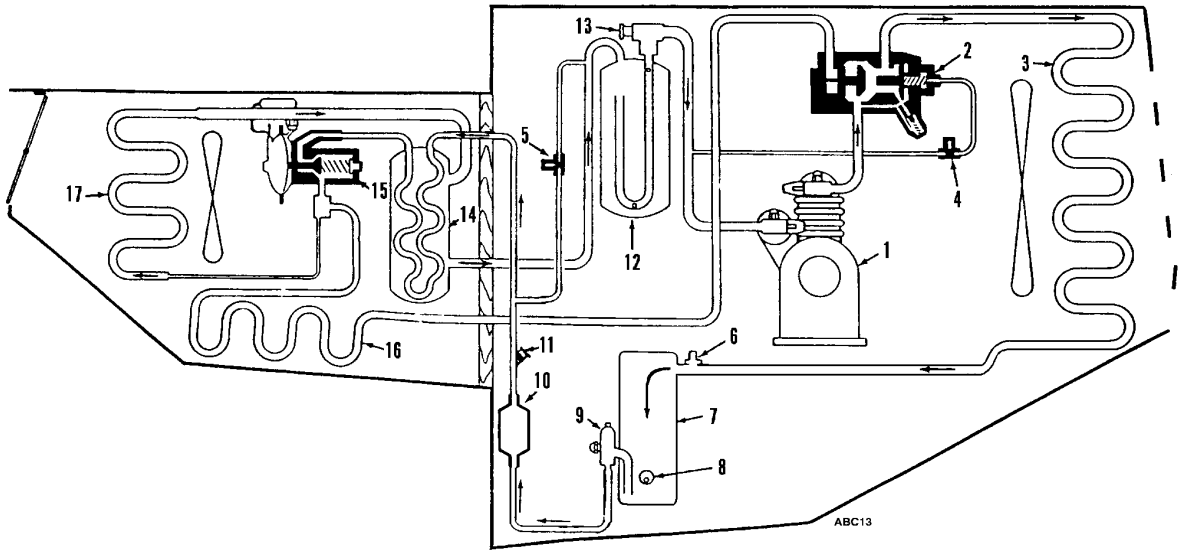
Refrigeration Diagnosis

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

Refrigeration Diagrams

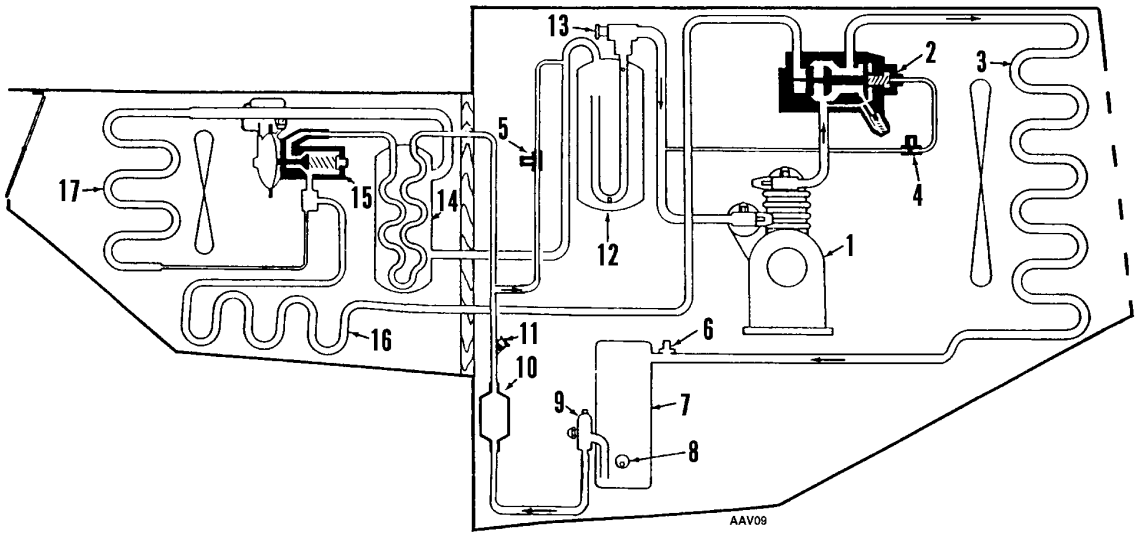
Cool Cycle—MD-II with TherMax™ Heating



1.	Compressor	10.	Dehydrator
2.	Three-Way Valve	11.	Receiver Outlet Check Valve
3.	Condenser Coil	12.	Accumulator Tank
4.	Pilot Solenoid	13.	Suction Pressure Regulator
5.	Heat Solenoid	14.	Heat Exchanger
6.	High Pressure Relief Valve	15.	Expansion Valve
7.	Receiver Tank	16.	Pan Heater
8.	Sight Glass	17.	Evaporator Coil
9.	Receiver Outlet Valve		

Figure 85: Cool Cycle Diagram

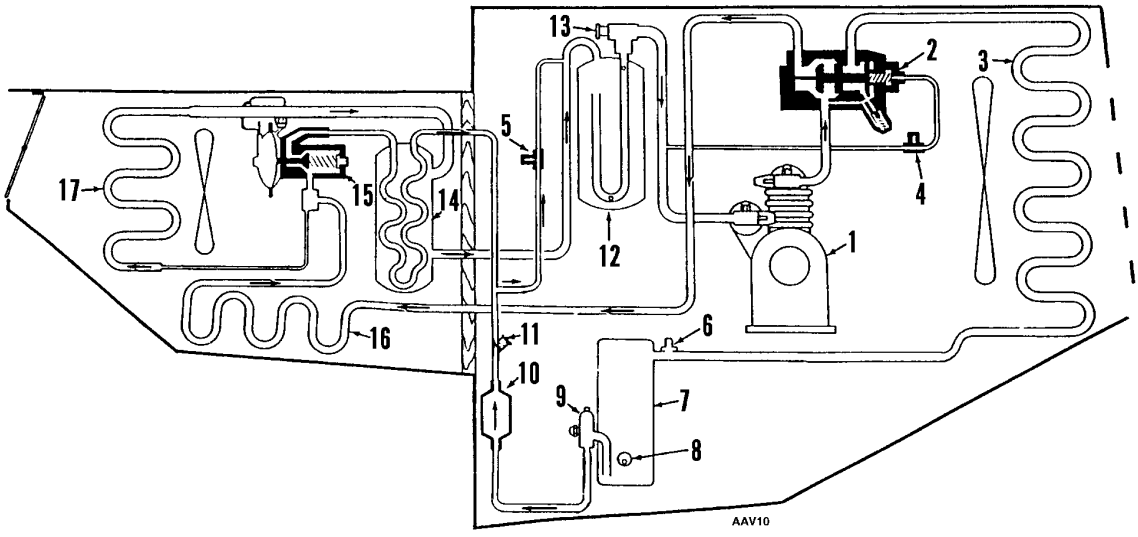
Condenser Evacuation Cycle—MD-II with TherMax™ Heating



1.	Compressor	10.	Dehydrator
2.	Three-Way Valve	11.	Receiver Outlet Check Valve
3.	Condenser Coil	12.	Accumulator Tank
4.	Pilot Solenoid	13.	Suction Pressure Regulator
5.	Heat Solenoid	14.	Heat Exchanger
6.	High Pressure Relief Valve	15.	Expansion Valve
7.	Receiver Tank	16.	Pan Heater
8.	Sight Glass	17.	Evaporator Coil
9.	Receiver Outlet Valve		

Figure 86: Condenser Evacuation Cycle Diagram

Heat and Defrost Cycle—MD-II with TherMax™ Heating



1.	Compressor	10.	Dehydrator
2.	Three-Way Valve	11.	Receiver Outlet Check Valve
3.	Condenser Coil	12.	Accumulator Tank
4.	Pilot Solenoid	13.	Suction Pressure Regulator
5.	Heat Solenoid	14.	Heat Exchanger
6.	High Pressure Relief Valve	15.	Expansion Valve
7.	Receiver Tank	16.	Pan Heater
8.	Sight Glass	17.	Evaporator Coil
9.	Receiver Outlet Valve		

Figure 87: Heat and Defrost Cycle Diagram

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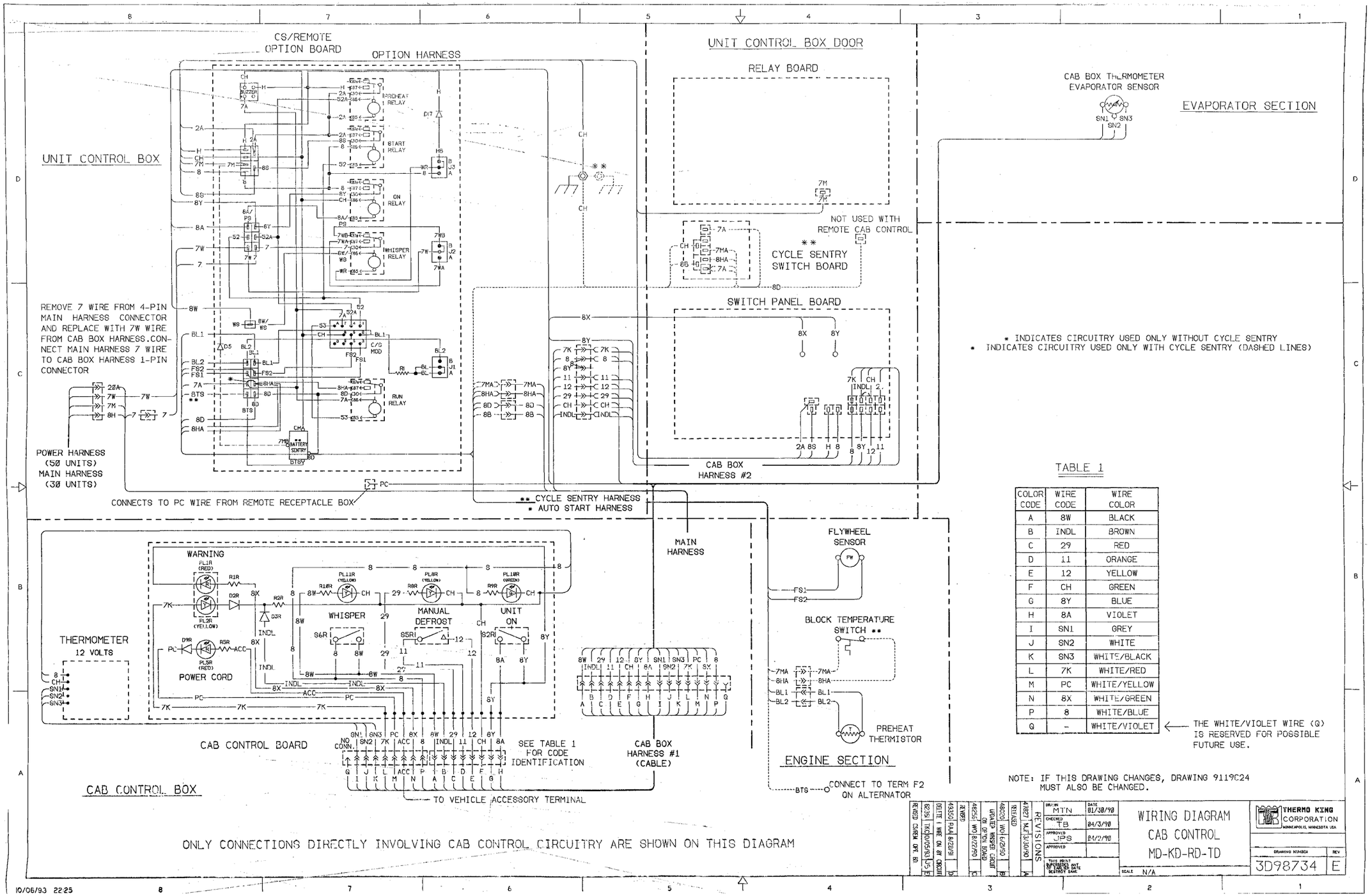
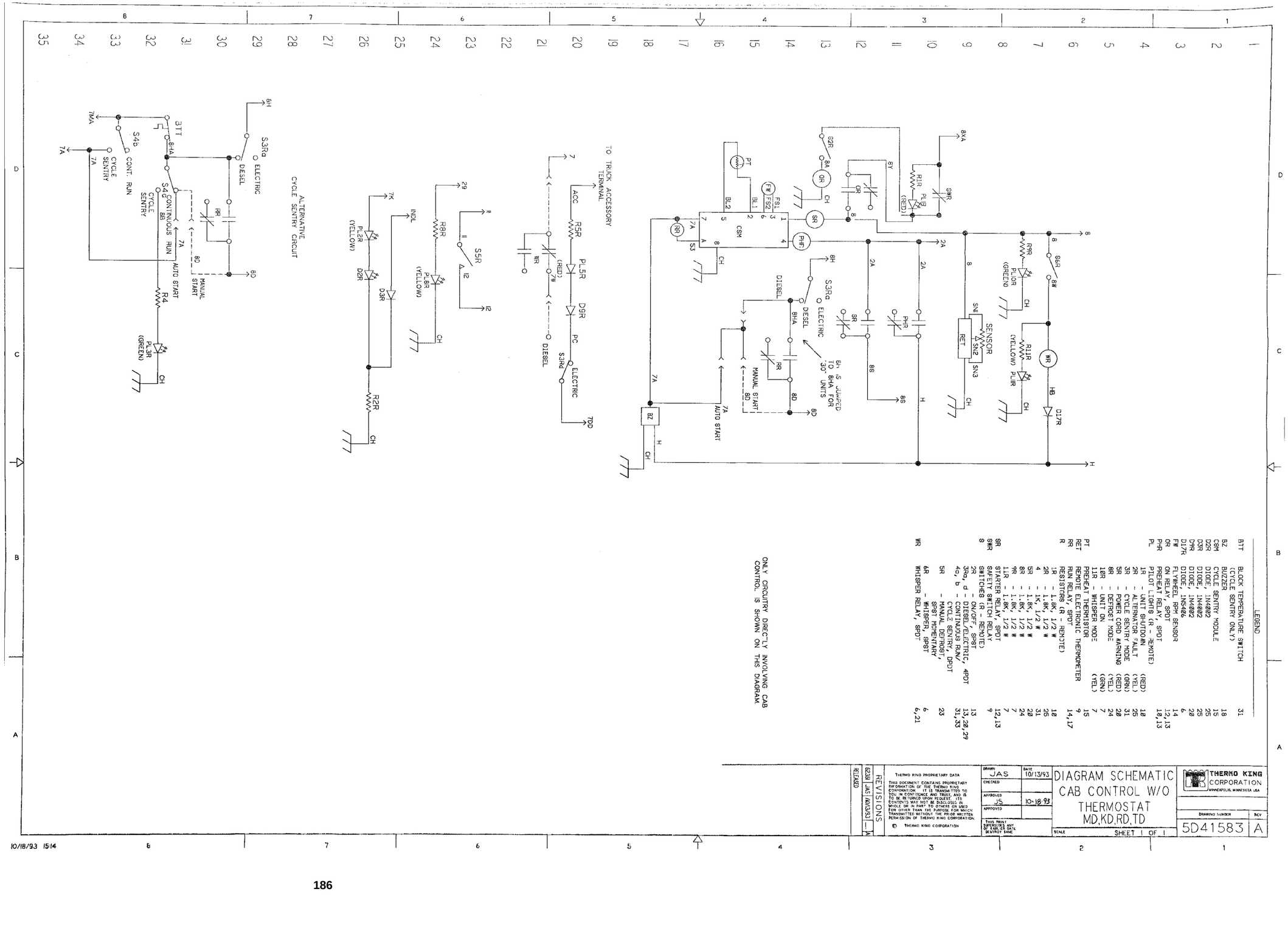
Wiring and Schematic Diagrams Index

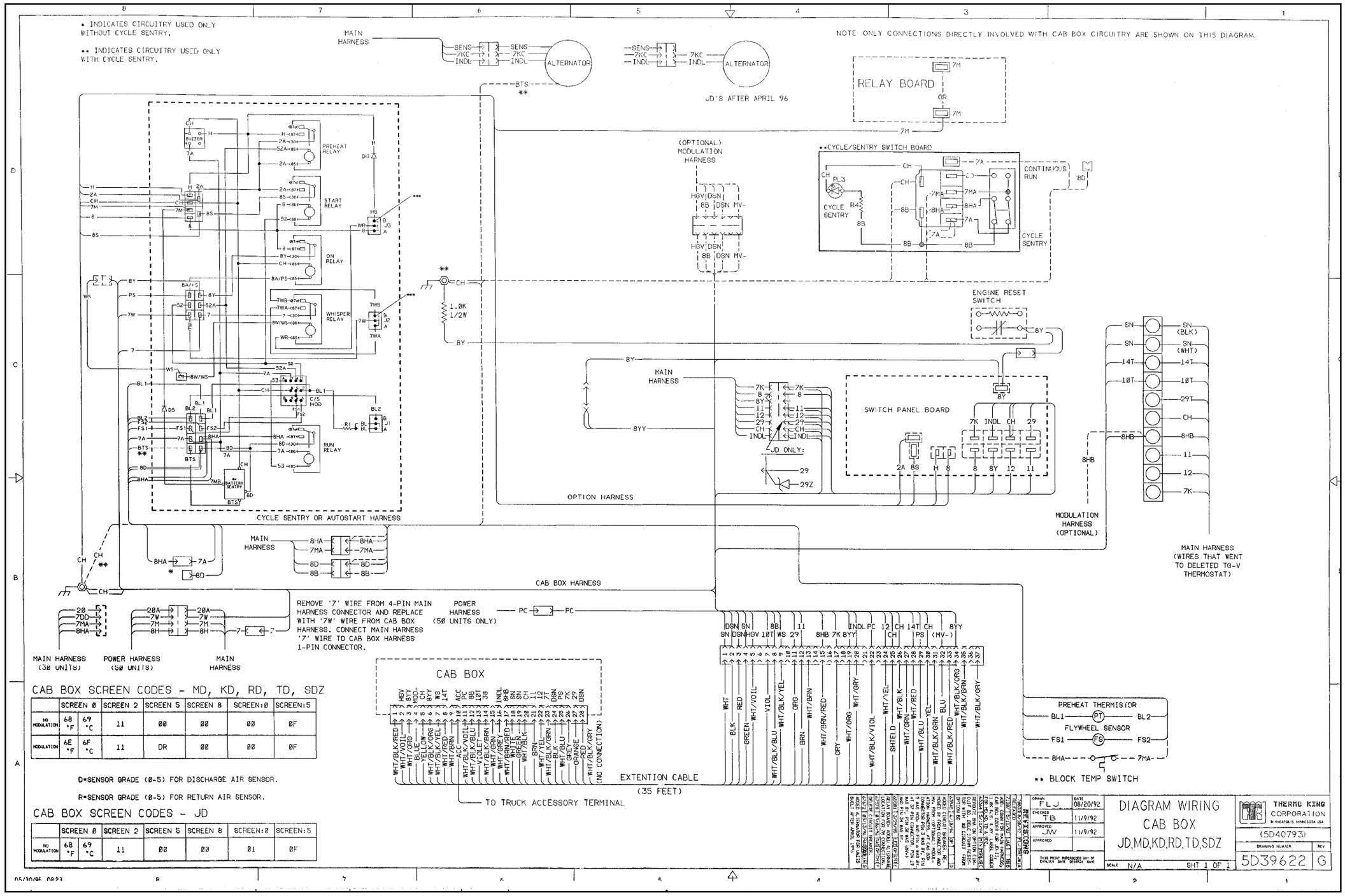
Cab Control MD Wiring Diagram



MD w/o Thermostat Cab Control Schematic



MD Cab Box Wiring Diagram



CAB BOX SCREEN CODES - MD, KD, RD, TD, SDZ

	SCREEN 0		SCREEN 2	SCREEN 5	SCREEN 8	SCREEN:0	SCREEN:5
NO MODULATION	68 °F	69 °C	11	00	00	00	0F
MODULATION	6E °F	6F °C	11	DR	00	00	0F

D=SENSOR GRADE (0-5) FOR DISCHARGE AIR SENSOR.

R=SENSOR GRADE (0-5) FOR RETURN AIR SENSOR.

CAB BOX SCREEN CODES - JD

	SCREEN 0		SCREEN 2	SCREEN 5	SCREEN 8	SCREEN:0	SCREEN:5
NO MODULATION	68 °F	69 °C	11	00	00	01	0F

DRAWN	FLJ	08/20/92
CHECKED	TB	11/9/92
APPROVED	JW	11/9/92
APPROVED		

DIAGRAM WIRING CAB BOX JD,MD,KD,RD,TD,SDZ

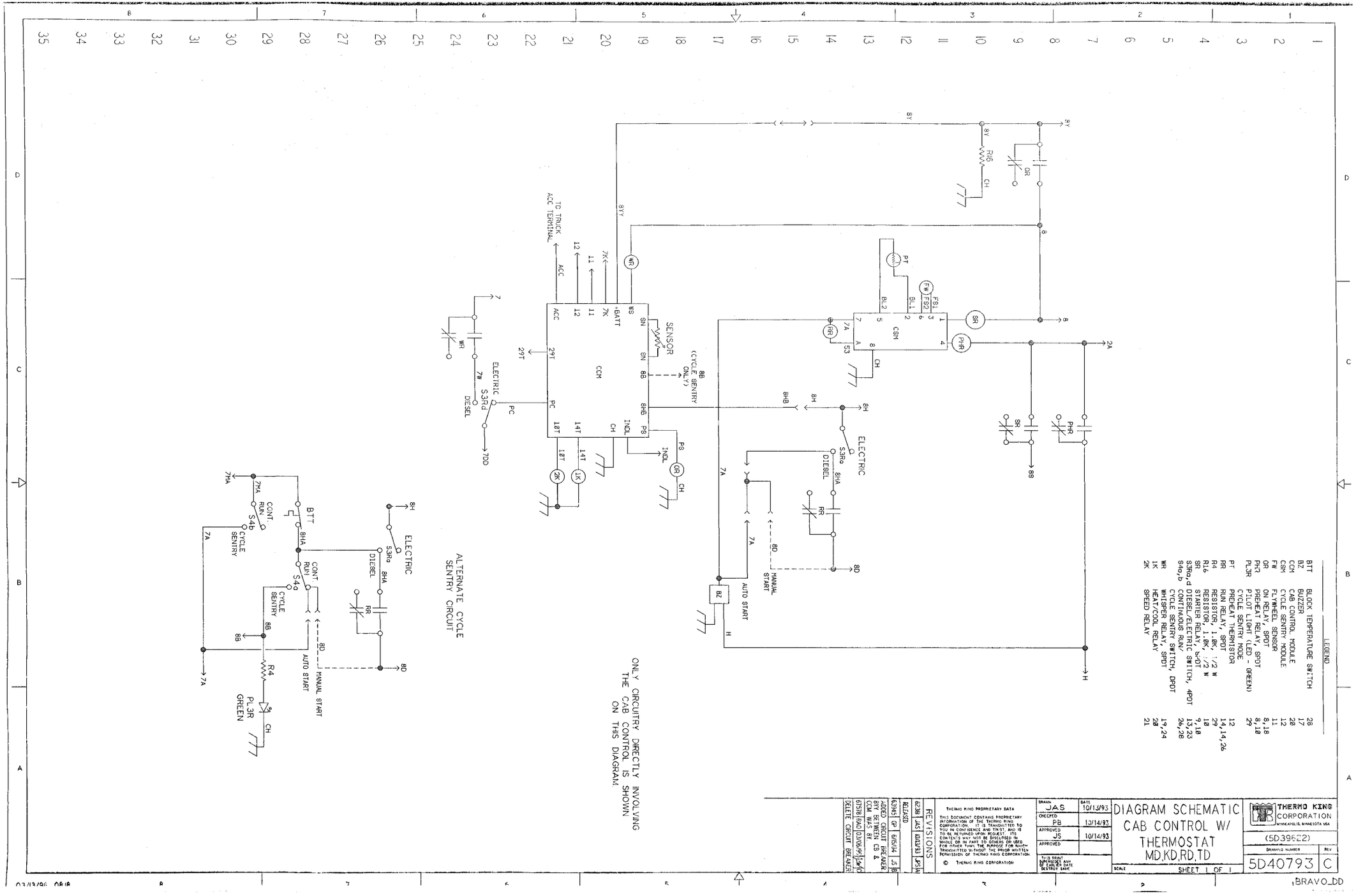
THERMO KING CORPORATION MINNEAPOLIS, MINNESOTA USA

(5D40793)

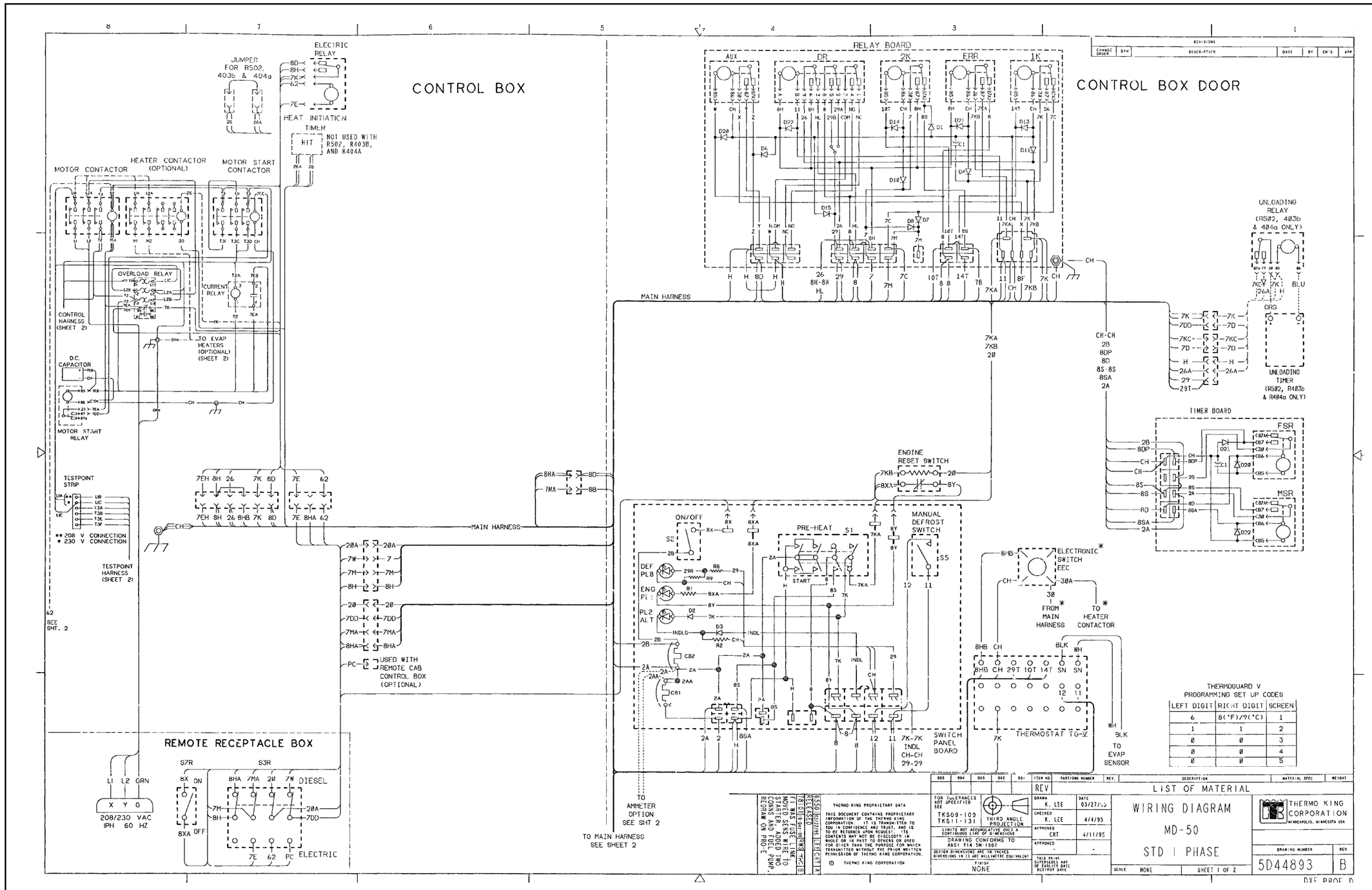
DRAWING NUMBER	REV
5D39622	G

SCALE N/A SHT 1 OF 1

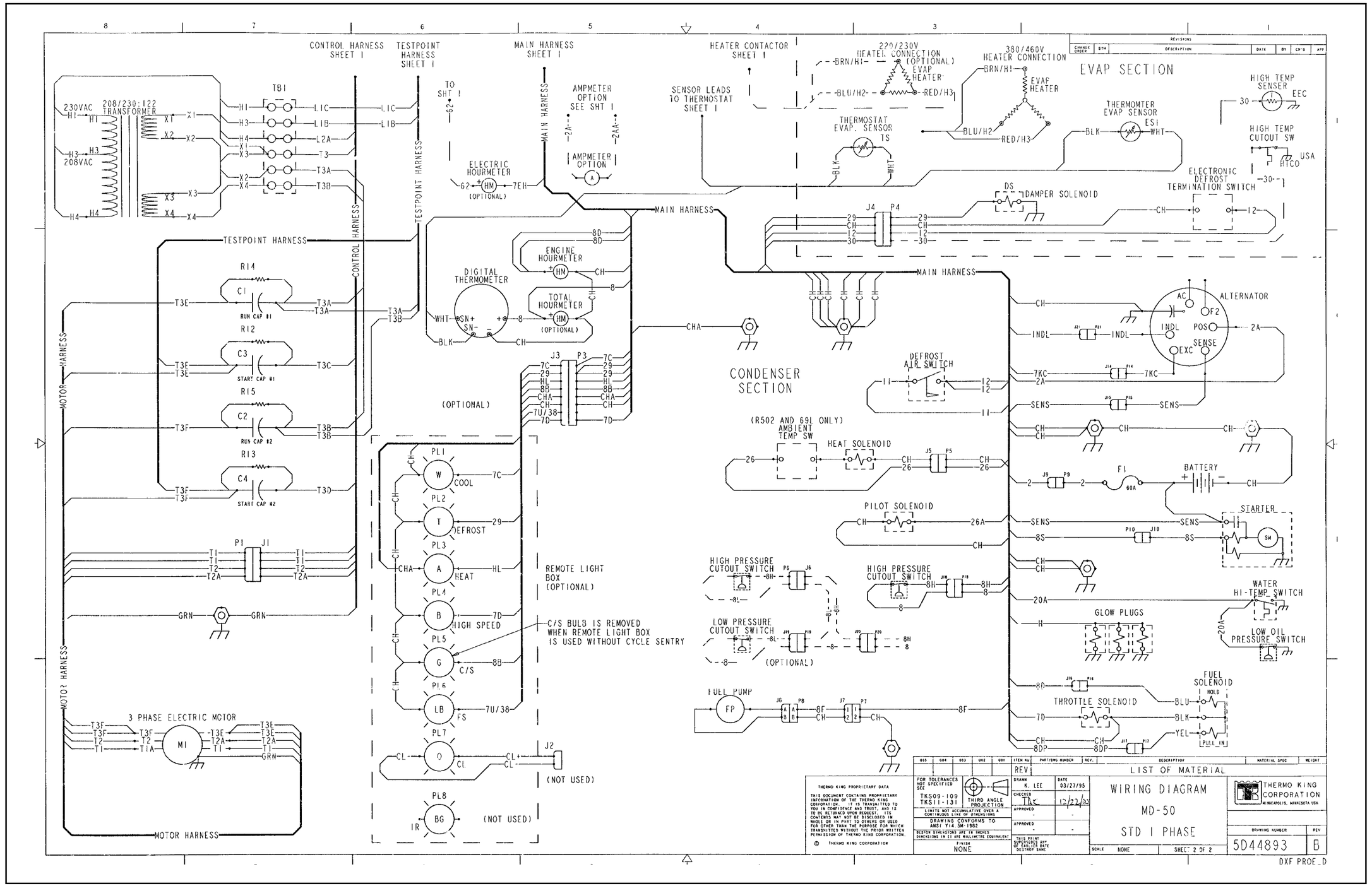
MD Cab Control w/Thermostat Schematic Diagram



MD-II 50 STD 1-Phase Wiring Diagram—Page 1 of 2



MD-II 50 STD 1-Phase Wiring Diagram—Page 2 of 2



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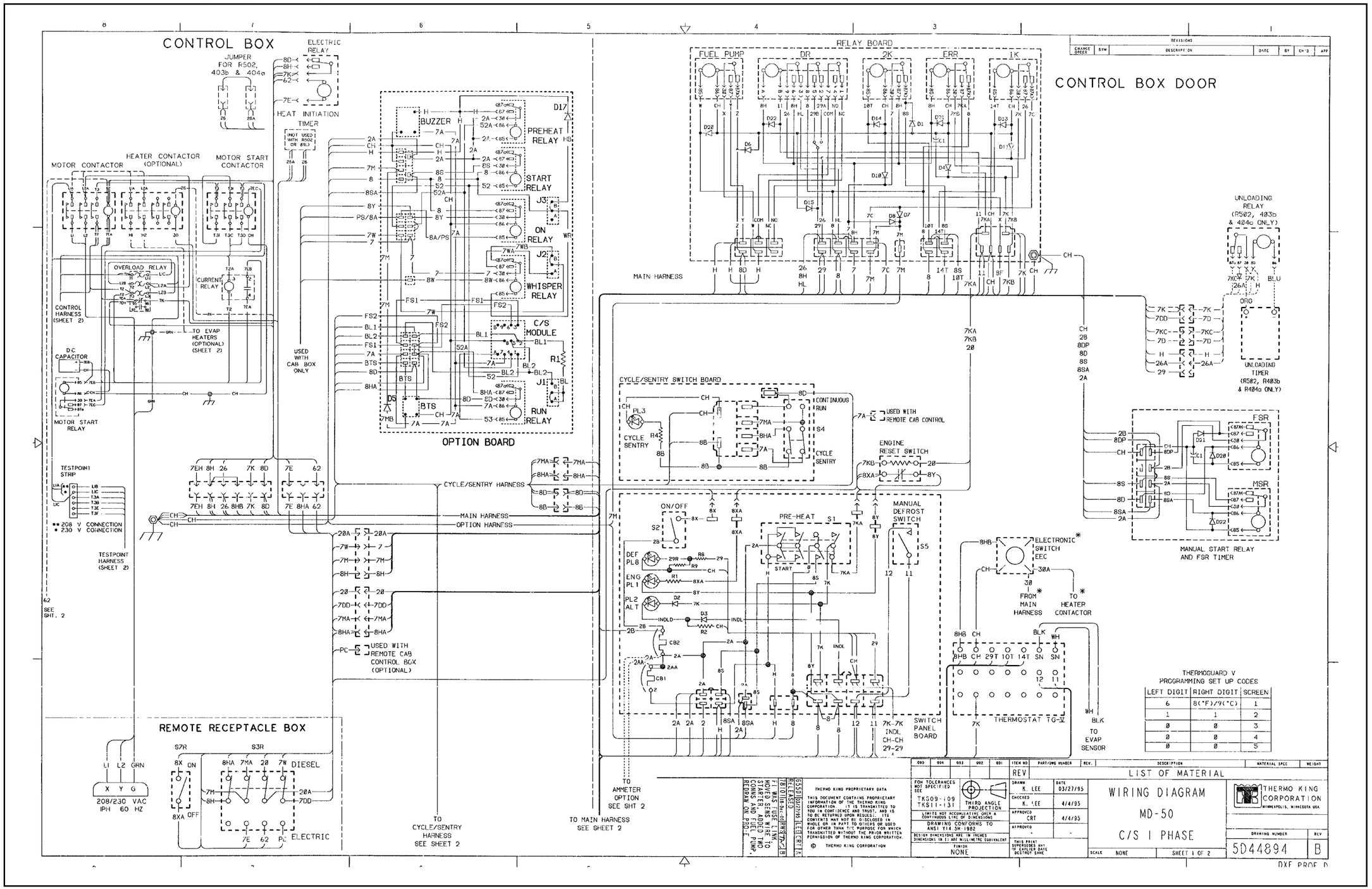
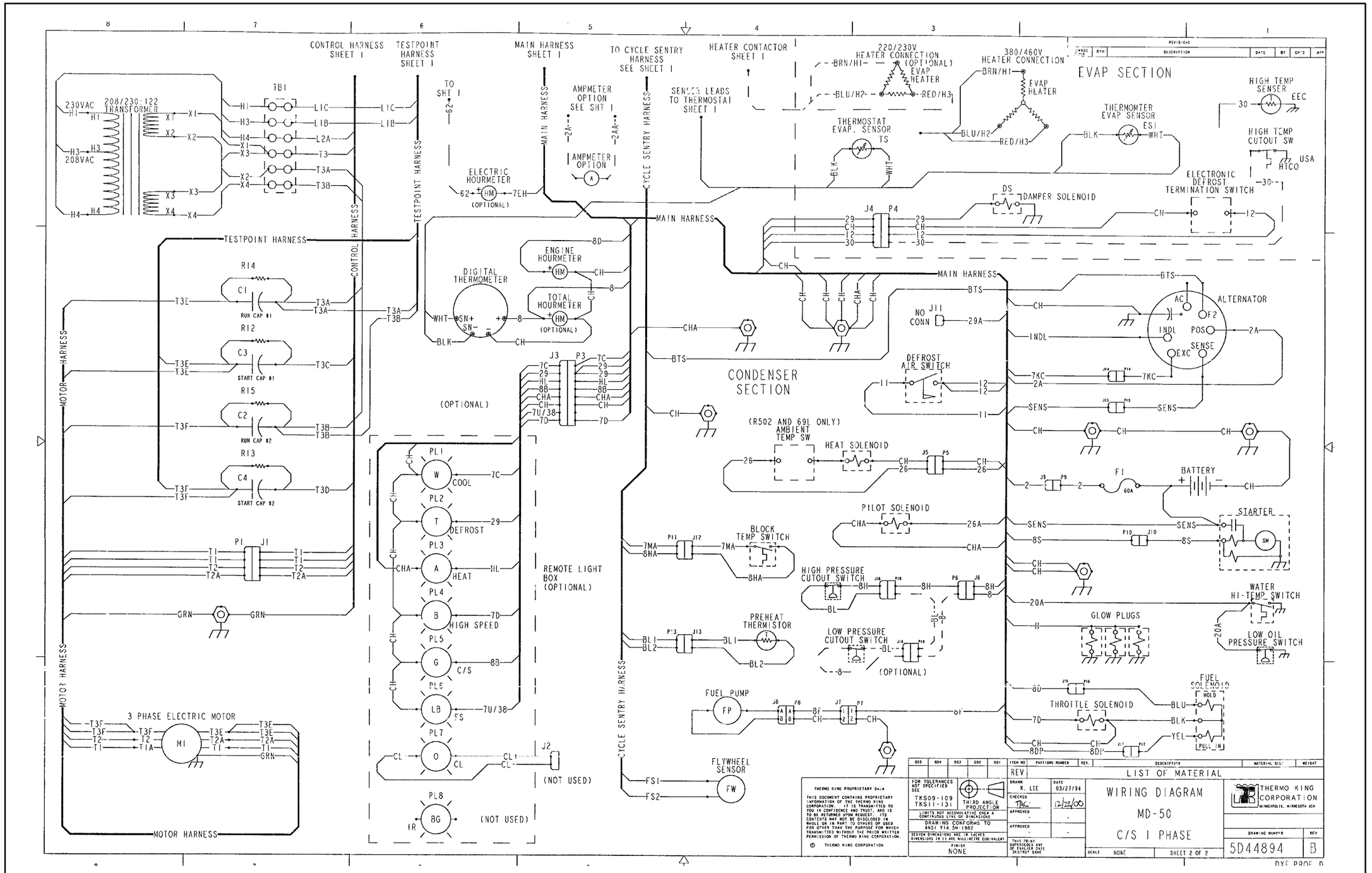
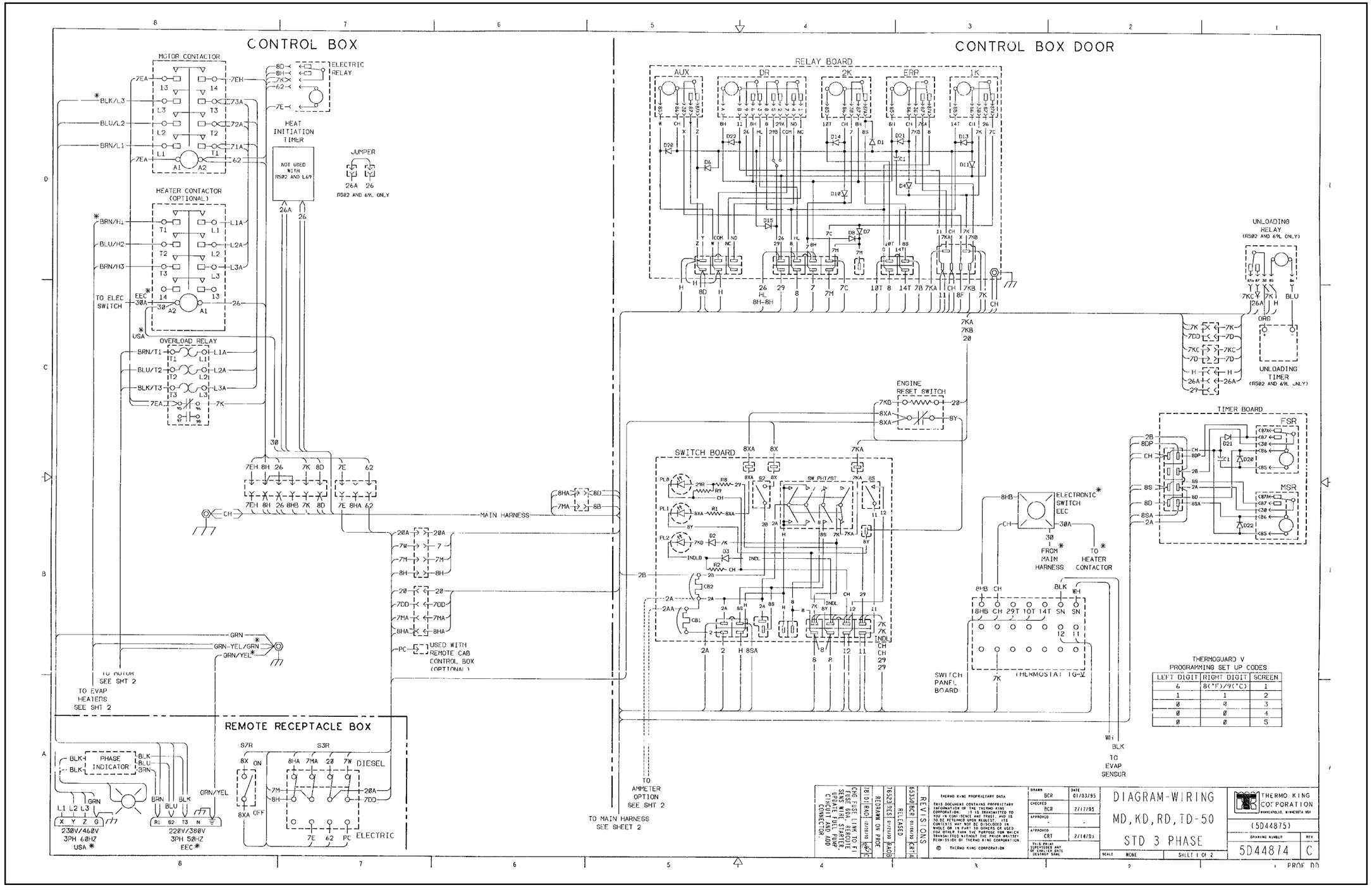


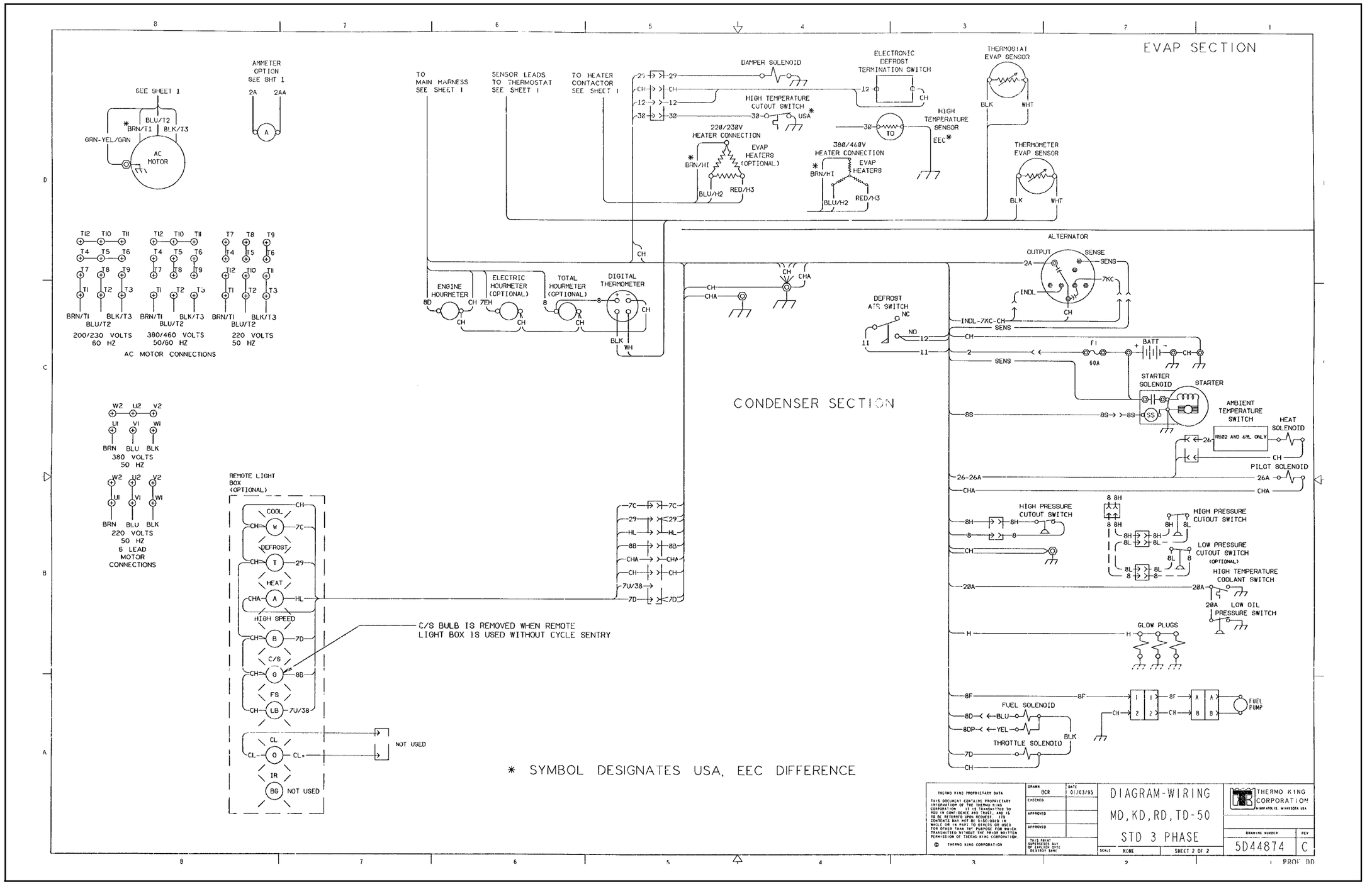
MD-II 50 C/S 1-Phase Wiring Diagram—Page 2 of 2



MD 50 STD 3-Phase Wiring Diagram—Page 1 of 2



MD 50 STD 3-Phase Wiring Diagram—Page 2 of 2



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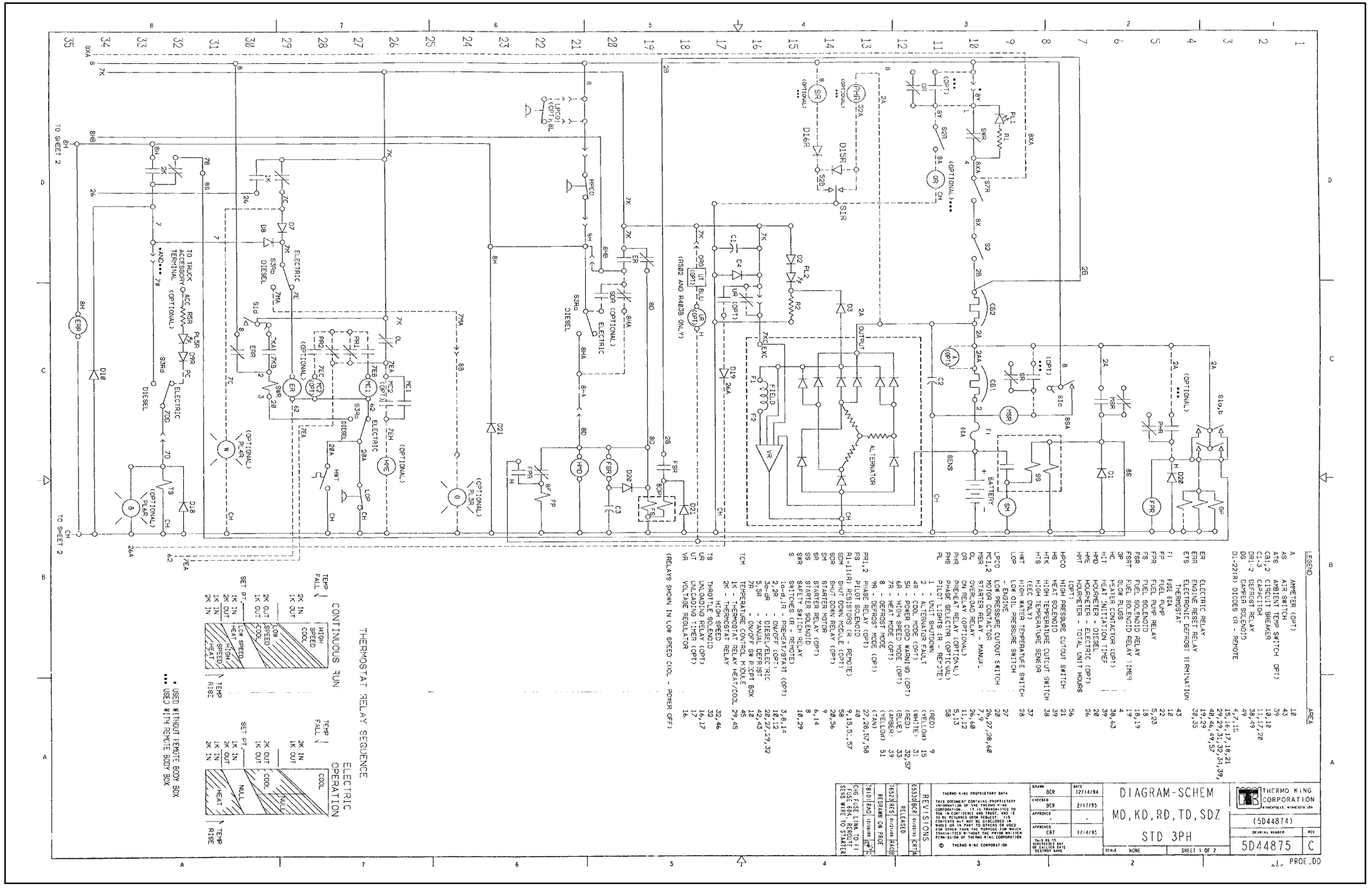

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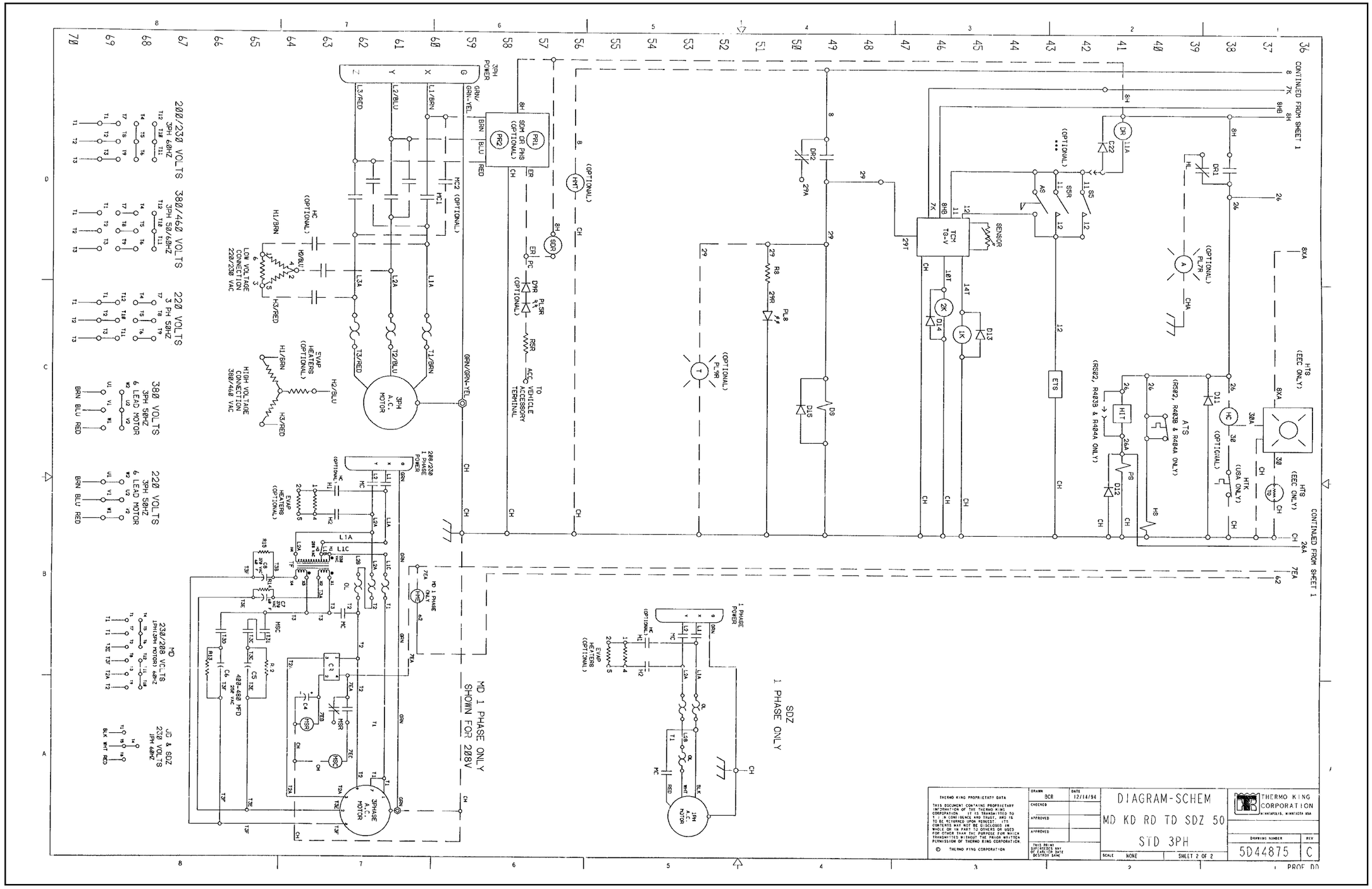

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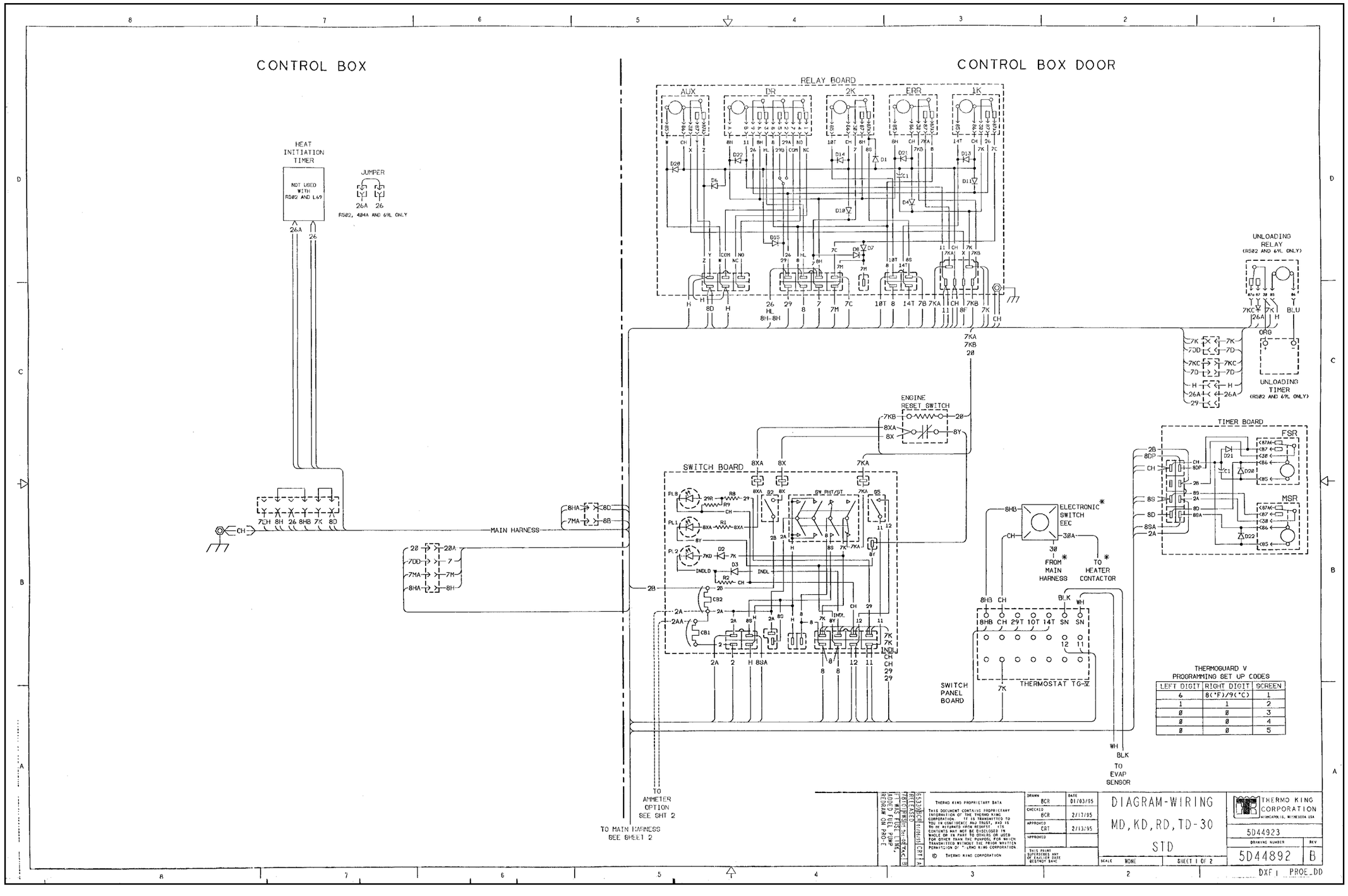

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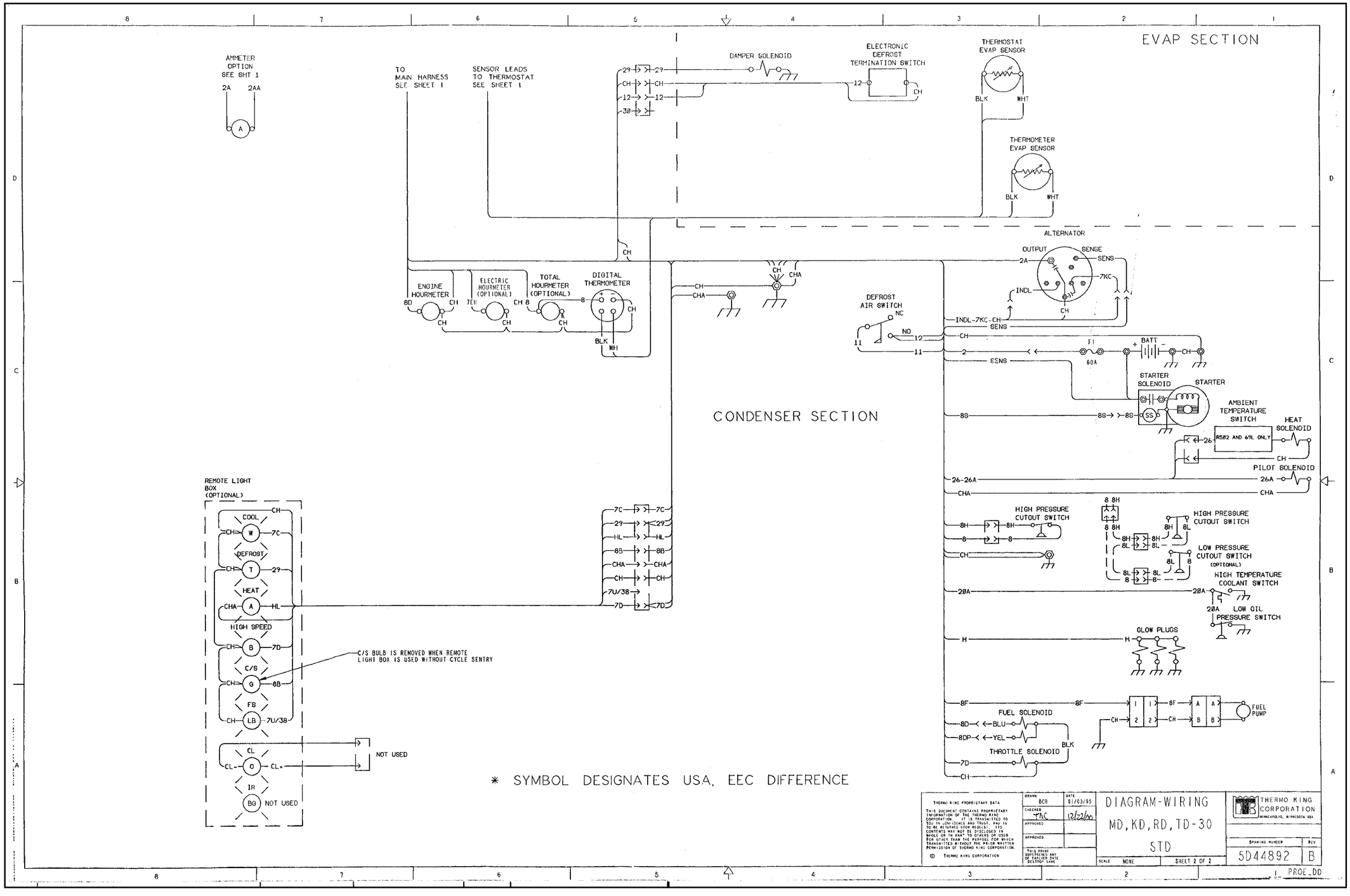

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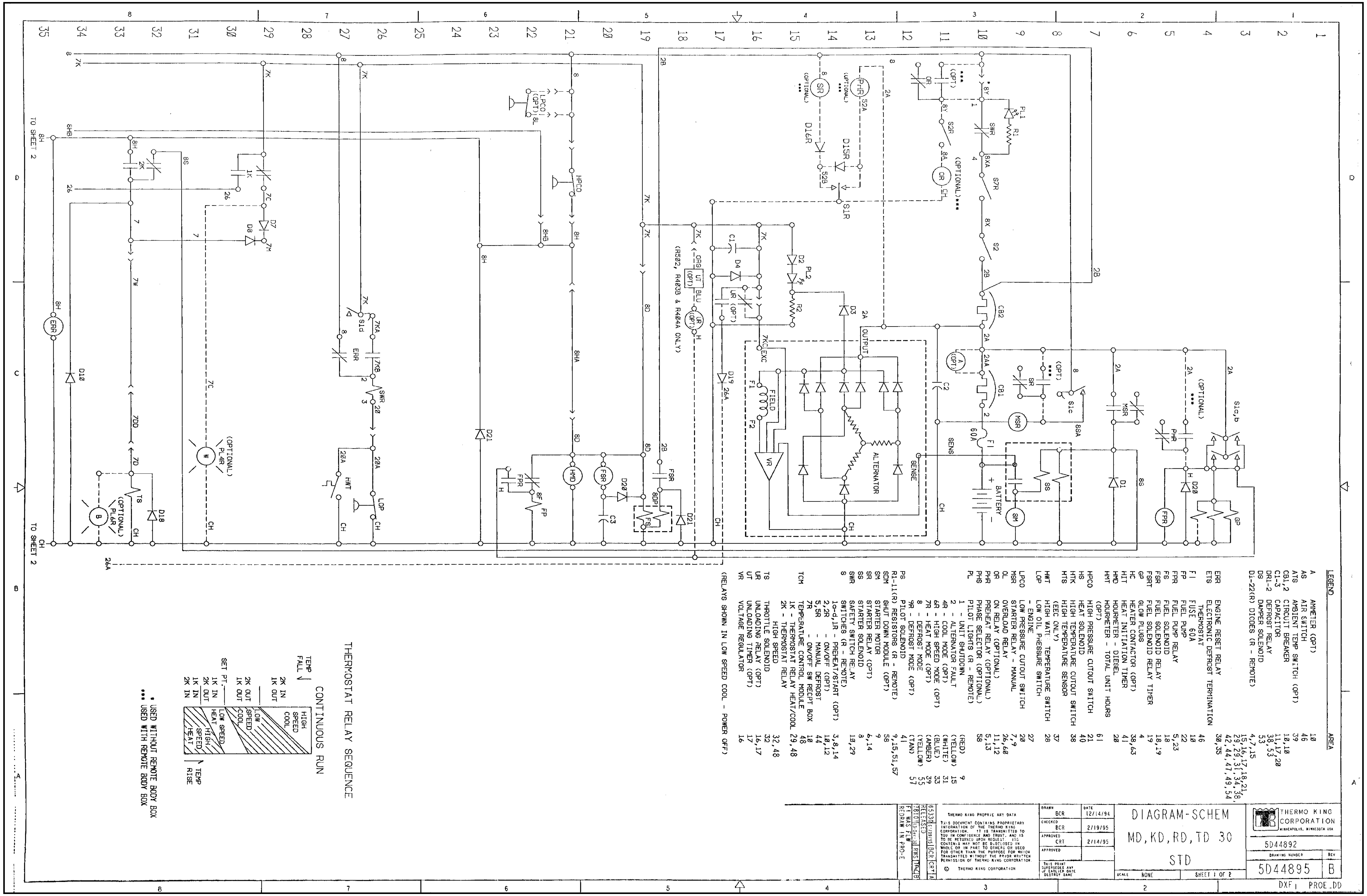

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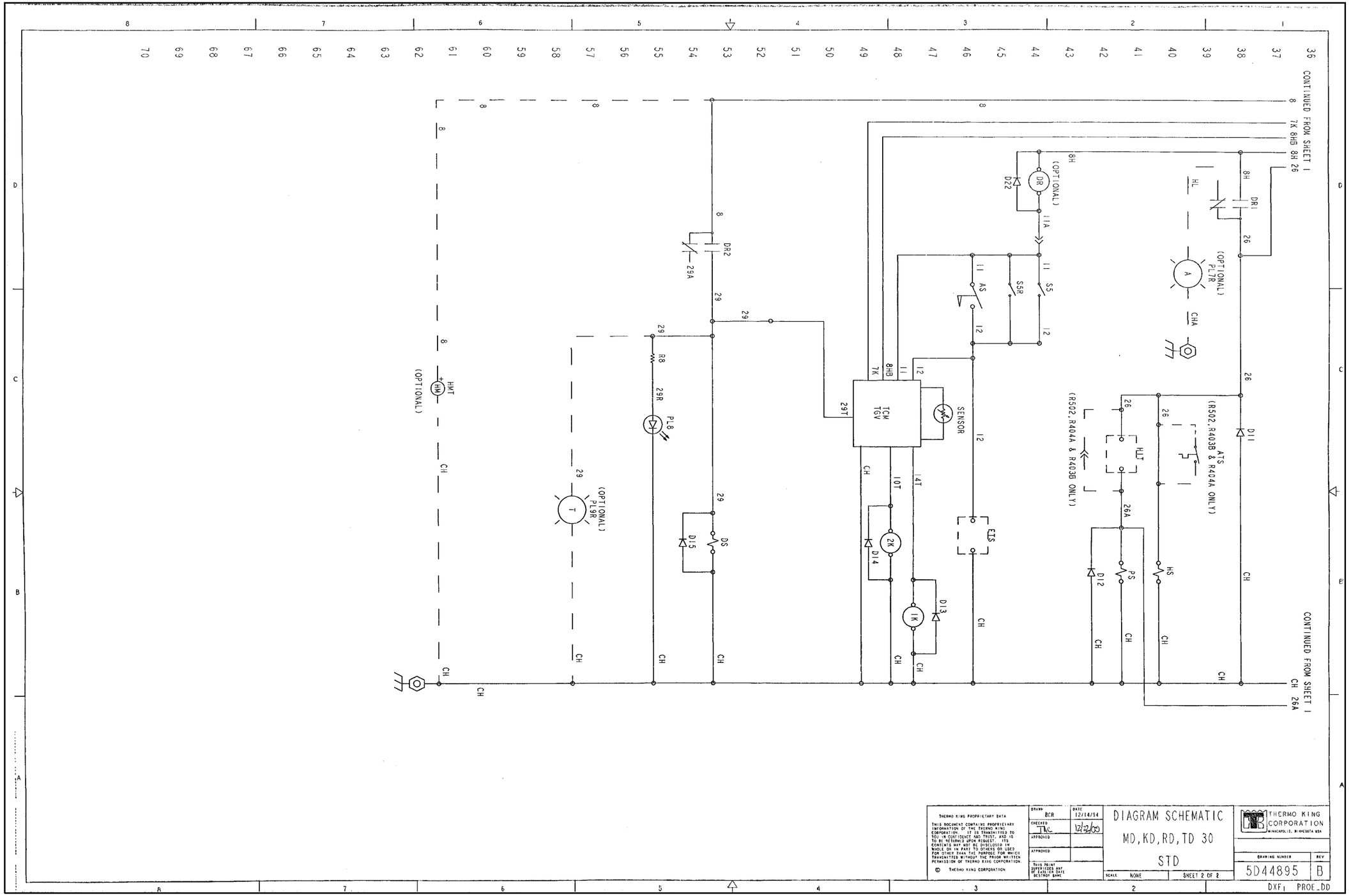

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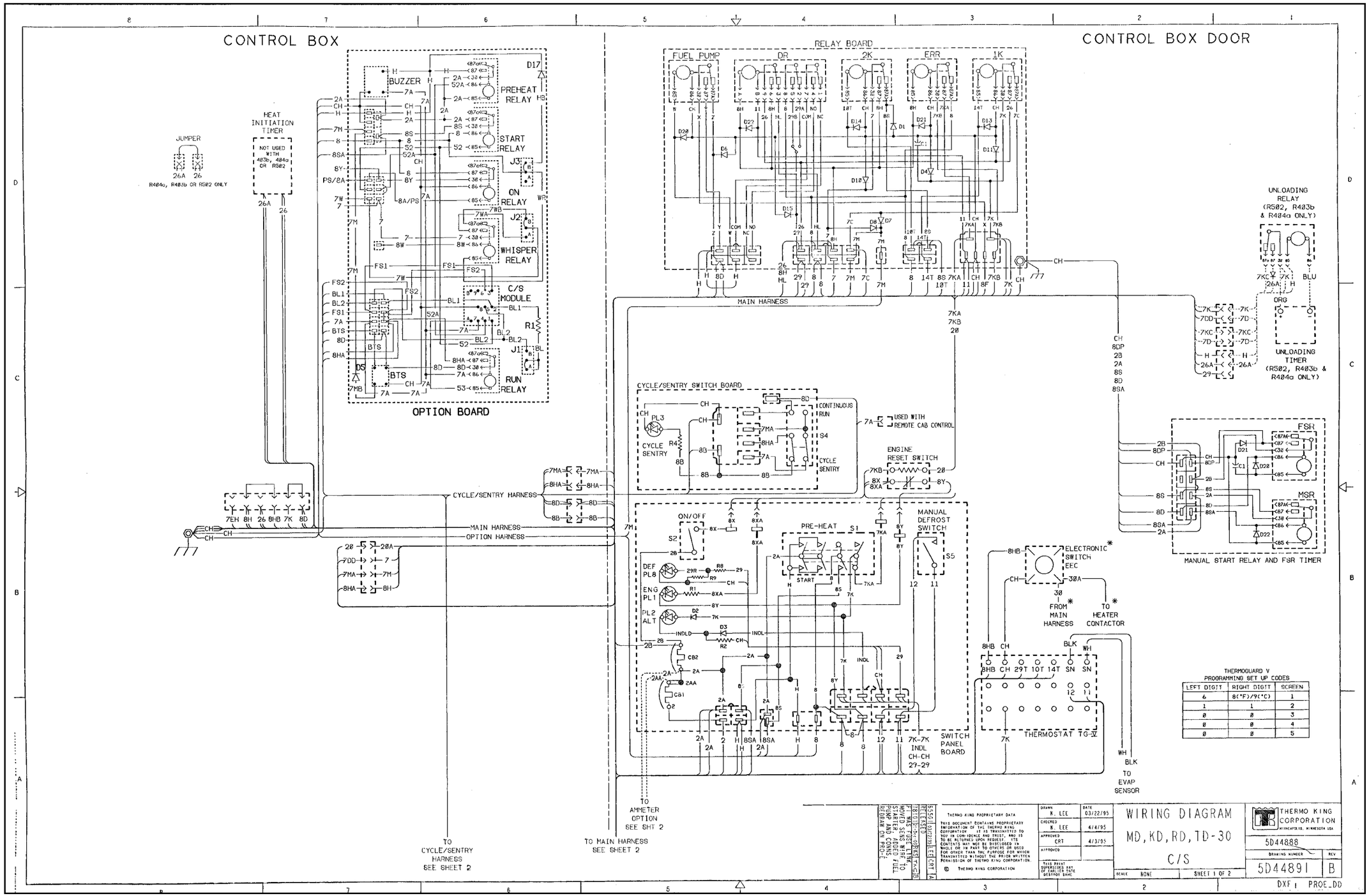

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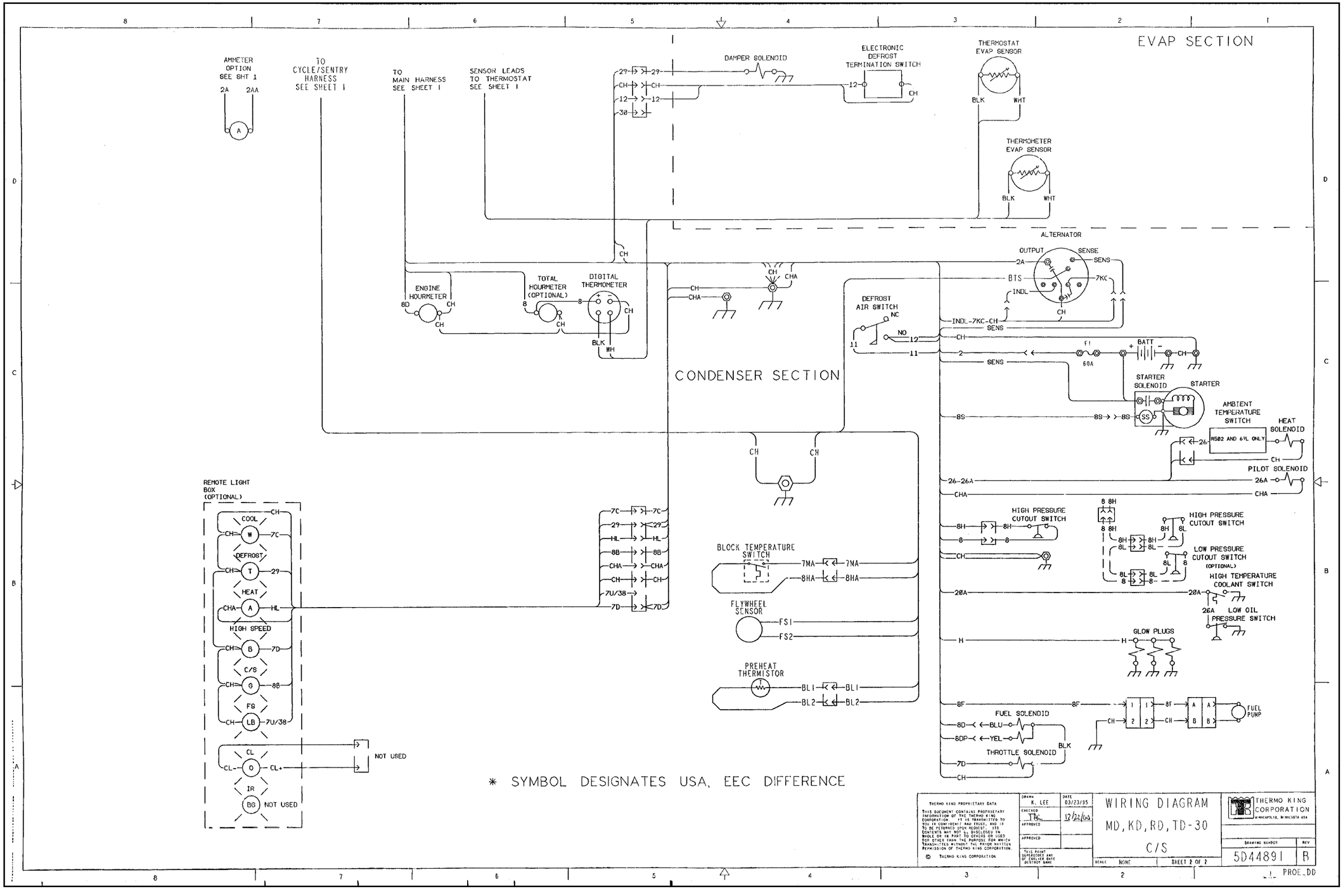

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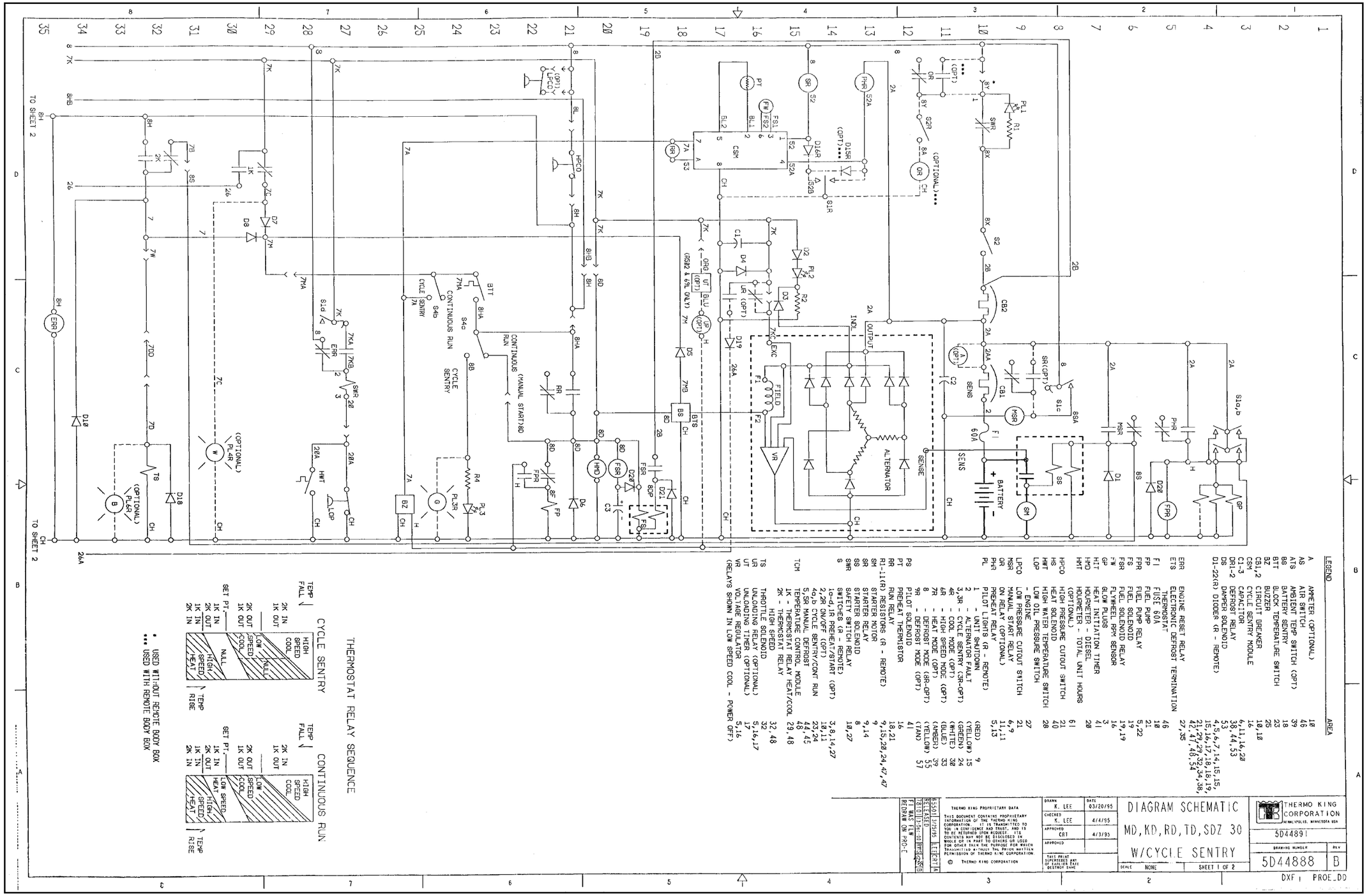

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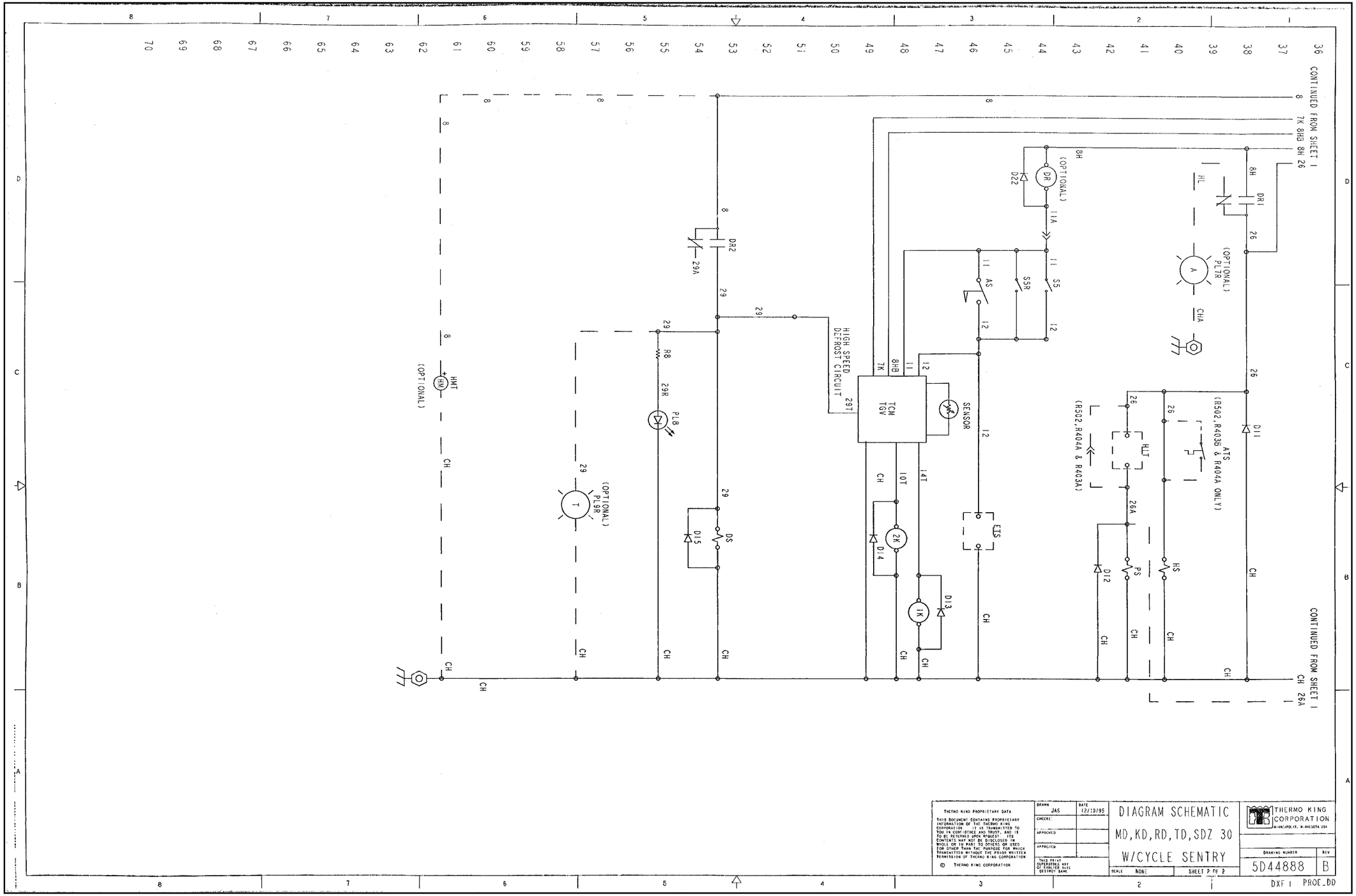

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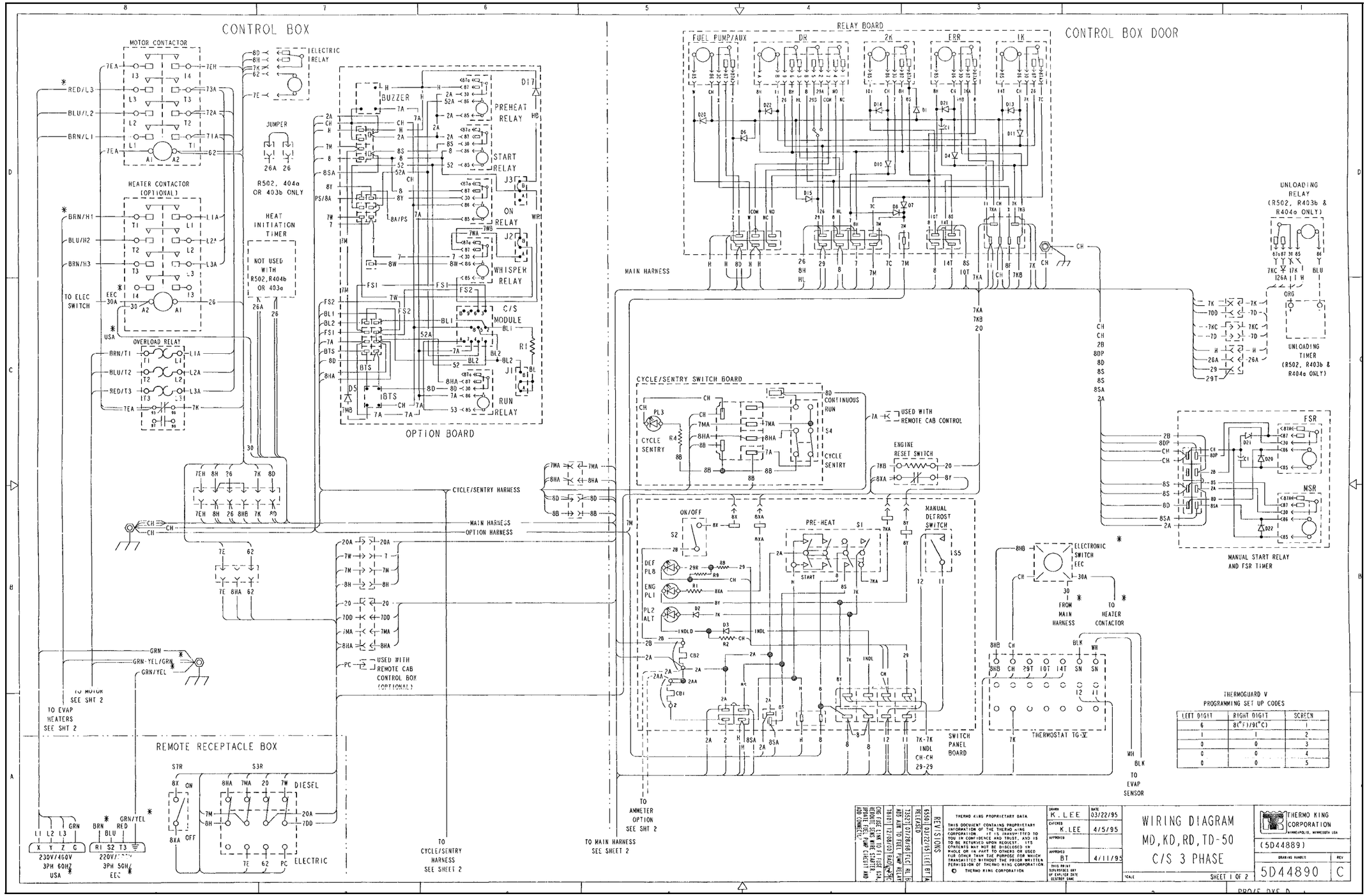

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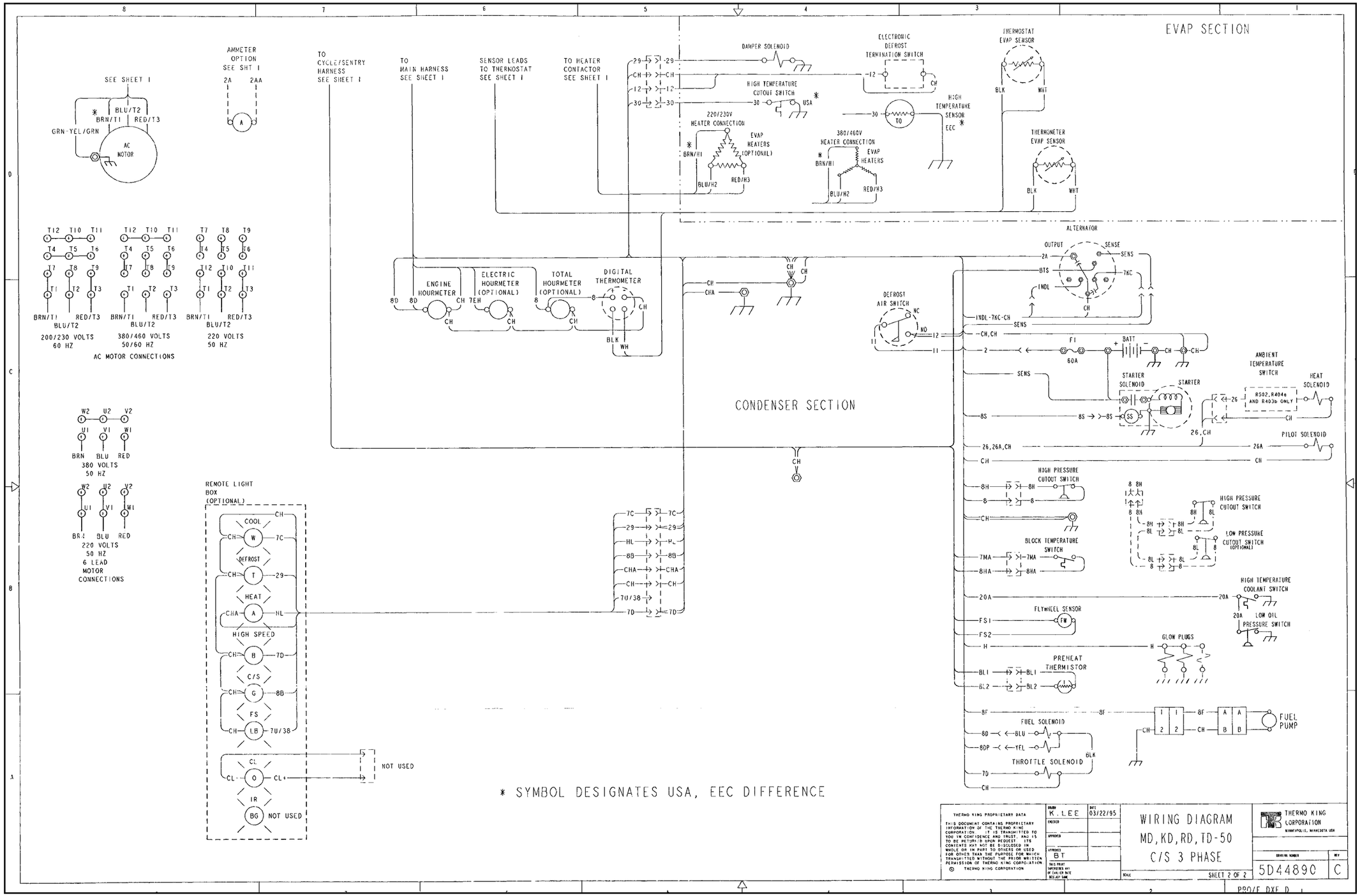

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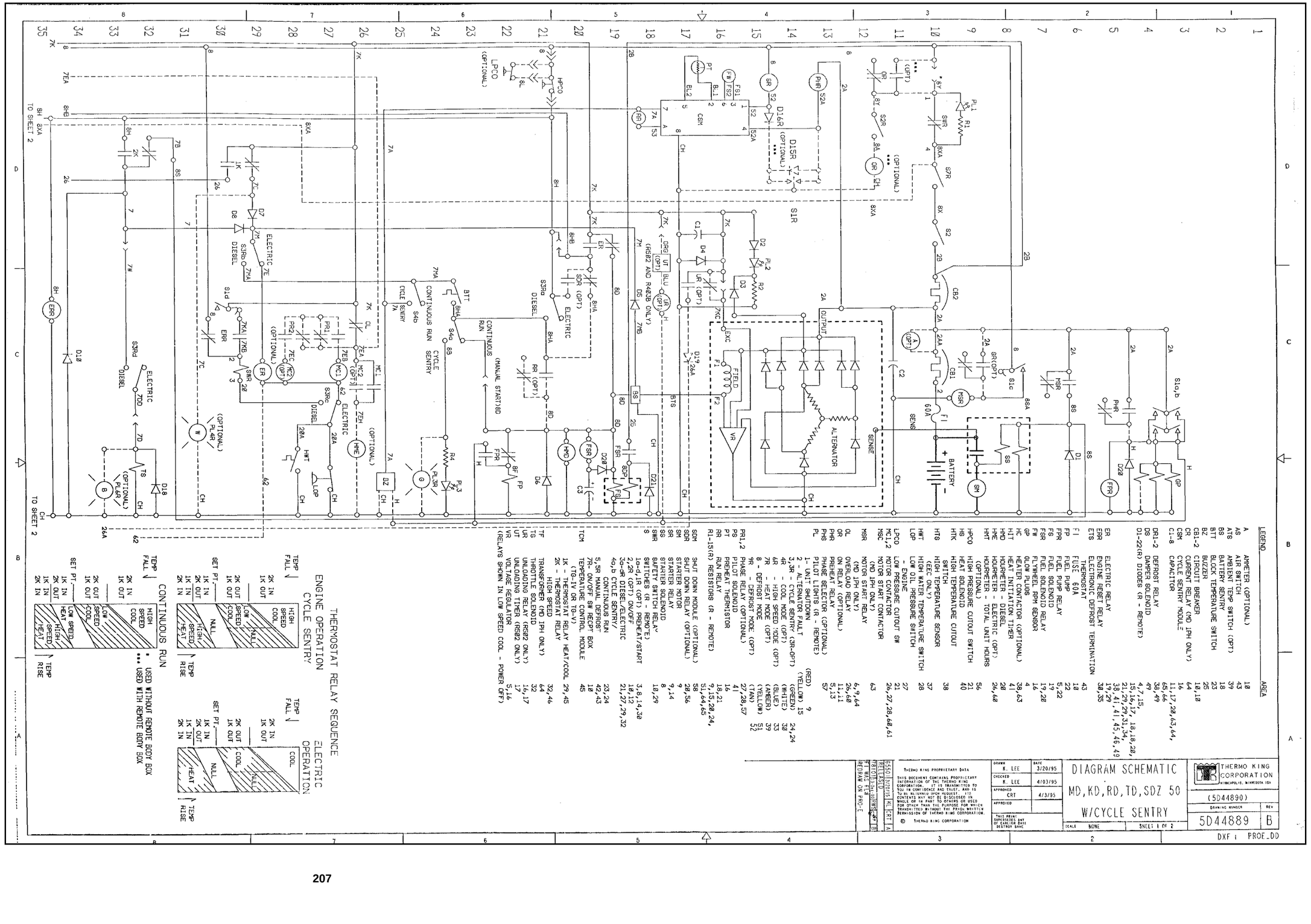

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