THERMO KING

Maintenance Manual

Truck Edition
V-520, V-520 MAX, V-520 SPECTRUM

Revision C

March 2023

TK 54343-18-MM-EN

TRANE TECHNOLOGIES

THERMO KING

Introduction

This manual is published for informational purposes only. Thermo King® makes no representations warranties express or implied, with respect to the information recommendations and descriptions contained herein. Information provided should not be regarded as all-inclusive or covering all contingencies. If further information is required, Thermo King Service Department should be consulted.

Thermo King's warranty shall not apply to any equipment which has been "so installed, maintained, repaired or altered as, in the manufacturer's judgment, to affect its integrity."

Manufacturer shall have no liability to any person or entity for any personal injury, property damage or any other direct, indirect, special, or consequential damages whatsoever, arising out of the use of this manual or any information, recommendations or descriptions contained herein. The procedures described herein should only be undertaken by suitably qualified personnel. Failure to implement these procedures correctly may cause damage to the Thermo King unit or other property or personal injury.

Revision History

Revision A	(08/18) New format and other general updates.
Revision B	(06/2022) Updated maintenance inspection schedule and clutch air gap specification.
Revision C	(03/2023) Updated MAX units for R-452A refrigerant, see service bulletin SB874.

General Information

The maintenance information in this manual covers unit models:

V-520 10 (900829)	V-520 MAX 30 (902053)
V-520 20 (900830)	V-520 MAX 50 (902054)
V-520 30 (902041)	V-520 SPECTRUM 10 (900834)
V-520 50 (902049)	V-520 SPECTRUM 20 (900835)
V-520 MAX 10 (900831)	V-520 SPECTRUM 50 (902235)
V-520 MAX 20 (900833)	

For further information, refer to:

V-520 Series Operator's Manual	TK 54342
V-520 Series Parts Manual	TK 53990
V-520 SPECTRUM Parts Manual	TK 54016
Direct Smart Reefer Microprocessor Control System Diagnostic Manual	TK 52573
V-520 Series Diagrams Manual	TK 56674
V-520 Series Installation Manual	TK 54014
Vehicle Powered Truck Installation Standards and Procedures	TK 56430
Vehicle Powered Truck Refrigerant Charging Procedure	TK 56392
Diagnosing Thermo King Truck and Trailer Refrigeration Systems	TK 5984
Tool Catalog	TK 5955
Evacuation Station Operation and Field Application	TK 40612

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

Recover Refrigerant

Note: *In the USA, EPA Section 608 Certification is required to work on refrigeration systems. In the EU, local F-gas Regulations must be observed when working on refrigeration systems.*

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.

When working on transport temperature control systems, a recovery process that prevents or minimizes refrigerant loss to the atmosphere is required by law. In addition, service personnel must be aware of the appropriate European Union, National, Federal, State, and/or Local regulations governing the use of refrigerants and certification of technicians. For additional information on regulations and technician programs, contact your local THERMO KING dealer.

Service Tools - Use the proper service tools. Gauge manifold sets should include appropriate shutoff valves or disconnects near the end of each service line.

Recovery Equipment - Recovery equipment must be used. Proper recovering, storing and recycling of refrigerants is an important part of all service work.

Service Procedures - Recommended procedures must be used to minimize refrigerant loss.

Components may be isolated by closing service valves and performing system pump-downs.

Components unable to be isolated for service must be repaired only after refrigerant is properly recovered.

R-134a/R-404A/R-452A

R-134aR-404AR452A

NOTICE

Equipment Damage!

Use only Polyolester-based refrigeration compressor oil in R-134a/R-404A/R-452A systems. See Thermo King Parts Manual for part number.

NOTICE

System Contamination!

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

NOTICE

System Contamination!

When servicing Thermo King R-134a, R-23, R-404A, R-452A or R-513A units, use only those service tools certified for and dedicated to R-134a/R-23/R-404A/R-452A/R-513A refrigerant and Polyolester compressor oils. Residual non-HFC refrigerants or oils will contaminate R-134a/R-23/R-404A/R-452A/R-513A systems.Please check serial# plate for type and volume of Refrigerant charged. Please do not blend with other refrigerants than the original charged refrigerant

About This Manual

Purpose

The purpose of this manual is to provide general maintenance information necessary to maintain the climate control unit at peak operating standards. This includes safety information, unit information such as bills of material and kit numbers, general unit information, maintenance procedures and related information (such as wiring and schematic diagrams), and some diagnostic and troubleshooting information.

Note: *This manual may cover more than one unit. Therefore, it may contain information not applicable to your unit.*

Contents

This manual is organized into the following chapters:

Chapter	Purpose
Safety Precautions	Provides detailed safety information. You should be familiar with the safety precautions before working on any unit.
Model Systems (Systems Designations) Table	This table lists the bills of material and kit options that make up your unit. Use them for the following purposes: 1. To determine if you have the right manual for your unit: the bill of material (B/M) number on your unit serial plate should match one of the bill of material numbers listed in this section. If you cannot find your unit in the matrix, call TK Service for more information. 2. To communicate with TK Service Department: If you need to call TK Service, you must know your model number(s) in order for the service representative to help you.
Specifications	Lists unit specifications.
Unit Description	Gives an overview description of your unit including standard and optional features, illustrations, and general a/c theory.
Maintenance Inspection Schedule	Table of routine maintenance procedures.
Maintenance Chapters	Provide detailed maintenance procedures required for your unit. (Electrical, Refrigeration, Compressor, Clutch, Structural)
Diagnosis Chapters	Provides troubleshooting information for diagnosing problems.
Diagrams	Wiring, Schematic and Refrigeration diagrams applicable to the unit.

Before you Call Thermo King Service!

Who to call: Your Thermo King Service Representative.

Before you call Thermo King Service, have the following information on hand:

- Bill of Material (usually located on the unit serial plate)
- Model Number - found on side of the unit

Blank Pages

This manual may contain blank pages at the end of chapters. This is normal. There is no information missing from the manual.

Roadside/Curbside Terminology

Roadside/Curbside terminology: These terms can be confusing because of differences between North America and Europe. Please note:

Curbside:	The side of the truck to the driver's right when the driver is in his seat and facing forward.
Roadside:	The side of the truck to the driver's left when the driver is in his seat and facing forward.

Using the Model Systems Tables in “Model Systems (System Designations)”

The Model Systems Tables in this section list important unit information that you will need to communicate with the Thermo King Service Department.

Customer Satisfaction Survey

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Your feedback will help improve our manuals. The survey is accessible through any internet-connected device with a web browser.

Scan the Quick Response (QR) code or click Technical Publications TK Americas Feedback to complete the survey.

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Safety Precautions

Danger, Warning, Caution, and Notice

Thermo King® recommends that all service be performed by a Thermo King dealer and to be aware of several general safety practices.

Safety advisories appear throughout this manual as required. Your personal safety and the proper operation of this unit depend upon the strict observance of these precautions. The four types of advisories are defined as follows:

⚠ DANGER

Hazard!

Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

Hazard!

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

Hazard!

Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury and unsafe practices.

NOTICE

Hazard!

Indicates a situation that could result in equipment or property-damage only accidents.

General Practices

⚠ DANGER

Hazard of Explosion!

Never apply heat to a sealed refrigeration system or container. Heat increases internal pressure, which might cause an explosion resulting in death or serious injury.

⚠ DANGER

Hazardous Gases - Personal Protective Equipment (PPE) Required!

Refrigerant in the presence of an open flame, spark, or electrical short produces toxic gases that are severe respiratory irritants which can cause serious injury or possible death. When working with or around hazardous chemicals, ALWAYS refer to appropriate Material Data Safety Sheets (MSDS) and OSHA/GHS (Global Harmonized System of Classification and Labelling of Chemicals) guidelines for information on allowable personal exposure levels, proper respiratory protection, and handling instructions.

⚠ DANGER

Risk of Injury!

Keep your hands, clothing, and tools clear of fans and/or belts when working on a unit that is running or when opening or closing compressor service valves. Loose clothing might entangle moving pulleys or belts, causing serious injury or possible death.

⚠ DANGER

Refrigerant Vapor Hazard!

Do not inhale refrigerant. Use caution when working with refrigerant or a refrigeration system in any confined area with a limited air supply. Refrigerant displaces air and can cause oxygen depletion, resulting in suffocation and possible death. When working with or around hazardous chemicals, ALWAYS refer to appropriate Material Data Safety Sheets (MSDS) and OSHA/GHS (Global Harmonized System of Classification and Labelling of Chemicals) guidelines for information on allowable personal exposure levels, proper respiratory protection, and handling instructions.

⚠ WARNING

Hazard of Explosion!

Never close the compressor discharge service valve when the unit is operating. Never operate the unit with the discharge valve closed (front seated). This condition increases internal pressure, which can cause an explosion.

⚠ WARNING

Proper Equipment Condition!

Gauge manifold hoses must be in good condition before using them. Never let them come in contact with moving belts, fans, pulleys or hot surfaces. Defective gauge equipment can damage components or cause serious injury.

⚠ WARNING

Personal Protective Equipment (PPE) Required!

Always wear goggles or safety glasses and proper PPE when working on a unit. Refrigerant liquid, oil, and battery acid can permanently damage your eyes. When working with or around hazardous chemicals, ALWAYS refer to appropriate Material Data Safety Sheets (MSDS) and OSHA/GHS (Global Harmonized System of Classification and Labelling of Chemicals) guidelines for information on allowable personal exposure levels, proper respiratory protection, and handling instructions.

⚠ WARNING

Equipment Damage and Risk of Injury!

Never drill holes into the unit unless instructed by Thermo King. Holes drilled into high voltage cables could cause an electrical fire, severe personal injury, or even death.

⚠ WARNING

Risk of Injury!

When using ladders to install or service refrigeration systems, always observe the ladder manufacturer's safety labels and warnings. A work platform or scaffolding is the recommended method for installations and servicing.

⚠ CAUTION

Sharp Edges!

Exposed coil fins can cause lacerations. Service work on the evaporator or condenser coils should only be accomplished by a certified Thermo King technician.

NOTICE

Equipment Damage!

All unit mounting bolts must be installed, be the correct length for their application, and torqued to specifications. Missing bolts, incorrect bolt lengths and improper torque specifications can damage equipment and void the warranty.

Personal Protective Equipment (PPE)

⚠ WARNING

Personal Protective Equipment (PPE)!

Failure to wear proper PPE for the job being undertaken could result in death or serious injury. Technicians, in order to protect themselves from potential electrical, mechanical, and chemical hazards, MUST follow precautions in this manual and on tags, stickers, labels, as well as the instructions below:

• Before inspecting or servicing this unit, technicians MUST put on all PPE required for the work being undertaken (e.g., cut resistant gloves/sleeves, butyl gloves, safety glasses, hard hat/bump cap, fall protection, electrical PPE, and arc flash clothing). ALWAYS refer to appropriate Material Data Safety Sheets (MSDS) and OSHA guidelines for proper PPE.

• When working with or around hazardous chemicals, ALWAYS refer to appropriate Material Data Safety Sheets (MSDS) and OSHA/GHS (Global Harmonized System of Classification and Labelling of Chemicals) guidelines for information on allowable personal exposure levels, proper respiratory protection, and handling instructions.

• If there is a risk of energized electrical contact, arc, or flash, technicians MUST put on all PPE in accordance with OSHA, NFPA 70E, or other local, state, or country-specific requirements for arc flash protection PRIOR to servicing the unit. NEVER PERFORM ANY SWITCHING, DISCONNECTING, OR VOLTAGE TESTING WITHOUT PROPER ELECTRICAL PPE AND ARC FLASHING CLOTHING. ELECTRICAL METERS AND EQUIPMENT MUST BE PROPERLY RATED FOR INTENDED VOLTAGE.

Auto Start/Stop

⚠ CAUTION

Risk of Injury!

The unit can start and run automatically any time the unit is turned on. Turn the unit On/Off switch Off before doing inspections or working on any part of the unit. Please note that only Qualified and Certified personnel should attempt to service your Thermo King unit.

⚠ CAUTION

Risk of Injury!

The vehicle's engine may be equipped with Auto Start/Stop. The vehicle must be turned off before servicing the unit.

Battery Installation and Cable Routing

⚠ WARNING

Hazard of Explosion!

An improperly installed battery could result in a fire, explosion, or injury. A Thermo King approved battery must be installed and properly secured to the battery tray.

⚠ WARNING

Hazard of Explosion!

Improperly installed battery cables could result in a fire, explosion, or injury. Battery cables must be installed, routed, and secured properly to prevent them from rubbing, chaffing, or making contact with hot, sharp, or rotating components.

⚠ WARNING

Fire Hazard!

Do not attach fuel lines to battery cables or electrical harnesses. This has the potential to cause a fire and could cause serious injury or death.

⚠ WARNING

Personal Protective Equipment (PPE) Required!

A battery can be dangerous. A battery contains a flammable gas that can ignite or explode. A battery stores enough electricity to burn you if it discharges quickly. A battery contains battery acid that can burn you. Always wear goggles or safety glasses and personal protective equipment when working with a battery. If you get battery acid on you, immediately flush it with water and get medical attention.

⚠ WARNING

Hazard of Explosion!

Always cover battery terminals to prevent them from making contact with metal components during battery installation. Battery terminals grounding against metal could cause the battery to explode.

⚠ CAUTION

Hazardous Service Procedures!

Set all unit electrical controls to the OFF position before connecting battery cables to the battery to prevent the unit from starting unexpectedly and causing personal injury.

NOTICE

Equipment Damage!

Do not connect other manufacturers equipment or accessories to the unit or to the Thermo King Batteries unless approved by Thermo King. Failure to do so can result in severe damage to equipment and void the warranty.

Refrigerant Hazards

⚠ DANGER

Hazardous Pressures!

Always store refrigerant in proper containers, out of direct sunlight and away from intense heat. Heat increases pressure inside storage containers, which can cause them to burst and could result in severe personal injury.

⚠ DANGER

Combustible Hazard!

Do not use oxygen (O_2) or compressed air for leak testing. Oxygen mixed with refrigerant is combustible.

⚠ WARNING

Hazardous Gases!

Do not use a Halide torch. When a flame comes in contact with refrigerant, toxic gases are produced. These gases can cause suffocation, even death.

⚠ WARNING

Personal Protective Equipment (PPE) Required!

Refrigerant in a liquid state evaporates rapidly when exposed to the atmosphere, freezing anything it contacts. Wear butyl lined gloves and other clothing and eye wear when handling refrigerant to help prevent frostbite. When working with or around hazardous chemicals, ALWAYS refer to appropriate Material Data Safety Sheets (MSDS) and OSHA/GHS (Global Harmonized System of Classification and Labelling of Chemicals) guidelines for information on allowable personal exposure levels, proper respiratory protection, and handling instructions.

NOTICE

Equipment Damage!

When being transferred, refrigerant must be in liquid state to avoid possible equipment damage.

Refrigerant Oil Hazards

⚠ WARNING

Personal Protective Equipment (PPE) Required!

Protect your eyes from contact with refrigerant oil. The oil can cause serious eye injuries. Protect skin and clothing from prolonged or repeated contact with refrigerant oil. To prevent irritation, wash your hands and clothing thoroughly after handling the oil. Rubber gloves are recommended. When working with or around hazardous chemicals, ALWAYS refer to appropriate Material Data Safety Sheets (MSDS) and OSHA/GHS (Global Harmonized System of Classification and Labelling of Chemicals) guidelines for information on allowable personal exposure levels, proper respiratory protection, and handling instructions.

NOTICE

Equipment Damage!

Use the correct oil in Thermo King systems to avoid damaging equipment and nullifying its warranty.

NOTICE

Equipment Damage!

Do not mix refrigerant oils. Mixing incompatible oils will damage the system.

NOTICE

Equipment Damage!

Use dedicated refrigeration equipment to prevent contaminating refrigeration systems with the wrong type of oil or refrigerant.

NOTICE

System Contamination!

Do not expose the refrigerant oil to the air any longer than necessary. Store refrigerant oil in an approved sealed container to avoid moisture contamination. The oil will absorb moisture, which results in much longer evacuation times and possible system contamination.

NOTICE

Material Damage!

Wipe up spills immediately. Refrigerant oil can damage paints and rubber materials.

Electrical Hazards

High Voltage

⚠ DANGER

Hazardous 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.

⚠ WARNING

Hazardous Voltage!

The unit On/Off switch must be turned Off before connecting or disconnecting the standby power plug. Never attempt to stop the unit by disconnecting the power plug.

⚠ WARNING

Risk of Injury!

The unit power plug must be clean and dry before connecting it to a power source.

⚠ WARNING

Risk of Injury!

Do not make rapid moves when working on high voltage circuits in refrigeration units. Do not grab for falling tools because you might accidentally touch a high voltage source.

⚠ WARNING

Hazardous Voltage!

Treat all wires and connections as if they were high voltage until a meter and wiring diagram indicate otherwise. Only use tools with insulated handles. Never hold uninsulated metal tools near exposed, energized conductors. If there is a risk of energized electrical contact, arc, or flash, technicians MUST put on all PPE in accordance with OSHA, NFPA 70E, or other local, state, or country-specific requirements for arc flash protection PRIOR to servicing the unit. NEVER PERFORM ANY SWITCHING, DISCONNECTING, OR VOLTAGE TESTING WITHOUT PROPER ELECTRICAL PPE AND ARC FLASHING CLOTHING. ELECTRICAL METERS AND EQUIPMENT MUST BE PROPERLY RATED FOR INTENDED VOLTAGE.

⚠ WARNING

Hazardous Voltage!

Never work alone on high voltage circuits in the refrigeration unit. Another person should be nearby to shut off the unit and provide aid in the event of an accident. If there is a risk of energized electrical contact, arc, or flash, technicians MUST put on all PPE in accordance with OSHA, NFPA 70E, or other local, state, or country-specific requirements for arc flash protection PRIOR to servicing the unit. NEVER PERFORM ANY SWITCHING, DISCONNECTING, OR VOLTAGE TESTING WITHOUT PROPER ELECTRICAL PPE AND ARC FLASHING CLOTHING. ELECTRICAL METERS AND EQUIPMENT MUST BE PROPERLY RATED FOR INTENDED VOLTAGE.

⚠ WARNING

Personal Protective Equipment (PPE) Required!

In the event of an electrical accident, all required PPE should be near the work area in accordance with OSHA, NFPE 70E, or other local, state, or country-specific requirements for a Category 2 risk.

⚠ WARNING

Hazardous Voltage w/Capacitors!

Be careful when working with electrical circuits that contain capacitors. Some capacitors hold a significant electrical charge that might cause burns or shocks if accidentally discharged. Capacitors must be discharged before working on electrical circuits. If there is a risk of energized electrical contact, arc, or flash, technicians MUST put on all PPE in accordance with OSHA, NFPA 70E, or other local, state, or country-specific requirements for arc flash protection PRIOR to servicing the unit. NEVER PERFORM ANY SWITCHING, DISCONNECTING, OR VOLTAGE TESTING WITHOUT PROPER ELECTRICAL PPE AND ARC FLASHING CLOTHING. ELECTRICAL METERS AND EQUIPMENT MUST BE PROPERLY RATED FOR INTENDED VOLTAGE.

Low Voltage

⚠ WARNING

Live Electrical Components!

Control circuits used in refrigeration units are low voltage (12 to 48 Vdc). However, the large amount of amperage available can cause severe burns if accidentally shorted to ground with metal objects, such as tools. Do not wear jewelry, watches, or rings because they increase the risk of shorting out electrical circuits and damaging equipment or causing severe burns. If there is a risk of energized electrical contact, arc, or flash, technicians MUST put on all PPE in accordance with OSHA, NFPA 70E, or other local, state, or country-specific requirements for arc flash protection PRIOR to servicing the unit. NEVER PERFORM ANY SWITCHING, DISCONNECTING, OR VOLTAGE TESTING WITHOUT PROPER ELECTRICAL PPE AND ARC FLASHING CLOTHING. ELECTRICAL METERS AND EQUIPMENT MUST BE PROPERLY RATED FOR INTENDED VOLTAGE.

Controller / Microprocessor Service Precautions

Take precautions to prevent electrostatic discharge when servicing the controller or microprocessor and its related components. Even tiny amounts of current can severely damage or destroy electronic components.

Observe the following precautions when servicing a controller or microprocessor control system to avoid damaging electronic components. Refer to the appropriate unit, controller, or microprocessor diagnostic manual for more information.

- If the unit has a service or microprocessor ON/OFF switch, turn it OFF before connecting or disconnecting the battery.
- Disconnect power to the unit.
- Avoid wearing clothing that generates static electricity (wool, nylon, polyester, etc.).
- Wear a wrist strap (P/N 204-622 or equivalent) with the lead end connected to the microprocessor or unit ground terminal (if equipped). These straps are available from most electronic equipment distributors. DO NOT wear these straps with power applied to the unit.
- Avoid unnecessary contact with the electronic components.
- Store and ship electronic components in antistatic bags and protective packaging.
- Leave electronic components in their antistatic packing materials until you're ready to use them.
- After servicing any electronic components, check the wiring for possible errors before restoring power to the unit.
- Never use a battery and a light bulb to test circuits on any controller or microprocessor-based equipment.

Welding Precautions

Take precautions before electrically welding any portion of the unit or the vehicle to which it is attached. Verify that welding currents are not allowed to flow through the unit's electronic circuits.

Observe the following precautions when welding to avoid damaging electronic components.

- If the microprocessor has a power switch, turn it OFF before connecting or disconnecting the battery.
- Disconnect power to the unit.
- Disconnect all wire harnesses from the microprocessor.
- If there are any electrical circuit breakers in the control box, switch them OFF.
- Close the control box.
- Components that could be damaged by welding sparks should be removed from the unit.
- Use normal welding procedures, but keep the ground return electrode as close to the area being welded as practical. This will reduce the likelihood of stray welding currents passing through any electronic circuits.

First Aid

REFRIGERANT

- **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 warm water. Do not apply heat. Remove contaminated clothing and shoes. Wrap burns with dry, sterile, bulky dressing to protect from infection. Get prompt medical attention. Wash contaminated clothing before reuse.
- **Inhalation:** Move victim to fresh air and use Cardio Pulmonary Resuscitation (CPR) or mouth-to-mouth resuscitation to restore breathing, if necessary. Stay with victim until emergency personnel arrive.
- **Frost Bite:** In the event of frost bite , the objectives of First Aid are to protect the frozen area from further injury, warm the affected area rapidly, and to maintain respiration.

REFRIGERANT OIL

- **Eyes:** Immediately flush with large amounts of water for at least 15 minutes. 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 use Cardio Pulmonary Resuscitation (CPR) or mouth-to-mouth resuscitation to restore breathing, if necessary. Stay with victim until emergency personnel arrive.
- **Ingestion:** Do not induce vomiting. Immediately contact local poison control center or physician.

ENGINE COOLANT

- **Eyes:** Immediately flush with large amounts of water for at least 15 minutes. Get prompt medical attention.
- **Skin:** Remove contaminated clothing. Wash thoroughly with soap and water. Get medical attention if irritation persists.
- **Ingestion:** Do not induce vomiting. Immediately contact local poison control center or physician.

BATTERY ACID

- **Eyes:** Immediately flush with large amounts of water for at least 15 minutes. Get prompt medical attention. Wash skin with soap and water.
- **Skin:** Immediately remove contaminated clothing. Wash skin with large volumes of water, for at least 15 minutes. Wash skin with soap and water. Do not apply fatty compounds. Seek immediate medical assistance.
- **Inhalation:** Provide fresh air. Rinse mouth and nose with water. Seek immediate medical assistance.
- **Ingestion:** If the injured person is fully conscious: make the person drink extensive amounts of milk. Do not induce vomiting. Take the injured person immediately to a hospital.

ELECTRICAL SHOCK

Take IMMEDIATE action after a person has received an electrical shock. Get quick medical assistance, if possible.

The source of the shock must be quickly stopped, by either shutting off the power or removing the victim. If the power cannot be shut off, the wire should be cut with an non-conductive tool, such as a wood-handle axe or thickly insulated cable cutters. Rescuers should wear insulated gloves and safety glasses, and avoid looking at wires being cut. The ensuing flash can cause burns and blindness.

If the victim must be removed from a live circuit, pull the victim away with a non-conductive material. Use wood, rope, a belt or coat to pull or push the victim away from the current. DO NOT TOUCH the victim. You will receive a shock from current flowing through the victim's body. After separating the victim from power source, immediately check for signs of a pulse and respiration. If no pulse is present, start Cardio Pulmonary Resuscitation (CPR). If a pulse is present, respiration might be restored by using mouth-to-mouth resuscitation. Call for emergency medical assistance.

ASPHYXIATION

Move victim to fresh air and use Cardio Pulmonary Resuscitation (CPR) or mouth-to-mouth resuscitation to restore breathing, if necessary. Stay with victim until emergency personnel arrive.

Model Systems (System Designations)

Important:

MAX and SPECTRUM units built Before December 12, 2022 were originally built using R-404A refrigerant.

MAX and SPECTRUM units built on and after December 12, 2022 are equipped with R-452A refrigerant.

See Service Bulletin SB874 Transition to R–452A Refrigerant for Vehicle-Powered (VP) Truck Units in North America

V-520 Truck Refrigeration Systems

System Designation	System Number	Install Kit	Refrigerant	Schematic, Wiring Diagrams
V-520 10	900829	800319	R-134a	2E54898, 2E54899
V-520 20	900830	800319	R-134a	1PH = 2E54900, 2E54901 3PH = 2E54902, 2E54903
V-520 30	902041	800319	R-134a	2E54898, 2E54899
V-520 50	902049	800319	R-134a	1PH = 2E54900, 2E54901 3PH = 2E54902, 2E54903
V-520 MAX 10	900831	800319	R-404A (before December 12, 2022) R-452A (on or after December 12, 2022)	2E54898, 2E54899
V-520 MAX 20	900833	800319	R-404A (before December 12, 2022) R-452A (on or after December 12, 2022)	1PH = 2E54900, 2E54901 3PH = 2E54902, 2E54903
V-520 MAX 30	902053	800319	R-404A (before December 12, 2022) R-452A (on or after December 12, 2022)	2E54898, 2E54899
V-520 MAX 50	902054	800319	R-404A (before December 12, 2022) R-452A (on or after December 12, 2022)	1PH = 2E54900, 2E54901 3PH = 2E54902, 2E54903
V-520 SPECTRUM 10	900834	800323	R-404A (before December 12, 2022) R-452A (on or after December 12, 2022)	1E49423, 1E49424
V-520 SPECTRUM 20	900835	800323	R-404A (before December 12, 2022) R-452A (on or after December 12, 2022)	1PH = 1E49440, 1E49441 3PH = 1E49442, 1E49443/1E53679
V-520 SPECTRUM 50	902235	800768	R-404A (before December 12, 2022) R-452A (on or after December 12, 2022)	1PH = 2E54904, 2E54905 3PH = 2E54906, 2E54907

Note: *When calling the dealer or factory for information or parts please have the Bill of Material number for your particular unit handy.*

Specifications

Electrical System

Fuses	
Fuse 1: Power Supply Circuit to PCB1	5 amps
Fuse 2: Condenser Fan Motor 1 (M1 Model 10 and 30, M2 Model 20, 50, and 50 Spectrum, CFM1 Model 10 and 20 Spectrum)	15 amps
Fuse 3: Evaporator Fan Motor 1 (M3 Model 10 and 30, M4 Model 20, 50, and 50 Spectrum, EFM1 Model 10 and 20 Spectrum)	15 amps
Fuse 4: Evaporator Fan Motor 2 (M4 Model 10 and 30, M5 Model 20, 50, and 50 Spectrum, EFM2 Model 10 and 20 Spectrum)	15 amps
Fuse 5: Compressor Clutch (MP1), Liquid Injection Switch (S2), Liquid Injection Solenoid (L1), Host Hot Gas Defrost Solenoid (L2), Compressor Motor Contactor (KP1), 26A Circuit to Heat Option, Condenser Blocking Solenoid (L3) Model 10 and 20 Spectrum only – Compressor Clutch (CCL1), Liquid Injection Switch (LIS), Liquid Injection Valve (LIV), Host Hot Gas Defrost Solenoid Valve (PS1), Compressor Motor Contactor (CC), 26A Circuit to Heat Option	20 amps
Fuse 6: Condenser Fan Motor 1 and 2 (M1 and M2 Model 10 and 30, M2 and M3 Model 20, 50, and 50 Spectrum, CFM1 and CFM 2 Model 10 and 20 Spectrum)	10 amps
Fuse 7: Condenser Fan Motor 2 (M2 Model 10 and 30, M3 Model 20, 50, and 50 Spectrum, CFM2 Model 10 and 20 Spectrum)	15 amps
Fuse 8: Model 10 and 20 Spectrum – Liquid Solenoid 2 (PS2), Liquid Solenoid 1 (PS3), Hot Gas Defrost Solenoid 2 (PS4), Suction Bypass Solenoid (PS6), Drain Heater 3 (HR3), Drain Heater 4 (HR4) Model 50 Spectrum – Suction Bypass Solenoid (L4), Liquid Solenoid 1 (L5), Liquid Solenoid 2 (L6), Hot Gas Defrost Solenoid 2 (PS4), Drain Heater 3 (HR3), Drain Heater 4 (HR4)	20 amps
Fuse 9: Evaporator Fan Motor 3 (M5 Model 10 and 30, M6 Model 20, 50, and 50 Spectrum, EFM3 Model 10 and 20 Spectrum)	15 amps
Fuse 10: Evaporator Fan Motor 4 (EFM4 Model 10 and 20 Spectrum, M7 Model 50 Spectrum)	15 amps
Fuse 11: Drain Heater 1 (HR1), Drain Heater 2 (HR2)	2 amps (10 amps for Model 10 Spectrum)
Fuse 21: Battery Power to K1 Rely (Model 10 and 30), or K3 Rely (Model 20 and 50), or BATR Rely (Model 10 Spectrum) (located in POS/2 wire near battery)	40 amps (60 amps for Spectrum units)
Fuse 22: Battery Power from Vehicle Ignition Switch (S1) to ECM (located in wire near Vehicle Ignition Switch (S1)	10 amps
Fuse 23: Model 10 and 30 – Condenser Fan Motors (M1, M2) (located between Red and CF1-01 wires near JP1 jumper)	15 amps
Fuse 23: Model 20, 20 Spectrum, 50, and 50 Spectrum – Transformer Input (located between L1-01 and L1A-01 wires near Motor Contactor)	5 amps
Fuse 24: Transformer Output (located in X1 wire near Transformer)	5 amps
Fuse 25: Transformer Output (located in X4 wire near Transformer)	5 amps
Fuse 26: Model 20, 50, and 50 Spectrum – Condenser Fan Motors (M2, M3) (located between Red and CF1-01 wires near JP1 jumper)	15 amps
Fuse 27: Drain Heater 3 (HR3)	1 amp
Fuse 28: Drain Heater 4 (HR4)	1 amp
Condenser Fan Motors (Each)	
Full Load Current	8.7-9.2 amps at 13 Vdc
Resistance	1.5 ohms

Evaporator Fan Motors (Each)		
Full Load Current		5.7- 6.2 amps at 13 Vdc
Resistance		2.0 ohms
Coils for Hot Gas, Liquid Line, Condenser Inlet, and CPR Bypass Solenoids		
Current		1.8 amps at 12 Vdc
Resistance		6.7 ohms
Coil for Liquid Injection Solenoid		
Current		0.7 amps at 12 Vdc
Resistance		17.0 ohms
Coil for Hot Water Solenoid (HWS) - Truck Engine Coolant Heat Option Only		
Current		1.5 amps at 12 Vdc
Resistance		8.0 ohms
Water Pump Motor (WP) - Truck Engine Coolant Heat Option Only		
Current		1.5 Amps at 12 Vdc
Resistance		8.0 ohms
Drain Line Heaters (Each) - MAX Only		
Voltage		12 Vdc
Current		0.9 amps ± 5% at 68 F (20 C)
Resistance		13.8 ohms ± 5% at 68 F (20 C)
Battery Power Relay - Model 10 and 30		
Type		Single Pole Single Throw (SPST)
Contacts	Terminals 30 to 87	Normally Open (NO)
Coil Resistance	Terminals 85 to 86	90 ohms
Battery Power Relay - Model 20 and 50		
Type		Single Pole Single Throw (SPST)
Contacts	Terminals 30 to 87	Normally Open (NO)
Coil Resistance	Terminals 85 to 86	43 ohms
Standby Power Relay		
Type		Single Pole Single Throw (SPST)
Contacts	Terminals 30 to 87	Normally Open (NO)
Coil Resistance	Terminals 85 to 86	43 ohms
Battery Disconnect Relay		
Type		Single Pole Double Throw (SPDT)
Contacts	Terminals 30 to 87 Terminals 30 to 87A	Normally Open (NO) Normally Closwe (NC)
Coil Resistance	Terminals 85 to 86	90 ohms
Hot Gas Heat Relay		
Type		Single Pole Single Throw (SPST)
Contacts	Terminals 30 to 87	Normally Open (NO)
Coil Resistance	Terminals 85 to 86	90 ohms

Refrigeration System

R-134a Refrigeration System V-520

Refrigerant Charge:	V-520 - Model 10 V-520 - Model 20 V-520 - Model 30 V-520 - Model 50	5.3 lb (2.42 kg) R-134a 5.7 lb (2.57 kg) R-134a 5.8 lb (2.63 kg) R-134a 5.7 lb (2.57 kg) R-134a
Defrost Termination Switch:	Opens Closes	48.0 ± 5.0 F (8.9 ± 2.8 C) 36.0 ± 5.0 F (2.2 ± 2.8 C)
Liquid Injection Switch (LISW):	Opens Closes	200 ± 5 F (93 ± 3 C) 230 ± 5 F (110 ± 3 C)
Low Pressure Cutout Switch (LPCO):	Opens Closes	5 to 11 in. Hg vacuum (-17 to -37 kPa) 4 to 7 psig (28 to 48 kPa)
Engine Driven Compressor Pressure Regulator (CPR) Valve Setting - Model 30 and 50 Only		50.0 ± 5 psig (345 ± 34 kPa)
Electric Standby Suction Pressure Regulator (SPR) Valve Setting - Model 20 and 50 Only	230V 1 Phase Electric Motor 230V 3 Phase Electric Motor	24.0 ± 4 psig (165.5 ± 28 kPa) 39.0 ± 4 psig (269 ± 28 kPa)

R-404A / R-452A Refrigeration System V-520 MAX

Important: *MAX and SPECTRUM units built Before December 12, 2022 were originally built using R-404A refrigerant.* *MAX and SPECTRUM units built on and after December 12, 2022 are equipped with R-452A refrigerant.* *See Service Bulletin SB874 Transition to R–452A Refrigerant for Vehicle-Powered (VP) Truck Units in North America*		
Refrigerant Charge:	V-520 MAX - Model 10 (before December 12, 2022) V-520 MAX - Model 10 (on or after December 12, 2022) V-520 MAX - Model 20 (before December 12, 2022) V-520 MAX - Model 20 (on or after December 12, 2022) V-520 MAX - Model 30 (before December 12, 2022) V-520 MAX - Model 30 (on or after December 12, 2022) V-520 MAX - Model 50 (before December 12, 2022) V-520 MAX - Model 50 (on or after December 12, 2022) V-520 SPECTRUM - Model 10 (before December 12, 2022) V-520 SPECTRUM - Model 10 (on or after December 12, 2022) V-520 SPECTRUM - Model 20 (before December 12, 2022) V-520 SPECTRUM - Model 20 (on or after December 12, 2022) V-520 SPECTRUM - Model 50 (before December 12, 2022) V-520 SPECTRUM - Model 50 (on or after December 12, 2022)	4.9 lb (2.22 kg) R-404A 4.9 lb (2.22 kg) R-452A 5.2 lb (2.37 kg) R-404A 5.2 lb (2.37 kg) R-452A 5.5 lb (2.52 kg) R-404A 5.5 lb (2.52 kg) R-452A 5.4 lb (2.43 kg) R-404A 5.4 lb (2.43 kg) R-452A 5.3 lb (2.42 kg) R-404A 5.3 lb (2.42 kg) R-452A 5.7 lb (2.57 kg) R-404A 5.7 lb (2.57 kg) R-452A 5.8 lb (2.63 kg) R-404A 5.8 lb (2.63 kg) R-452A
Defrost Termination Switch:	Opens Closes	48.0 ± 5.0 F (8.9 ± 2.8 C) 36.0 ± 5.0 F (2.2 ± 2.8 C)
Liquid Injection Switch (LISW):	Opens Closes	200 ± 5 F (93 ± 3 C) 230 ± 5 F (110 ± 3 C)
Low Pressure Cutout Switch (LPCO):	Opens Closes	5 to 11 in. Hg vacuum (-17 to -37 kPa) 4 to 7 psig (28 to 48 kPa)
Over Temperature Switch - Electric Heater Option Only:	Opens Closes	105 ± 5 F (41 ± 3 C) 90 ± 5 F (32 ± 3 C)
Engine Driven Compressor Pressure Regulator (CPR) Valve Setting - Model 30 and 50 Only		50.0 ± 5 psig (345 ± 34 kPa)
Electric Standby Suction Pressure Regulator (SPR) Valve Setting - Model 20 and 50 Only	230V 1 Phase Electric Motor 230V 3 Phase Electric Motor	24.0 ± 4 psig (165.5 ± 28 kPa) 39.0 ± 4 psig (269 ± 28 kPa)
Suction Bypass CPR Valve Setting - SPECTRUM Only		See "Compressor Pressure Regulator Valve Setup Procedure" under "Compressor Pressure Regulator Valve in SPECTRUM Units".

Compressors

Standard Engine Driven Compressor: Optional Engine Driven Compressor		TK-16, 10 cu. in. (147 cc), Swash Plate, 6 Cylinder TK-312R, 11.4 cu. in. (187 cc), Reciprocating, 3 Cylinder
Electric Standby Compressor - Model 20 and 50 Only		D211Y, Reciprocating, 2 Cylinder
System Oil Capacity - Swash Plate Compressors:	Model 10* Model 20* Model 30* Model 50* SPECTRUM Model 10** SPECTRUM Model 20** SPECTRUM Model 50**	15 oz (444 cc) 57 oz (1686 cc) 19 oz (562 cc) 61 oz (1804 cc) 20 oz (591 cc) 62 oz (1834 cc) 66 oz (1952 cc)
System Oil Capacity - Reciprocating Compressor:	Model 10* Model 20* Model 30* Model 50* SPECTRUM Model 10** SPECTRUM Model 20** SPECTRUM Model 50**	37 oz (1094 cc) 79 oz (2336 cc) 41 oz (1213 cc) 83 oz (2455 cc) 42 oz (1242 cc) 84 oz (2484 cc) 88 oz (2602 cc)
*Units built before April 15, 2016 with the Legacy Accumulator Tank add an additional 8 oz. of oil to the suction line during installation or repair. **Units built before December 1, 2016 with the Legacy Accumulator Tank add an additional 8 oz. of oil to the suction line during installation or repair. ***Note:*** *If utilizing a discharge muffler add an additional 3 oz. of oil during installation or repair.*		
Compressor Oil Type:		POE 120 2030515 33.8 oz. (1 Liter) POE 120 2030505 8 oz. (236 ml)
Compressor Clutch Coil - Swash Plate:	Voltage Resistance	12 Vdc 3.2 ohms at 77 F (25 C)
Compressor Clutch Coil - Reciprocating:	Voltage Resistance	12 Vdc 3-4 ohms
Compressor Clutch Air Gap (Swash Plate Compressors only)		0.3 - 0.8mm (0.012 – 0.031”)
Defrost Method		Hot Gas
Defrost Timer Initiation Interval		Adjustable, 0 to 8 hours, default is 4 hours
Defrost Termination Interval		Defrost is terminated by Klixon switch, or by Defrost Termination Timer [dtt] adjustable, 5 to 50 minutes, default is 30 minutes.

NOTICE

Equipment Damage!

Use the correct oil in Thermo King systems to avoid damaging equipment and nullifying its warranty.

Belt Tension

Belt	Field Reset
Engine Driven Compressor Belt	Check vehicle manufacturer specifications

AC Semi-Hermetic Compressor

Voltage/Phase/ Frequency	Horsepower	Kilowatts	RPM	Full Load (Amps)	Locked Rotor (Amps)
230/1/60	2.0	1.5	1740	16.0	83.2
230/3/60	2.0	1.5	1740	14.1	86.9

Contactors

Compressor Motor Contactor (KP1) and Optional Electric Heat Contactor (HC)	
Contacts	Normally Open
Coil Voltage	12 Vdc
Coil Current	0.25 amps
Coil Resistance	48 ohms

Capacitors

Capacitor	Capacitance
Smoothing Capacitor (C1) – all voltages	6800 µF
Electric Motor Start Capacitors (C2 and C3) – 230/1/60 units	145-174 µF
Electric Motor Run Capacitor (C4) – 230/1/60 units	30 µF

Transformer

Power	700 VA
Frequency	50/60 Hz
Primary Inputs	230-400 Vac
Secondary Nominal Voltage	11.7 Vac (30.4 Amps)

Start Relay

Type		Single Pole Single Throw (SPST)
Contacts	Terminals 1 to 2	Normally Closed (NC)
Coil Resistance	Terminals 2 to 5	3,600 ohms

Electric Standby Power Supply Requirements

				Power Cord Length Power Cord Size (AWG)		
Voltage	**Phase**	**Hz**	**Power Supply Circuit Breaker**	**25 ft**	**50 ft**	**75 ft**
230 Vac	1	50/60	30 amp	10	8	8
230 Vac	3	50/60	30 amp	10	8	8

Optional Electric Heaters

Voltage	Power Rating Watts	Current	Resistance
230 Vac	1500	6.5 amps	35.4 ohms

Solder Applications

Refrigeration Components	
For general refrigeration tubing connections: copper to copper or copper to brass	Joint Clearances: 0.003 to 0.005 in. (0.076 to 0.127 mm) Use: Solder Type 15% Silver TK No. 203-364 Use: Flux Type TK No. 203-365
For refrigeration tubing connections of dissimilar metals: copper to stainless steel or brass to stainless steel	Joint Clearances: 0.003 to 0.005 in. (0.076 to 0.127 mm) Use: Solder Type 35% Silver TK No. 203-366 Use: Flux Type TK No. 203-365

Hot Water Component	
For hot water tubing connections: copper to copper or copper to brass	Joint Clearances: 0.003 to 0.005 in. (0.076 to 0.127 mm) Use: Solder Type 95% Tin and 5% antimony TK No. 204-167 Use: Flux Type TK No. 204-417
For hot water tubing connections of dissimilar metals: copper to stainless steel or brass to stainless steel	Joint Clearances: 0.003 to 0.005 in. (0.076 to 0.127 mm) Use: Solder Type 35% Silver TK No. 203-366 Use: Flux Type TK No. 203-365

NOTE: Some units may be equipped with compressor pressure regulator (CPR) valve and/or suction pressure regulator (SPR) valve. To reduce the chance of overheating the CPR/SPR/DPR valve, 95-5 solder or equivalent may be used.

Use 95-5 TK No. 204-167

Use Flux TK No. 204-417

Unit Description

Introduction

The Thermo King V-520 and V-520 MAX truck refrigeration systems are two or three piece units. They are designed for medium-sized trucks and vans carrying fresh produce and frozen and deep frozen goods.

The system condenser is mounted on the front of the truck box or container. The system evaporator is mounted on the cargo compartment ceiling. SPECTRUM units have two evaporators. The main compressor is powered by the vehicle engine via a belt. The unit is connected to the compressor by refrigeration hoses. Model 20 and 50 units also have an electric compressor mounted in the condenser.

The refrigeration system is protected by a high pressure cutout and a low pressure cutout.

The operating mode is selected automatically: When the unit is connected to an electric power source, engine-driven operation is automatically blocked. If the vehicle engine is started up while the power cable is still connected to the electric power source, the unit will continue to operate in electric standby mode. It is not possible to start the engine-driven compressor until the power cable is disconnected from the unit.

There are four basic models:

- Model 10: Cool and defrost on truck engine driven compressor operation.
- Model 20: Cool and defrost on both truck engine driven compressor operation and electric standby compressor operation.
- Model 30: Cool, heat, and defrost on truck engine driven compressor operation.
- Model 50: Cool, heat, and defrost on both vehicle engine driven compressor operation and electric standby compressor operation.

Standard Features

- In-Cab Controls with Digital LCD Thermometer
- Hot Gas Defrost
- Defrost Termination Switch
- Oil Separator
- Liquid Injection
- Main Compressor, 6-Cylinder Swash Plate

Optional Features

- Electric Compressor, Model 20 and 50 Units
- Evaporator Drain Heaters (MAX Units Only)
- Heat, Truck Engine Coolant (Model 10 before fourth quarter of 2011 and Model 10 SPECTRUM only)
- Heat, Truck Engine Coolant and Electric Standby Heater Strip (Model 20 before fourth quarter of 2011 and Model 20 SPECTRUM only)
- Hot Gas Heat (Model 30 and 50 Units Only)

Condenser

The condenser is designed to be mounted on the front of the truck box.

Figure 1. V-520 Condenser Unit

Evaporator

The evaporator is mounted on the ceiling inside the truck box. SPECTRUM units have two or more evaporators, one in each compartment.

Compressor

The main compressor is mounted on and driven by the truck engine. Refrigeration hoses or lines are used to connect the condenser, evaporator, main compressor and other refrigeration components.

Model 20 and 50 units have an electric compressor mounted in the condenser section for electric standby operation. The electric standby compressor is connected in parallel with the engine-driven compressor.

Both compressors use the same refrigeration system circuit. Check valves isolate one compressor from the other during operation.

Compressor operation is controlled by the electronic control system, which energizes the compressor clutch during engine operation or starts the electric compressor on electric standby operation. The refrigeration system is protected by a high pressure transducer and a low pressure cutout switch.

When plugged into standby power, engine operation is automatically locked out. If the truck engine is turned on while the power cord is still plugged into a power receptacle, the unit will remain working in electric mode; the engine driven compressor cannot be started until the power cord is unplugged from the unit because the selection of engine operation or standby operation is automatic.

Control Circuits

The control circuits operate on 12 Vdc or 24 Vdc supplied by the vehicle batteries for engine operation. On standby operation, the power is rectified through an AC transformer.

DSR Control System

The DSR Control System is composed of an Electronic Control Module (ECM) located in the control box, and the In-Cab Control Box. This In-Cab Control Box, also called the HMI, allows the truck driver to operate the Thermo King refrigeration unit.

Refer to the Direct Smart Reefer Microprocessor Control System Diagnostic Manual TK 52573 for complete service information about the DSR Control System and the related components.

Refer to the V-520 Series Operating Manual TK 54342 for information about basic unit operation.

Oil Separator

An oil separator is a standard feature. The oil separator separates compressor oil from refrigerant vapor and returns the oil to the compressor through the suction line. The oil return line is attached to a suction tube in the condenser. The oil separator helps provide positive oil return at high compressor speeds and low operating temperatures. This feature enhances compressor lubrication and extends compressor life.

Refrigerant

Important:

MAX and SPECTRUM units built Before December 12, 2022 were originally built using R-404A refrigerant.

MAX and SPECTRUM units built on and after December 12, 2022 are equipped with R-452A refrigerant.

See Service Bulletin SB874 Transition to R–452A Refrigerant for Vehicle-Powered (VP) Truck Units in North America

- V-520 10, V-520 20, V-520 30, and V-520 50 units use R-134a refrigerant.
- V-520 MAX 10, V-520 MAX 20, V-520 MAX 30, V-520 MAX 50, V-520 SPECTRUM 10, V-520 SPECTRUM 20, and V-520 SPECTRUM 50 units use R-404A or R-452A refrigerant.

Liquid Injection System

MAX units use R-404A or R-452A. These units have a liquid injection system to limit discharge temperature of the engine driven compressor. Liquid injection is activated when the temperature switch is closed or when the unit is running in heat mode on Model 30 and Model 50 units. If the discharge gas leaving the compressor reaches a temperature of 230 ± 5 F (110 ± 3 C) the liquid injection switch closes, providing voltage to the liquid injection solenoid. The solenoid opens a valve, allowing liquid refrigerant to flow from the liquid line in the evaporator to the metering orifice. The metering orifice is attached to the suction tube assembly in the condenser. As the refrigerant passes through the metering orifice it expands and evaporates, cooling the suction gas entering the compressor. This cooling effect is transferred to the discharge gas leaving the compressor from the adjacent cavity in the compressor head. When the discharge gas is cooled to 200 ± 5 F (93 ± 3 C), the liquid injection switch opens, the liquid injection solenoid closes and refrigerant no longer flows through the liquid injection system.

Evaporator Drain Line Heaters

Evaporator drain line heaters are used in these units to avoid drain line blockage because of ice accumulation inside the evaporator. Two harnesses are located inside the drain lines. These resistive wires melt the ice when energized/while in defrost mode. These drain line heaters are standard on all MAX units, but can be an option with R-134A units. Please contact your Thermo King Dealer for more information.

Electric Standby Operation

When the unit is connected to an electric power source, the battery relay is de-energized, and the standby relay is energized to provide rectified power from the transformer to the electronic control system.

During electric standby operation, the electronic control system controls the operation of the unit by energizing and de-energizing the compressor contactor and standby compressor clutch (if applicable) and places the unit in cool, heat, or defrost mode by energizing the compressor contactor and standby compressor clutch (if applicable).
The electronic control system places the unit in null by de-energizing the compressor contactor and standby compressor clutch.

Protection Features

- Discharge (High) Pressure Transducer - The discharge pressure transducer is a pressure sensitive device. It is located in the condenser section discharge line near the oil separator.

  If the discharge pressure rises above a certain pressure, the ECM opens the circuit to the compressor clutch to stop unit operation.

  For units with R-134a, the ECM opens the compressor clutch circuit at 300 psig (2068 kPa) and shuts down the unit. The ECM closes the compressor clutch circuit when the pressure drops to 200 psig (1379 kPa).

  For units with R-404A or R-452A, the ECM opens the compressor clutch circuit at 450 psig (3103 kPa) and shuts down the unit. The ECM closes the compressor clutch circuit when the pressure drops to 375 psig (2586 kPa).
- Low Pressure Cutout Switch - The Low Pressure Cutout Switch is a pressure sensitive switch located on the suction line assembly in the evaporator. If the suction pressure falls below 5 to 11 in. Hg vacuum (-17 to -34 kPa), the switch opens the LPCO/CH circuit. This signals the ECM to open the circuit to the compressor clutch to stop unit operation. The ECM closes the compressor clutch circuit when the pressure rises to 4 to 7 psig (28 to 48 kPa).

Control Box

P.C. Boards

All Printed Circuit Boards within this unit, supplied by Thermo King can be easily identified by the Part Number stamped on them.

Electronic Control Module (ECM)

The ECM contains the system's secondary microprocessors, I/O connectors, output relays, fuses, LEDs, cooling fan, and discrete electronic components mounted on two printed circuit boards PCB2 is mounted on top of PCB1. This configuration is known as Platform 2.

The microprocessors receives output signals from the load compartment return air sensor and electronic thermostat. These signals are sent to the microprocessor in the In-Cab Control Box. Based on setpoint temperature and other parameters, the In-Cab Control Box microprocessor determines when to adjust the temperature-control state in the load compartment to Cool, Heat, or Null mode, or to initiate a Defrost cycle.

Refer to the Direct Smart Reefer Microprocessor Control System Diagnostic Manual TK 52573 for complete service information about the Electronic Control Module.

Refrigeration System Components

Solenoids and Valves

Hot Gas Solenoid (HGS)

Switches and Transducers

Low Pressure Cutout Switch (LPCO)

This normally closed switch monitors the suction pressure in the evaporator. It opens on low suction pressure to stop the unit and prevent damage to the compressor.

Liquid Injection Switch (LISW)

This switch is a normally open switch that monitors the discharge temperature on the engine driven compressor. It closes on high discharge temperature to energize the liquid injection valve and cool the compressor.

Discharge Pressure Transducer (DPT)

This transducer supplies the discharge pressure from the discharge line in the condenser to the microprocessor. This information is used by the microprocessor and software to determine the unit operating conditions.

Refrigeration System Component Nomenclature

The nomenclature for components in the schematic and wiring diagrams does not match the nomenclature above and in the refrigeration system diagrams on the following pages. The following table shows the nomenclature used in the various diagrams.

Single Temp Units		
Component/ Refrigeration Diagram	**Wiring Diagram**	**Schematic Diagram**
Liquid Injection Solenoid	L1 – LIV	L1
Hot Gas Solenoid	L2 – Hot Gas Defrost Solenoid	L2
Condenser Inlet Solenoid	L3 - Cond Blocking Solenoid	L3
Discharge Pressure Transducer (DPT)	A3 - High Pressure Transducer	A3

Single Temp Units		
Component/ Refrigeration Diagram	**Wiring Diagram**	**Schematic Diagram**
Liquid Injection Switch (LISW)	S2 - Liq Inj Temp Switch	S2
Low Pressure Cutout Switch (LPCO)	S3 - LPCO	S3

SPECTRUM Multi-Temp Units		
Component/ Refrigeration Diagram	**Wiring Diagram**	**Schematic Diagram**
Hot Gas Solenoid Zone 1	Hot Gas Defrost Solenoid 1 PS1/L2 - Hot Gas Defrost Solenoid	PS1/L2
Liquid Line Solenoid Zone 2	Liquid Solenoid 2 PS2/L6 - Liquid Solenoid	PS2/L6
Liquid Line Solenoid Zone 1	Liquid Solenoid 1 PS3/L5 - Liquid Solenoid	PS3/L5
Hot Gas Solenoid Zone 2	Hot Gas Defrost Solenoid 2 PS4/L7 - Hot Gas Defrost Solenoid	PS4/L7
CPR Bypass Solenoid	Suction Bypass Solenoid PS6/L4 - Suction Bypass Solenoid	PS6/L4
Liquid Injection Solenoid	Liquid Injection Valve/L1 - LIV	LIV/L1
Condenser Inlet Solenoid	L3 - Cond Blocking Solenoid	L3
Liquid Injection Switch (LISW)	Liq Inject Temp Switch	LIS/S2
Low Pressure Cutout Switch (LPCO)	LPCO Switch	LPCO
Discharge Pressure Transducer (DPT)	HP Transducer THPCO	THPCO

Unit Operation

Standard Model 10 and 20 units (without heat options) operate in Cool mode or Null mode, as required, to maintain the load compartment temperature at the setpoint temperature.

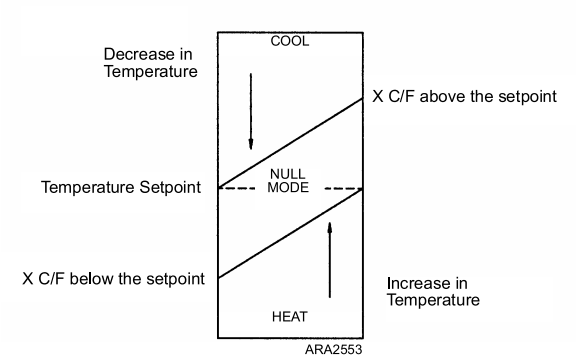
Model 30 and 50 units, and 10 and 20 units with heat options (coolant or electric heat), operate in Cool, Null, or Heat as required, to maintain the load compartment temperature at the setpoint temperature.

Defrost cycles occur manually or automatically, as required.

If power is shut off, the unit comes back in Null mode when the unit is restarted. There is a momentary delay at auto start-up for circuit protection.

Note: *The compressor will "bump start" five times while coming out of Null or when the unit is first started. In a "bump start" the compressor is turned on for about one second and then goes off for about four seconds.*

Figure 2. Thermostat Algorithm



For units with Electric Standby, there are protective delays for the electric compressor/compressor motor contactor.

Options:

- Coolant Heat - This option provides auxiliary heating by circulating hot engine coolant through the evaporator.
- Electric Heat - Provides auxiliary heat through resistive heat strips in the evaporator when connected to electric standby.
- SPECTRUM - Provides temperature control for two-compartment systems.

Operation

The vehicle engine must be running and the unit must be turned on. On units with Electric Standby, connect the external power cord and the unit switches to Electric mode operation. Unit operation can be tailored, as required, using programmable settings as shown in the Direct Smart Reefer Microprocessor Control System Diagnostic Manual TK 52573.

Cool Mode

When cooling is required (when there is a requirement to lower the evaporator return air temperature in the load compartment), the controller energizes the compressor clutch (or compressor motor contactor in Model 20/50 units) and evaporator fans. The controller monitors the discharge pressure through the discharge pressure transducer (DPT). The condenser fans are energized if necessary and turn on and off as determined by the controller.

In SPECTRUM units the controller also energizes the liquid line solenoid(s) in the compartment(s) that require cooling.

The unit operates in Cool mode until the setpoint temperature is reached. The unit then enters Null mode. When the temperature rises to a pre-determined number of degrees (programmable setting), the unit restarts in Cool mode.

In SPECTRUM units the compartment operates in Cool mode until the setpoint temperature is reached. The compartment then enters Null mode. When the temperature rises to a pre-determined number of degrees (programmable setting), the compartment restarts in Cool mode. The compressor will stop if both compartments are in Null.

These units have a triple-cooling capacity (TCC) feature. The controller monitors the discharge pressure through the discharge pressure transducer (DPT) and controls the speed of condenser fans CF1 and CF2 by opening and closing relays RY6, RY9, RY10 in the following manner:

- When the discharge pressure is less than 180 psig (1241 kPa), RY6, RY9, and RY10 are open. CF1 and CF2 receive no voltage and are in Null state.
- When the discharge pressure is between 180 psig (1241 kPa) and 300 psig (2068 kPa), RY9 closes. CF1 and CF2 become connected in series, receive low voltage, and operate at low speed.
- When the discharge pressure is greater than 300 psig (2068 kPa), RY6 and RY10 close and RY9 opens. CF1 and CF2 become connected in parallel, receive high voltage, and operate at high speed.

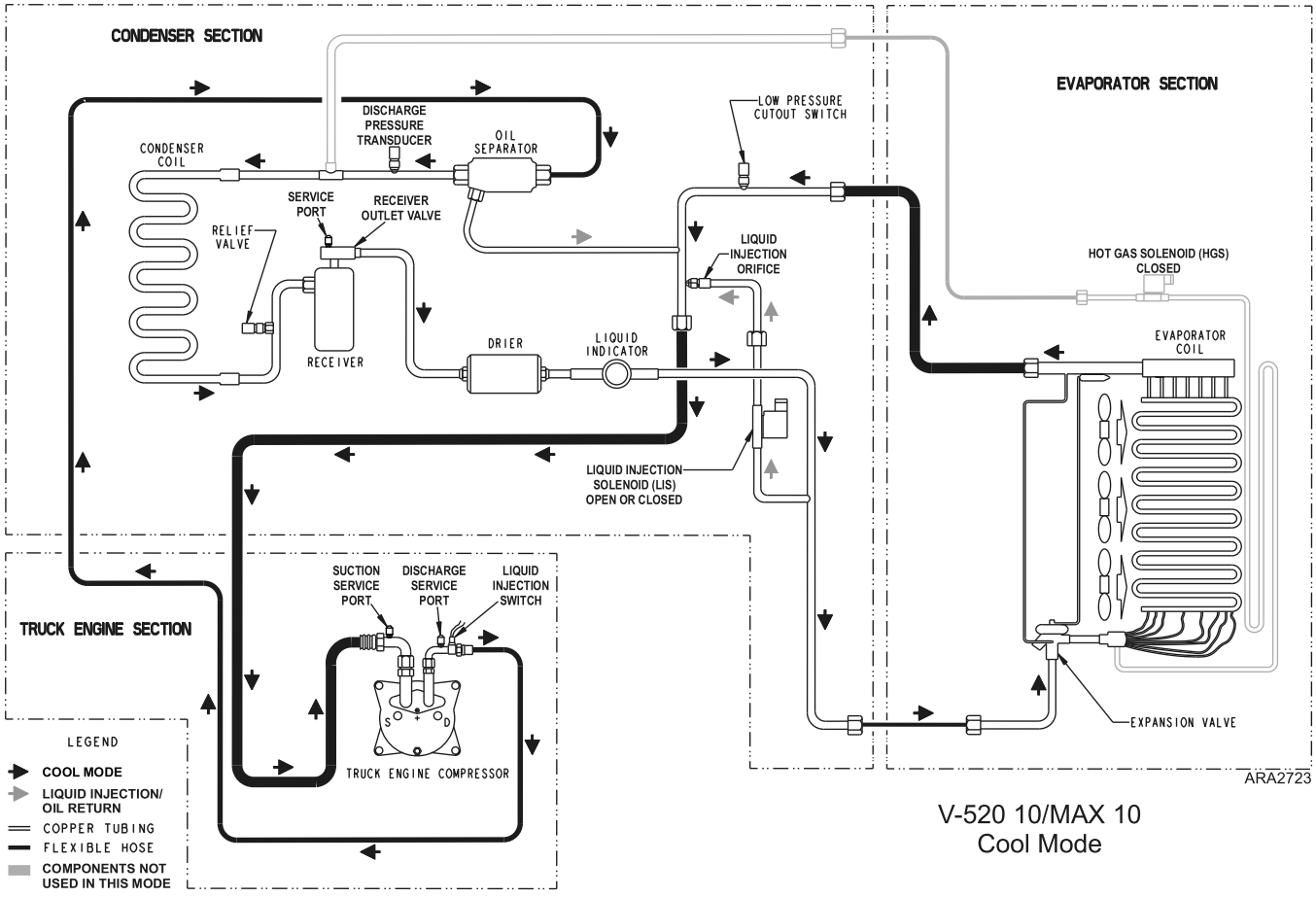
Cool Mode Model 10

High pressure refrigerant vapor leaves the compressor and flows through the oil separator where oil is separated and returned to the suction tube. The refrigerant flows through the condenser where the refrigerant releases heat and condenses into high pressure liquid. The liquid refrigerant flows through the receiver, drier, liquid indicator, and the expansion valve into the evaporator. There, liquid refrigerant absorbs heat as it evaporates into low pressure vapor. The refrigerant returns to the compressor through the suction line.

If the compressor discharge temperature rises enough to close the liquid injection switch, the liquid injection solenoid opens and liquid refrigerant flows through the liquid injection line and liquid injection orifice into the suction tube to cool the compressor. When the compressor discharge temperature falls enough to open the liquid injection switch, liquid injection valve closes to stop liquid injection.

- Hot Gas Solenoid – Closed/De-energized
- Liquid Injection Solenoid – Closed/De-energized, but will open (energize) when the liquid injection switch is closed to control the engine driven compressor temperature.

Figure 3. Cool Mode Model 10



V-520 10/MAX 10
Cool Mode

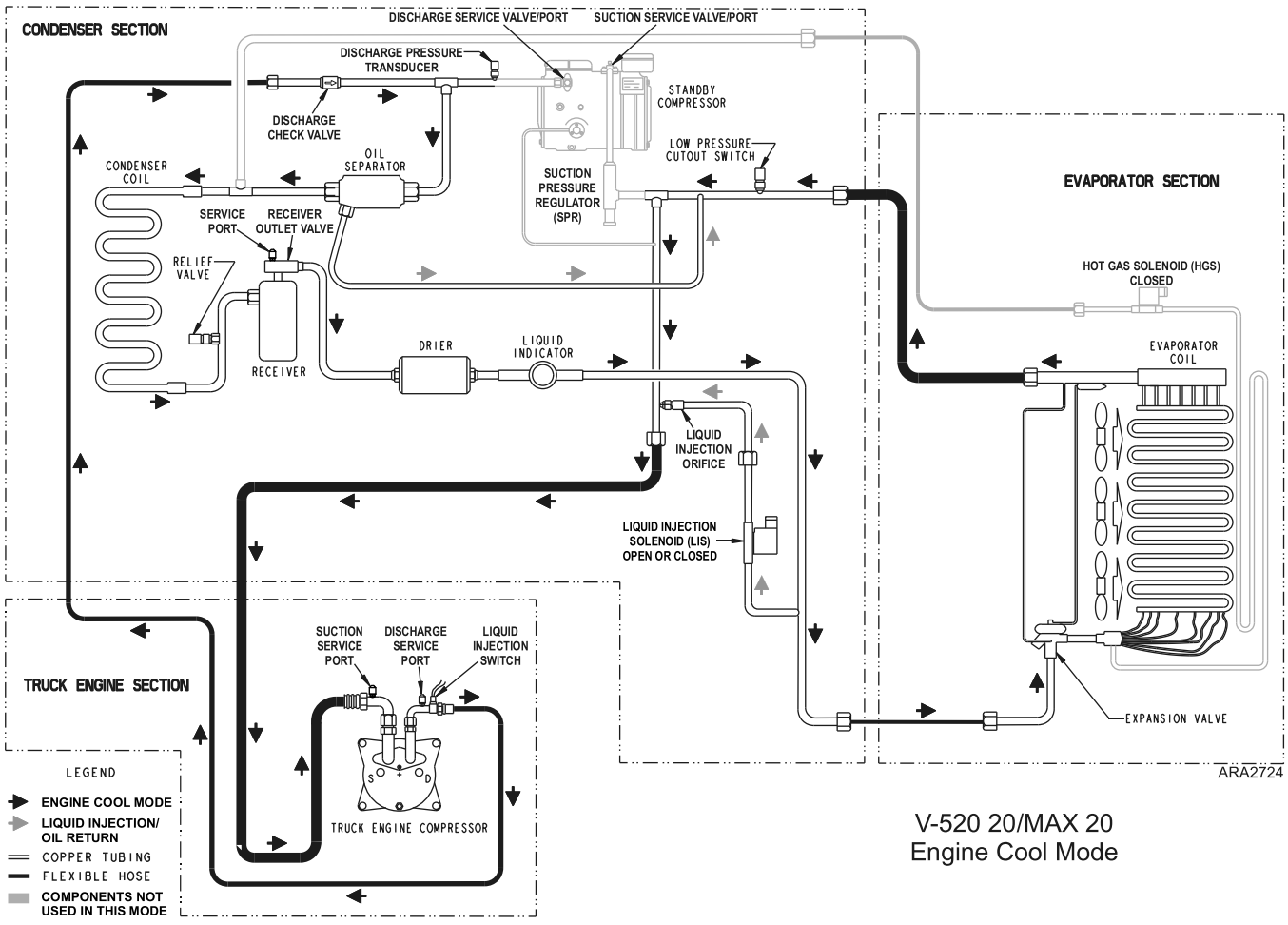
Cool Mode Model 20 Engine Operation

High pressure refrigerant vapor leaves the engine driven compressor and flows through the discharge check valve and the oil separator where oil is separated and returned to the suction tube. The refrigerant flows through the condenser where the refrigerant releases heat and condenses into high pressure liquid. The liquid refrigerant flows through the receiver, drier, liquid indicator, and the expansion valve into the evaporator. There, liquid refrigerant absorbs heat as it evaporates into low pressure vapor. The refrigerant returns to the compressor through the suction line.

If the compressor discharge temperature rises enough to close the liquid injection switch, the liquid injection valve opens and liquid refrigerant flows through the liquid injection line and liquid injection orifice into the suction tube to cool the compressor. When the compressor discharge temperature falls enough to open the liquid injection switch, liquid injection valve closes to stop liquid injection.

- Discharge Check Valve – Open
- Hot Gas Solenoid – Closed/De-energized
- Liquid Injection Solenoid – Closed/De-energized, but will open (energize) when the liquid injection switch is closed to control the engine driven compressor temperature.

Figure 4. Cool Mode Model 20 Engine Operation



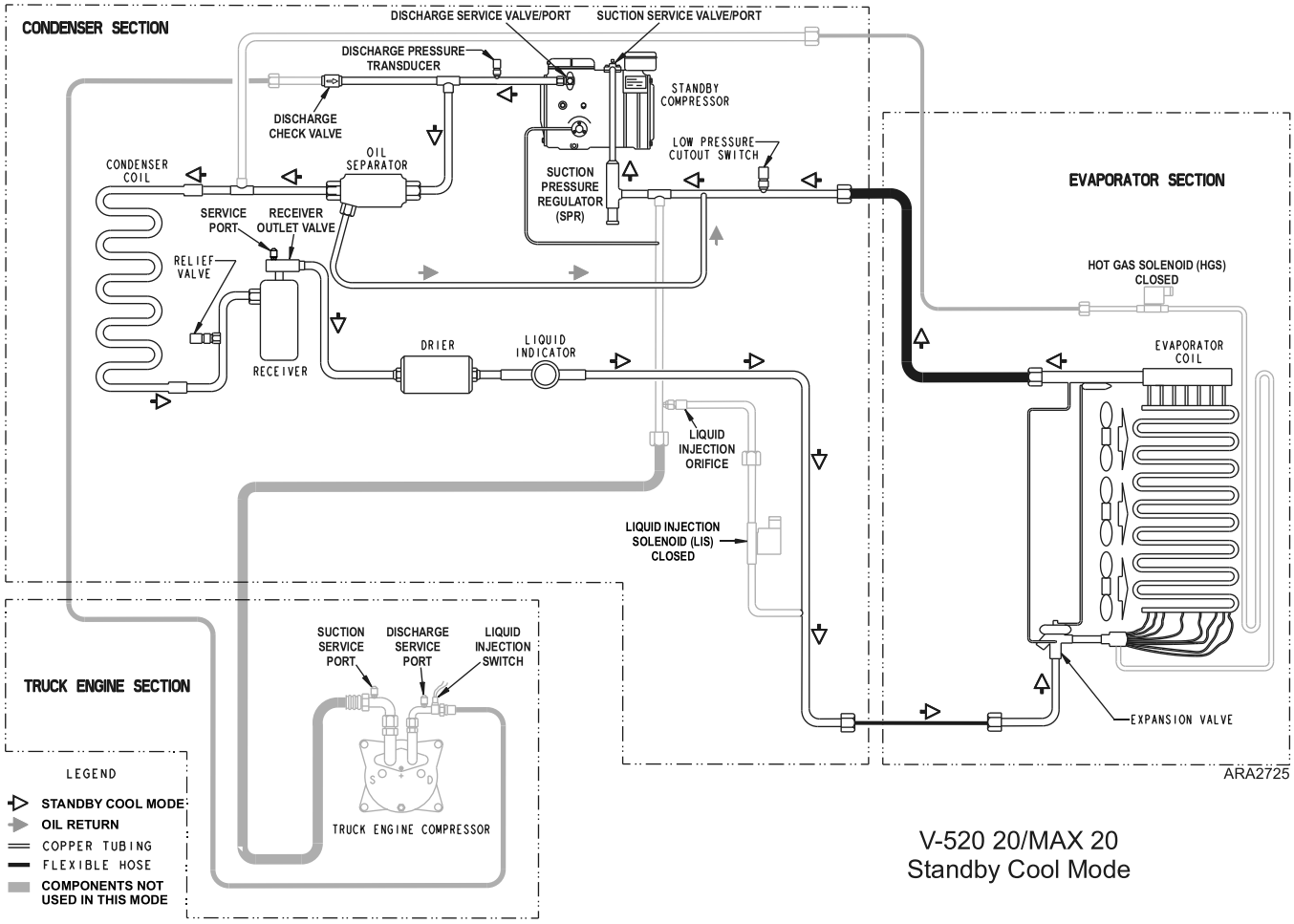
V-520 20/MAX 20
Engine Cool Mode

Cool Mode Model 20 Electric Standby Operation

High pressure refrigerant vapor leaves the electric standby compressor and flows through the oil separator where oil is separated and returned to the suction tube. The refrigerant flows through the condenser where the refrigerant releases heat and condenses into high pressure liquid. The liquid refrigerant flows through the receiver, drier, liquid indicator, and the expansion valve into the evaporator. There, liquid refrigerant absorbs heat as it evaporates into low pressure vapor. The refrigerant returns to the compressor through the suction pressure regulator.

- Discharge Check Valve – Closed
- Hot Gas Solenoid – Closed/De-energized
- Liquid Injection Solenoid – Closed/De-energized

Figure 5. Cool Mode Model 20 Electric Standby Operation



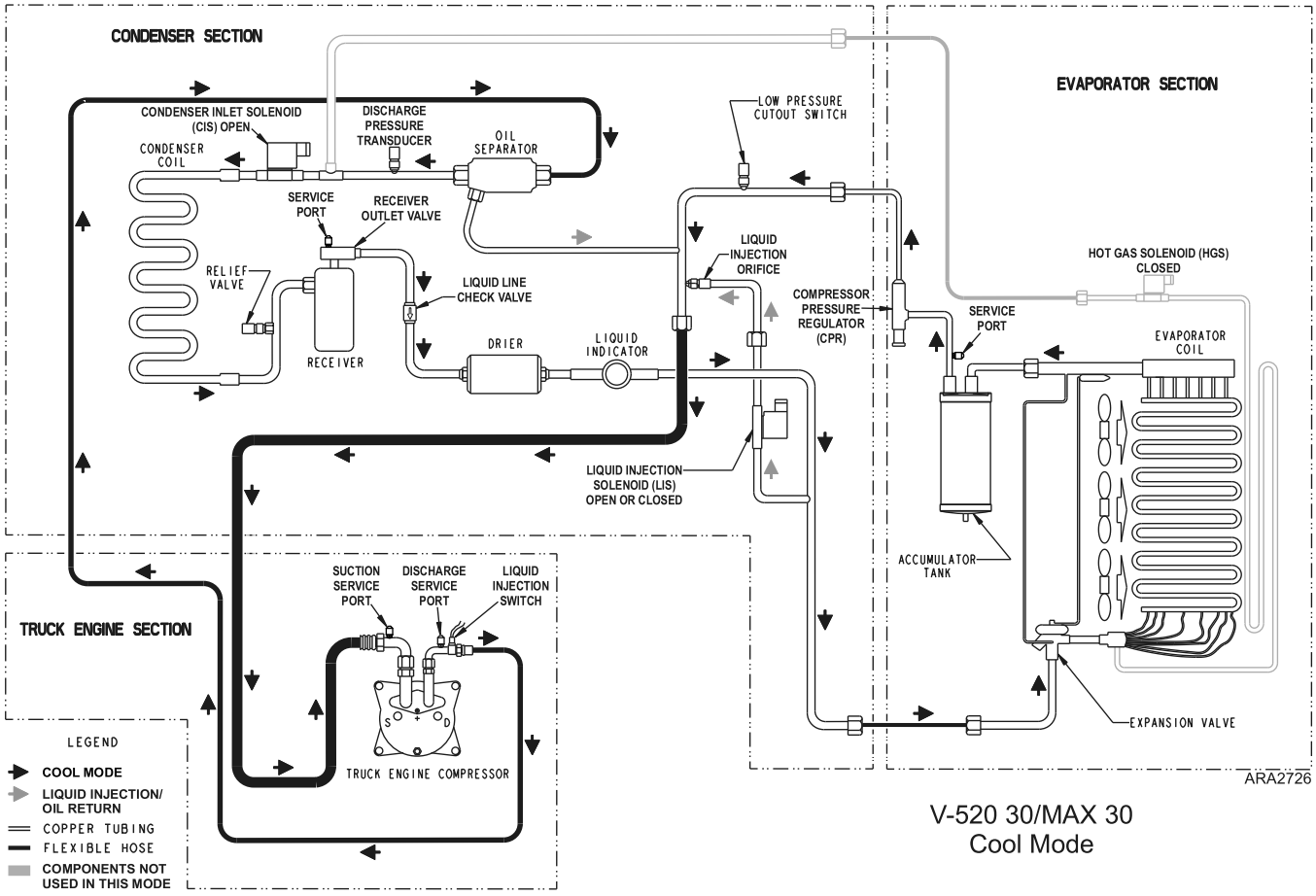
Cool Mode Model 30

High pressure refrigerant vapor leaves the compressor and flows through the oil separator where oil is separated and returned to the suction tube. The refrigerant flows through the open condenser inlet solenoid to the condenser where the refrigerant releases heat and condenses into high pressure liquid. The liquid refrigerant flows through the receiver, liquid line check valve, drier, liquid indicator, and the expansion valve into the evaporator. There, liquid refrigerant absorbs heat as it evaporates into low pressure vapor. The refrigerant returns to the compressor through the accumulator and compressor pressure regulator.

If the compressor discharge temperature rises enough to close the liquid injection switch, the liquid injection valve opens and liquid refrigerant flows through the liquid injection line and liquid injection orifice into the suction tube to cool the compressor. When the compressor discharge temperature falls enough to open the liquid injection switch, liquid injection valve closes to stop liquid injection.

- Condenser Inlet Solenoid – Open/De-energized
- Hot Gas Solenoid – Closed/De-energized
- Liquid Line Check Valve – Open
- Liquid Injection Solenoid – Closed/De-energized, but will open (energize) when the liquid injection switch is closed to control the engine driven compressor temperature.

Figure 6. Cool Mode Model 30



V-520 30/MAX 30
Cool Mode

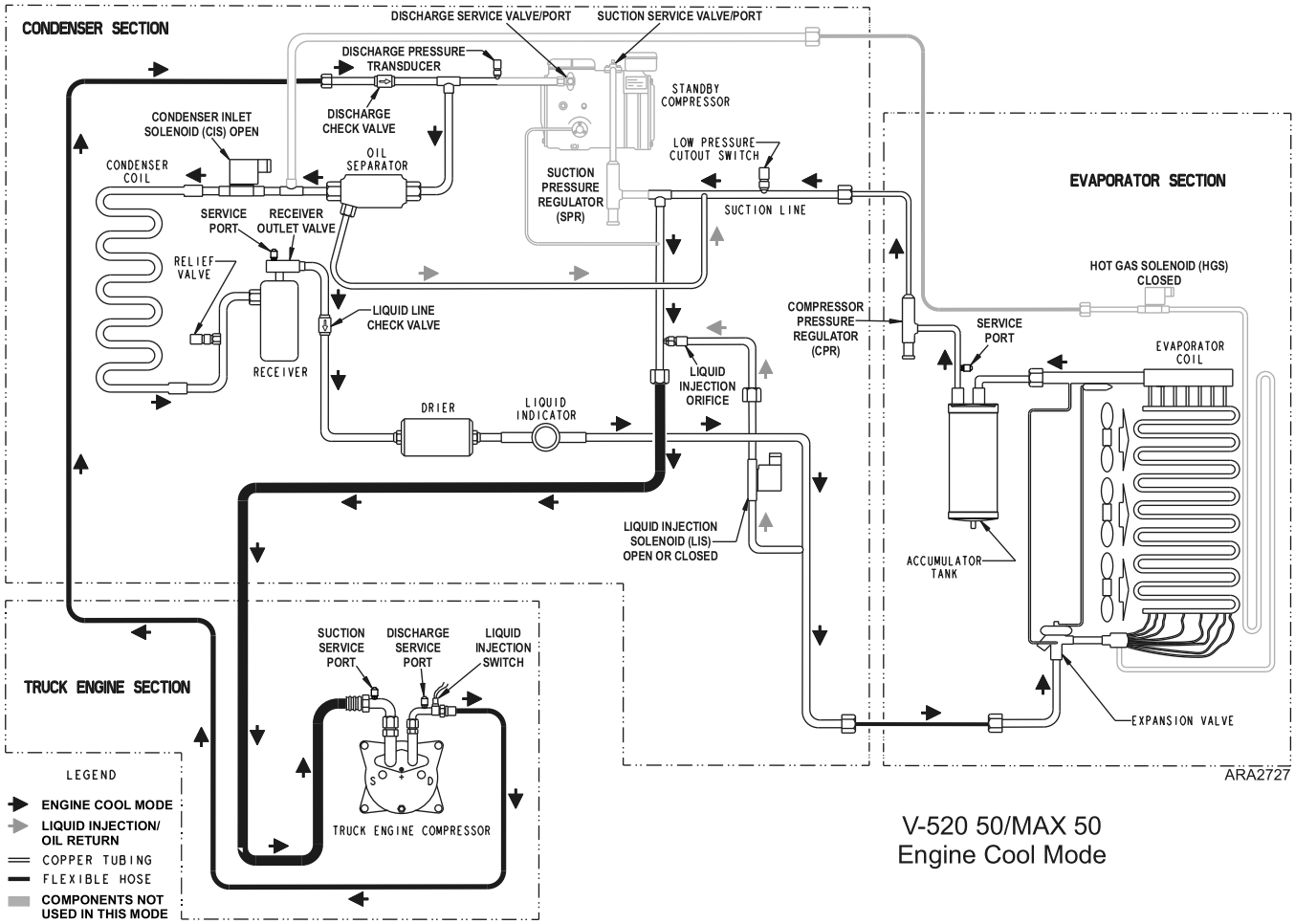
Cool Mode Model 50 Engine Operation

High pressure refrigerant vapor leaves the engine driven compressor and flows through the discharge check valve and the oil separator where oil is separated and returned to the suction tube. The refrigerant flows through the open condenser inlet solenoid to the condenser where the refrigerant releases heat and condenses into high pressure liquid. The liquid refrigerant flows through the receiver, liquid line check valve, drier, liquid indicator, and the expansion valve into the evaporator. There, liquid refrigerant absorbs heat as it evaporates into low pressure vapor. The refrigerant returns to the compressor through the accumulator and compressor pressure regulator.

If the compressor discharge temperature rises enough to close the liquid injection switch, the liquid injection solenoid opens and liquid refrigerant flows through the liquid injection line and liquid injection orifice into the suction tube to cool the compressor. When the compressor discharge temperature falls enough to open the liquid injection switch, liquid injection valve closes to stop liquid injection.

- Discharge Check Valve – Open
- Condenser Inlet Solenoid – Open/De-energized
- Hot Gas Solenoid – Closed/De-energized
- Liquid Line Check Valve – Open
- Liquid Injection Solenoid – Closed/De-energized, but will open (energize) when the liquid injection switch is closed to control the engine driven compressor temperature.

Figure 7. Cool Mode Model 50 Engine Operation



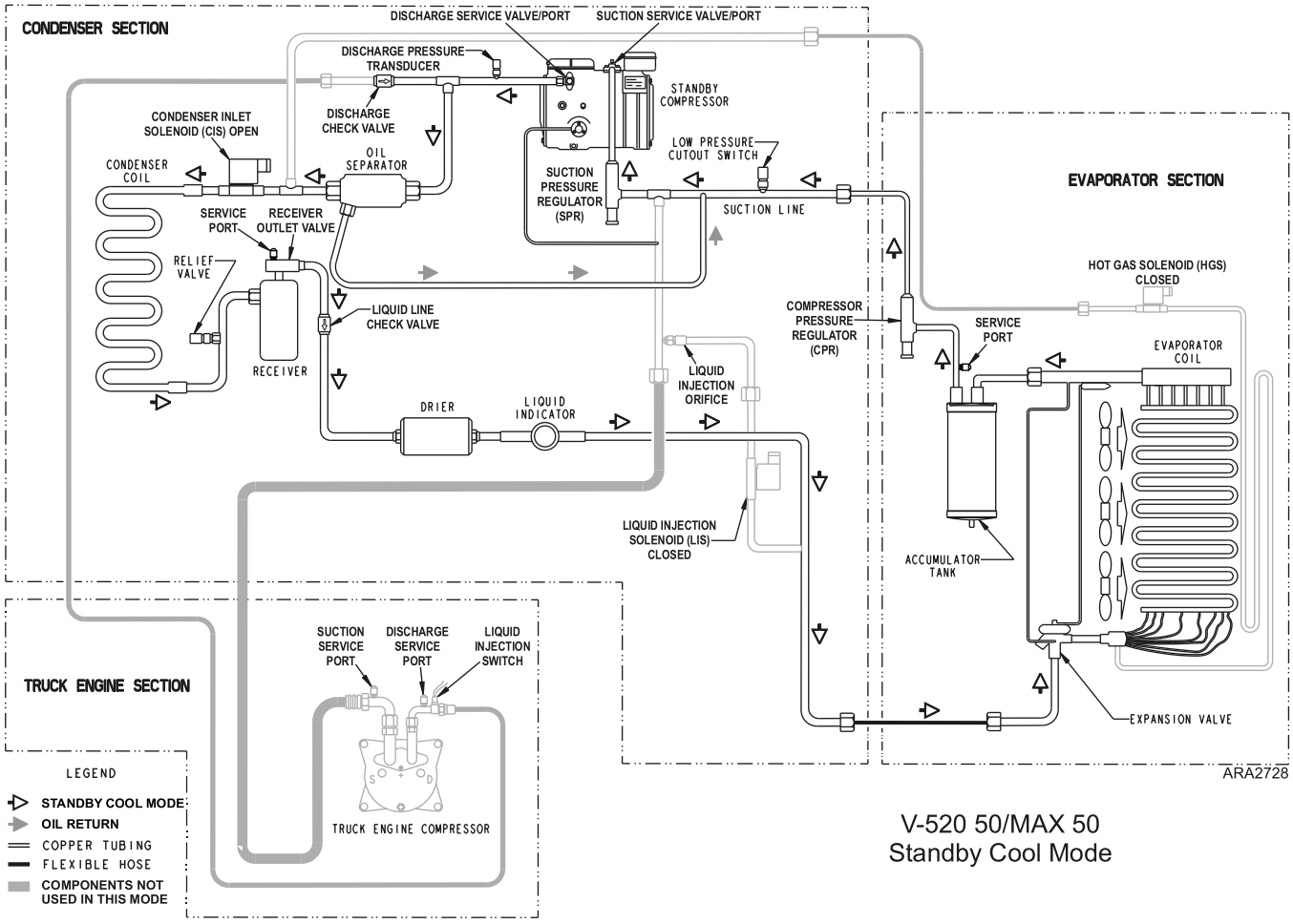
V-520 50/MAX 50
Engine Cool Mode

Cool Mode Model 50 Electric Standby Operation

High pressure refrigerant vapor leaves the electric standby compressor and flows through the oil separator where oil is separated and returned to the suction tube. The refrigerant flows through the open condenser inlet solenoid to the condenser where the refrigerant releases heat and condenses into high pressure liquid. The liquid refrigerant flows through the receiver, liquid line check valve, drier, liquid indicator, and the expansion valve into the evaporator. There, liquid refrigerant absorbs heat as it evaporates into low pressure vapor. The refrigerant returns to the compressor through the accumulator, compressor pressure regulator, and suction pressure regulator.

- Discharge Check Valve – Closed
- Condenser Inlet Solenoid – Open/De-energized
- Hot Gas Solenoid – Closed/De-energized
- Liquid Line Check Valve – Open
- Liquid Injection Solenoid – Closed/De-energized

Figure 8. Cool Mode Model 50 Electric Standby Operation



V-520 50/MAX 50
Standby Cool Mode

SPECTRUM Model 10 Zone 1 Cool, Zone 2 Cool

High pressure refrigerant vapor leaves the compressor and flows through the oil separator where oil is separated and returned to the suction tube. The refrigerant flows through the condenser where the refrigerant releases heat and condenses into high pressure liquid. The liquid refrigerant flows through the receiver, drier, and liquid indicator into the liquid lines.

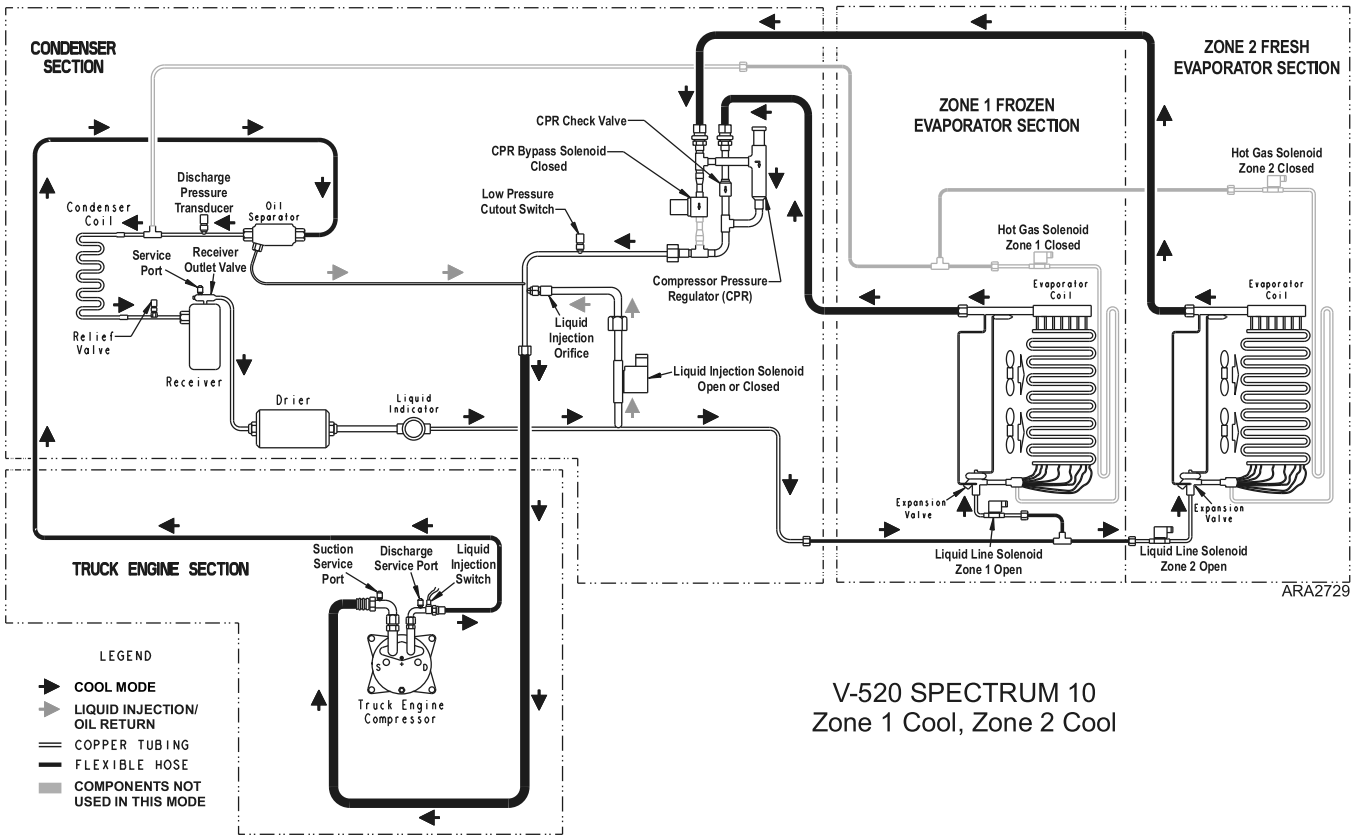
The Zone 1 liquid line solenoid is open so some of the refrigerant flows through the Zone 1 expansion valve into the evaporator. There, liquid refrigerant absorbs heat as it evaporates into low pressure vapor. The refrigerant returns to the compressor through the CPR check valve and suction line.

The Zone 2 liquid line solenoid is also open so some of the refrigerant flows through the Zone 2 expansion valve into the evaporator. There, liquid refrigerant absorbs heat as it evaporates into low pressure vapor. The CPR bypass solenoid is closed so the refrigerant returns to the compressor through the compressor pressure regulator and suction line.

If the compressor discharge temperature rises enough to close the liquid injection switch, the liquid injection solenoid opens and liquid refrigerant flows through the liquid injection line and liquid injection orifice into the suction tube to cool the compressor. When the compressor discharge temperature falls enough to open the liquid injection switch, liquid injection valve closes to stop liquid injection.

- Zone 1 Liquid Line Solenoid – Open/Energized
- Zone 1 Hot Gas Solenoid – Closed/De-energized
- Zone 2 Liquid Line Solenoid – Open/Energized
- Zone 2 Hot Gas Solenoid – Closed/De-energized
- CPR Bypass Solenoid – Closed/Energized
- Liquid Injection Solenoid – Closed/De-energized, but will open (energize) when the liquid injection switch is closed to control the engine driven compressor temperature.

Figure 9. SPECTRUM Model 10 Zone 1 Cool, Zone 2 Cool



SPECTRUM Model 20 Engine Operation Zone 1 Cool, Zone 2 Cool

High pressure refrigerant vapor leaves the engine driven compressor and flows through the discharge check valve and the oil separator where oil is separated and returned to the suction tube. The refrigerant flows through the condenser where the refrigerant releases heat and condenses into high pressure liquid. The liquid refrigerant flows through the receiver, drier, and liquid indicator into the liquid lines.

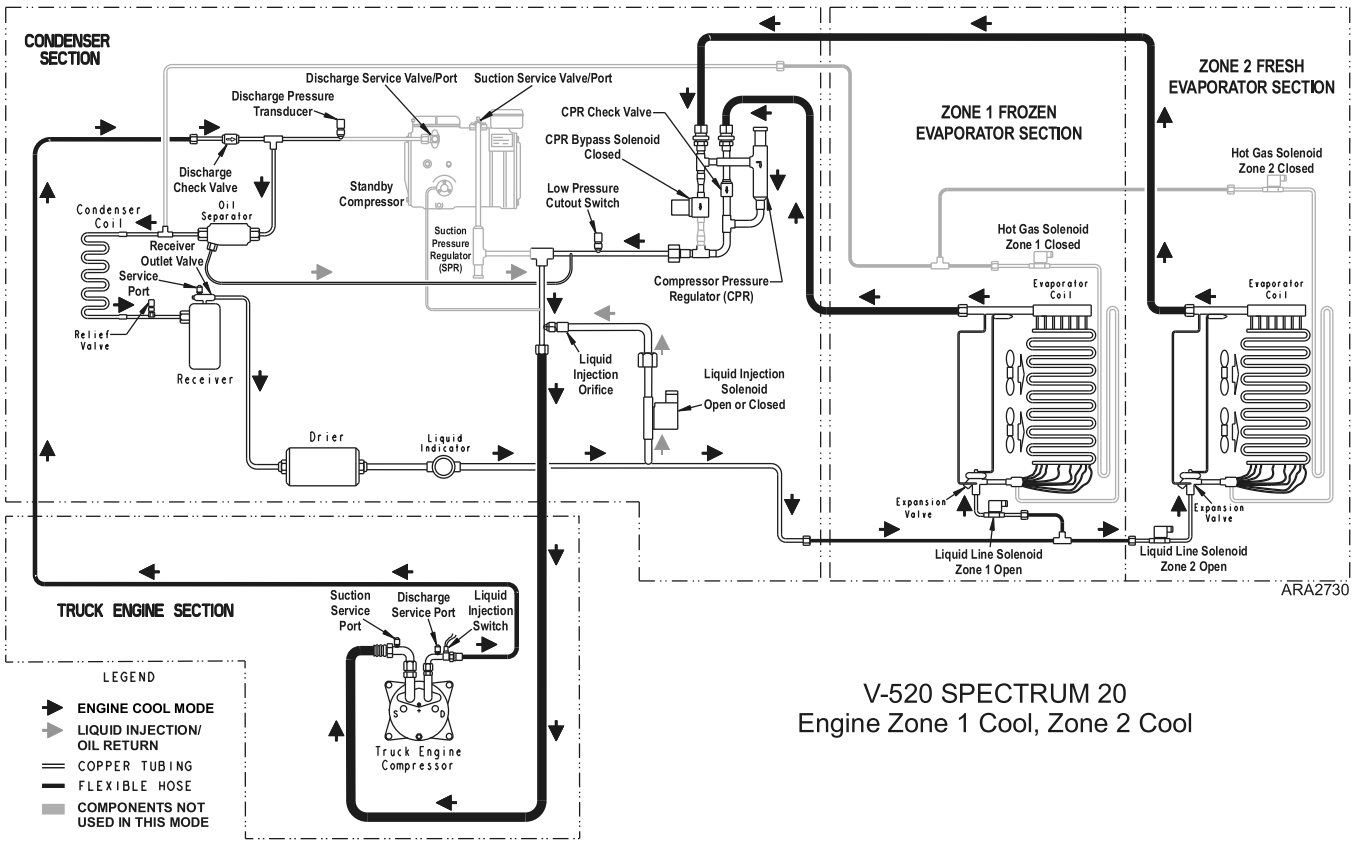
The Zone 1 liquid line solenoid is open so some of the refrigerant flows through the Zone 1 expansion valve into the evaporator. There, liquid refrigerant absorbs heat as it evaporates into low pressure vapor. The refrigerant returns to the compressor through the CPR check valve and suction line.

The Zone 2 liquid line solenoid is also open so some of the refrigerant flows through the Zone 2 expansion valve into the evaporator. There, liquid refrigerant absorbs heat as it evaporates into low pressure vapor. The CPR bypass solenoid is closed so the refrigerant returns to the compressor through the compressor pressure regulator and suction line.

If the compressor discharge temperature rises enough to close the liquid injection switch, the liquid injection solenoid opens and liquid refrigerant flows through the liquid injection line and liquid injection orifice into the suction tube to cool the compressor. When the compressor discharge temperature falls enough to open the liquid injection switch, liquid injection valve closes to stop liquid injection.

- Discharge Check Valve – Open
- Zone 1 Liquid Line Solenoid – Open/Energized
- Zone 1 Hot Gas Solenoid – Closed/De-energized
- Zone 2 Liquid Line Solenoid – Open/Energized
- Zone 2 Hot Gas Solenoid – Closed/De-energized
- CPR Bypass Solenoid – Closed/Energized
- Liquid Injection Solenoid – Closed/De-energized, but will open (energize) when the liquid injection switch is closed to control the engine driven compressor temperature.

Figure 10. SPECTRUM Model 20 Engine Operation Zone 1 Cool, Zone 2 Cool



V-520 SPECTRUM 20
Engine Zone 1 Cool, Zone 2 Cool

SPECTRUM Model 20 Electric Standby Operation Zone 1 Cool, Zone 2 Cool

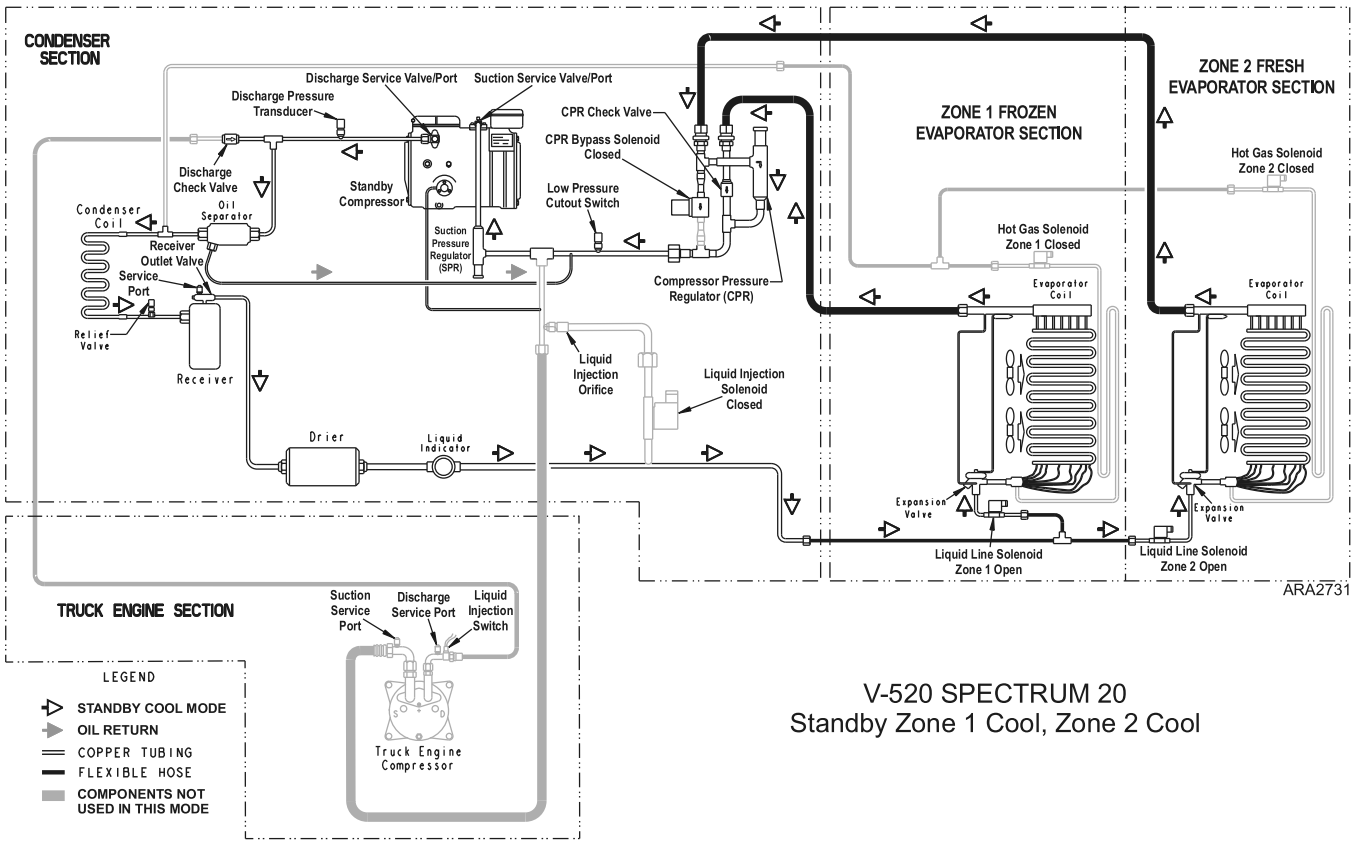
High pressure refrigerant vapor leaves the electric standby compressor and flows through the oil separator where oil is separated and returned to the suction tube. The refrigerant flows through the condenser where the refrigerant releases heat and condenses into high pressure liquid. The liquid refrigerant flows through the receiver, drier, and liquid indicator into the liquid lines.

The Zone 1 liquid line solenoid is open so some of the refrigerant flows through the Zone 1 expansion valve into the evaporator. There, liquid refrigerant absorbs heat as it evaporates into low pressure vapor. The refrigerant returns to the compressor through the CPR check valve, suction line, and suction pressure regulator.

The Zone 2 liquid line solenoid is also open so some of the refrigerant flows through the Zone 2 expansion valve into the evaporator. There, liquid refrigerant absorbs heat as it evaporates into low pressure vapor. The CPR bypass solenoid is closed so the refrigerant returns to the compressor through the compressor pressure regulator, suction line, and suction pressure regulator.

- Discharge Check Valve – Closed
- Zone 1 Liquid Line Solenoid – Open/Energized
- Zone 1 Hot Gas Solenoid – Closed/De-energized
- Zone 2 Liquid Line Solenoid – Open/Energized
- Zone 2 Hot Gas Solenoid – Closed/De-energized
- CPR Bypass Solenoid – Closed/Energized
- Liquid Injection Solenoid – Closed/De-energized

Figure 11. SPECTRUM Model 20 Electric Standby Operation Zone 1 Cool, Zone 2 Cool



SPECTRUM Model 50 Engine Operation Zone 1 Cool, Zone 2 Cool

High pressure refrigerant vapor leaves the engine driven compressor and flows through the discharge check valve and the oil separator where oil is separated and returned to the suction tube. The refrigerant flows through the open condenser inlet solenoid to the condenser where the refrigerant releases heat and condenses into high pressure liquid. The liquid refrigerant flows through the receiver, drier, and liquid indicator into the liquid lines.

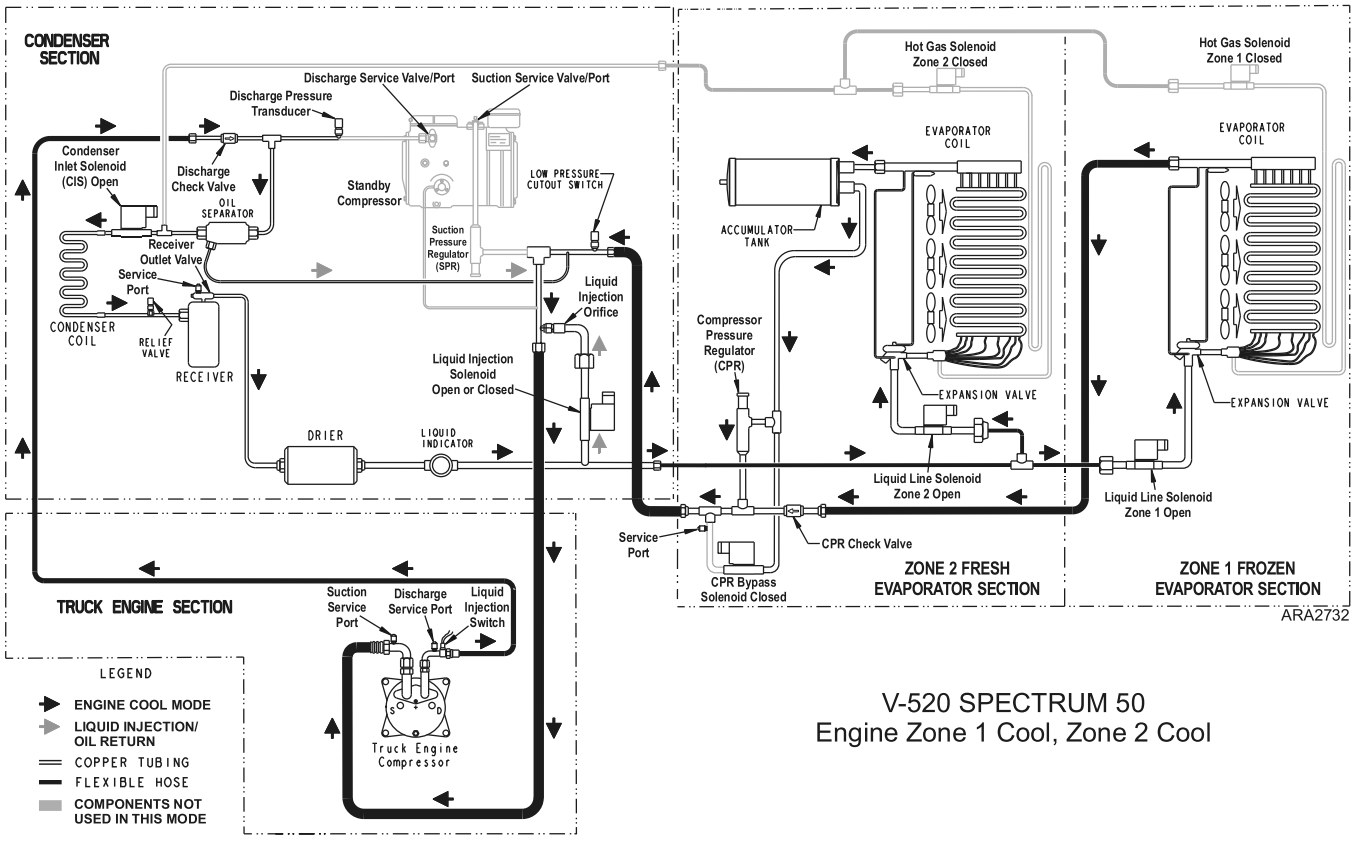
The Zone 1 liquid line solenoid is open so some of the refrigerant flows through the Zone 1 expansion valve into the evaporator. There, liquid refrigerant absorbs heat as it evaporates into low pressure vapor. The CPR bypass solenoid is closed so the refrigerant returns to the compressor through the compressor pressure regulator and suction lines.

The Zone 2 liquid line solenoid is also open so some of the refrigerant flows through the Zone 2 expansion valve into the evaporator. There, liquid refrigerant absorbs heat as it evaporates into low pressure vapor. The refrigerant returns to the compressor through the CPR check valve and suction lines.

If the compressor discharge temperature rises enough to close the liquid injection switch, the liquid injection solenoid opens and liquid refrigerant flows through the liquid injection line and liquid injection orifice into the suction tube to cool the compressor. When the compressor discharge temperature falls enough to open the liquid injection switch, liquid injection valve closes to stop liquid injection.

- Discharge Check Valve – Open
- Condenser Inlet Solenoid – Open/De-energized
- Zone 1 Liquid Line Solenoid – Open/Energized
- Zone 1 Hot Gas Solenoid – Closed/De-energized
- Zone 2 Liquid Line Solenoid – Open/Energized
- Zone 2 Hot Gas Solenoid – Closed/De-energized
- CPR Bypass Solenoid – Closed/Energized
- Liquid Injection Solenoid – Closed/De-energized, but will open (energize) when the liquid injection switch is closed to control the engine driven compressor temperature.

Figure 12. SPECTRUM Model 50 Engine Operation Zone 1 Cool, Zone 2 Cool



V-520 SPECTRUM 50
Engine Zone 1 Cool, Zone 2 Cool

SPECTRUM Model 50 Electric Standby Operation Zone 1 Cool, Zone 2 Cool

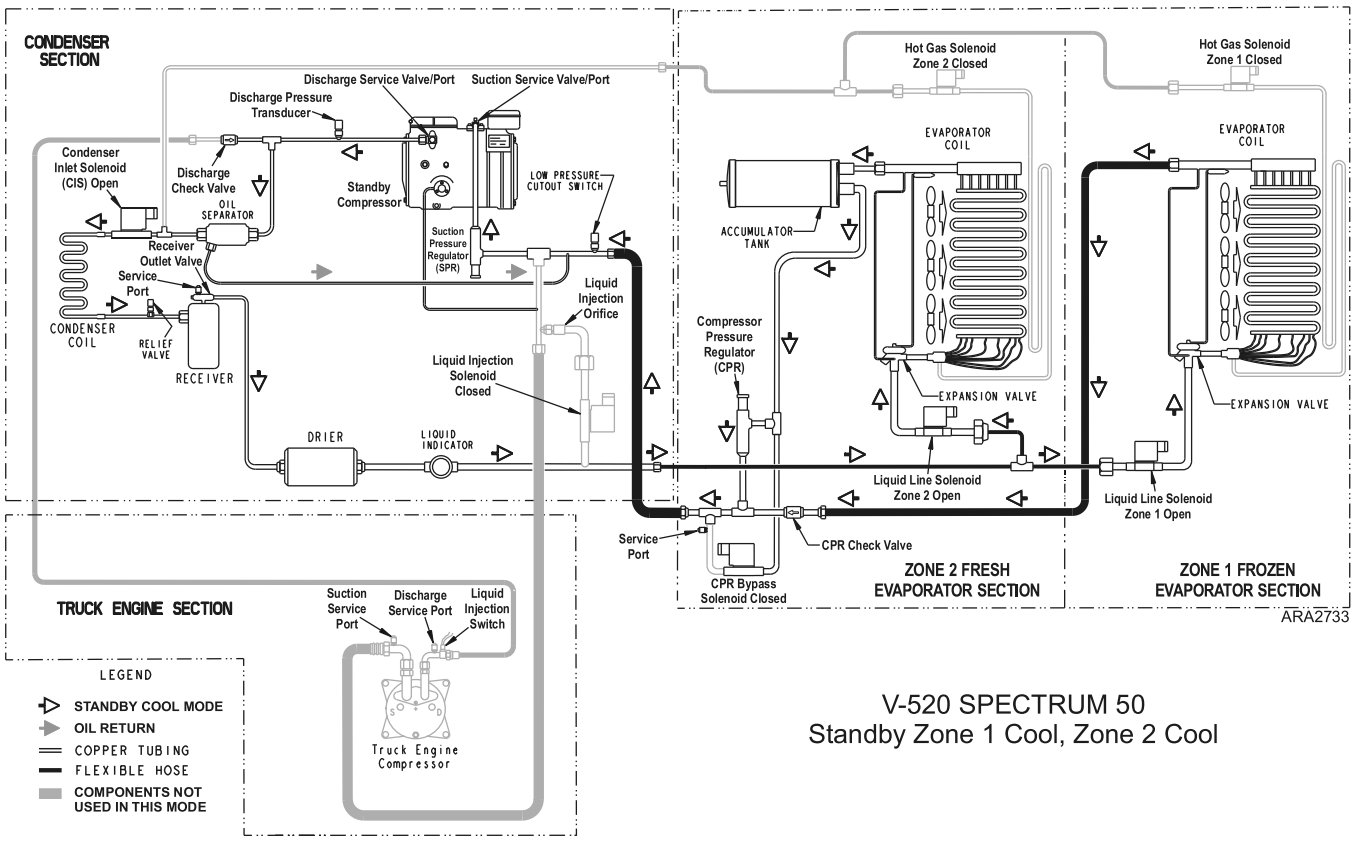
High pressure refrigerant vapor leaves the electric standby compressor and flows through the oil separator where oil is separated and returned to the suction tube. The refrigerant flows through the open condenser inlet solenoid to the condenser where the refrigerant releases heat and condenses into high pressure liquid. The liquid refrigerant flows through the receiver, drier, and liquid indicator into the liquid lines.

The Zone 1 liquid line solenoid is open so some of the refrigerant flows through the Zone 1 expansion valve into the evaporator. There, liquid refrigerant absorbs heat as it evaporates into low pressure vapor. The CPR bypass solenoid is closed so the refrigerant returns to the compressor through the compressor pressure regulator, suction lines, and suction pressure regulator.

The Zone 2 liquid line solenoid is also open so some of the refrigerant flows through the Zone 2 expansion valve into the evaporator. There, liquid refrigerant absorbs heat as it evaporates into low pressure vapor. The refrigerant returns to the compressor through the CPR check valve, suction lines, and suction pressure regulator.

- Discharge Check Valve – Closed
- Condenser Inlet Solenoid – Open/De-energized
- Zone 1 Liquid Line Solenoid – Open/Energized
- Zone 1 Hot Gas Solenoid – Closed/De-energized
- Zone 2 Liquid Line Solenoid – Open/Energized
- Zone 2 Hot Gas Solenoid – Closed/De-energized
- CPR Bypass Solenoid – Closed/Energized
- Liquid Injection Solenoid – Closed/De-energized

Figure 13. SPECTRUM Model 50 Electric Standby Operation Zone 1 Cool, Zone 2 Cool



V-520 SPECTRUM 50
Standby Zone 1 Cool, Zone 2 Cool

Null Mode – Single Temperature Units

The unit operates in Null mode when the setpoint temperature is reached and cooling (or heating) is not required. All outputs are de-energized. If the temperature rises a pre-determined number of degrees (programmable setting), the unit restarts in Cool mode. If the temperature falls a pre-determined number of degrees, and a heat option is present, the unit restarts in Heat mode.

In addition, the evaporator fans might operate during Null mode if evaporator fan constant blow feature is enabled. See the Direct Smart Reefer Microprocessor Control System Diagnostic Manual TK 52573.

Null Mode – SPECTRUM Multi-Temp Units

A compartment operates in Null mode when its setpoint temperature is reached and cooling (or heating) is not required. All outputs to that compartment are de-energized. If the temperature rises a pre-determined number of degrees, the compartment shifts to Cool mode. If the temperature falls a pre-determined number of degrees, and a heat option is present, the compartment shifts to Heat mode. The compressor will stop if both compartments are in Null.

In addition, the evaporator fans might operate during Null mode if evaporator fan constant blow feature is enabled. See the Direct Smart Reefer Microprocessor Control System Diagnostic Manual TK 52573.

Purge Mode – Model 30 and Model 50 Units Only

When a compartment temperature falls a pre-determined number of degrees below the setpoint temperature, the controller prepares the unit for the Heat mode by placing the unit, or both compartments, in the Null mode for 10 seconds, and then placing the unit in the Purge mode for 45 seconds before shifting to the Heat mode. In the Purge mode the compressor clutch, or standby compressor, is energized but the evaporator fans are not. This moves the refrigerant from the condenser to the low side to increase the heating capacity. The refrigerant flow is the same as shown previously in the Cool mode.

Heat Mode – Model 30 and Model 50 Single Temperature Units Only

If a Heat option is present, the unit enters Heat mode when the temperature falls a pre-determined number of degrees below the setpoint temperature. When heat is required, the outputs of the microprocessor energize the compressor clutch (or compressor motor contactor in Model 50 units), the evaporator fans, the hot gas solenoid and the condenser inlet solenoid.

The unit operates in Heat mode until the setpoint temperature is reached. The unit then enters Null mode.

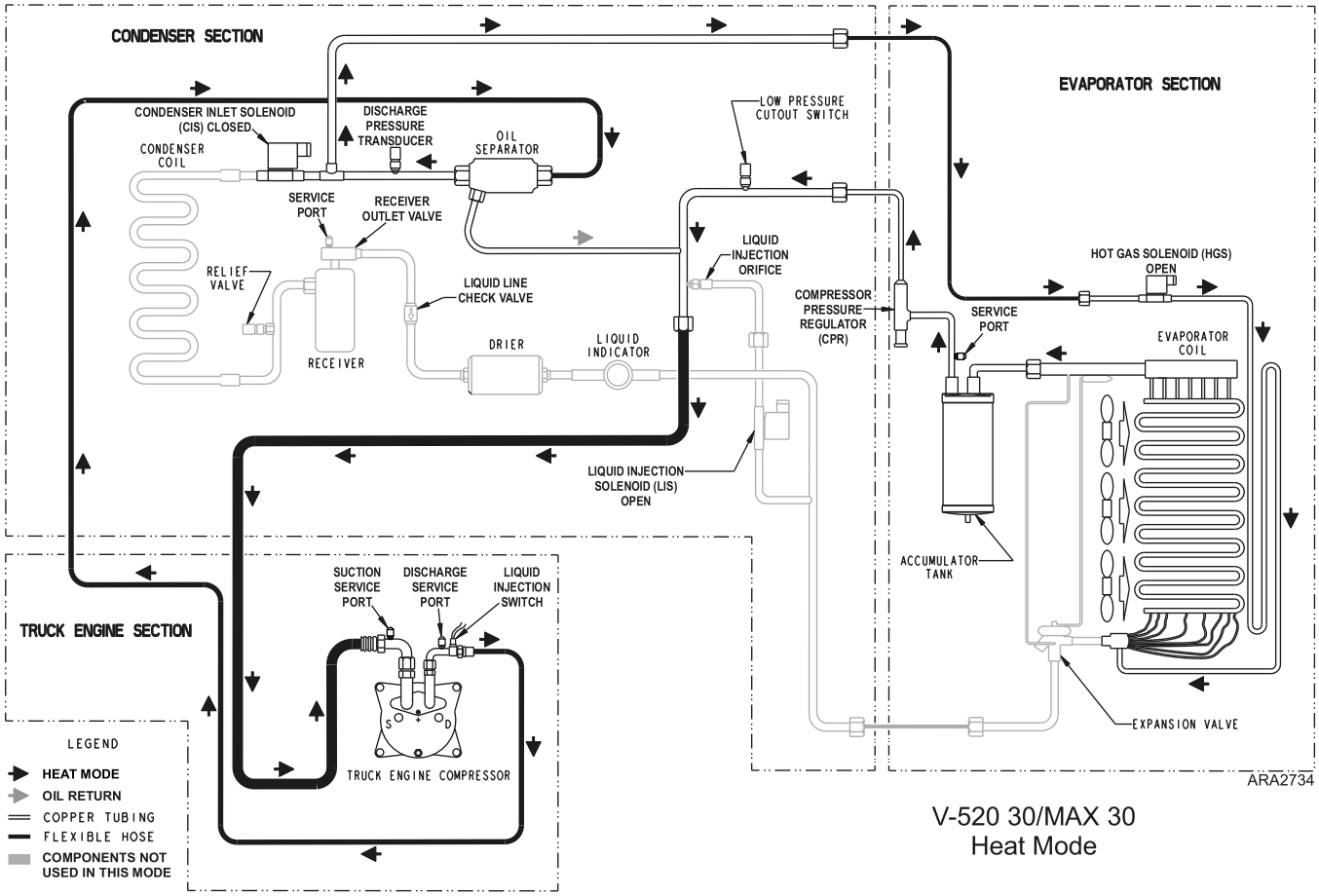
- If the temperature falls a pre-determined number of degrees, the unit restarts in Heat mode.
- If the temperature rises a pre-determined number of degrees, the unit restarts in Cool mode.

Heat Mode Model 30

High pressure refrigerant vapor leaves the compressor and flows through the oil separator where oil is separated and returned to the suction tube. The condenser inlet solenoid is closed and the hot gas solenoid is open so the refrigerant flows through the hot gas line and the drain pan heater to the evaporator. There, the refrigerant heats the evaporator. The refrigerant returns to the compressor through the accumulator and compressor pressure regulator.

- Condenser Inlet Solenoid – Closed/Energized. To control the discharge pressure the controller will open the CIS briefly if the discharge pressure rises to a certain level and will then close it when the discharge pressure drops to a lower level.
- Hot Gas Solenoid – Open/Energized
- Liquid Line Check Valve – Closed
- Liquid Injection Solenoid – Open/Energized

Figure 14. Heat Mode Model 30



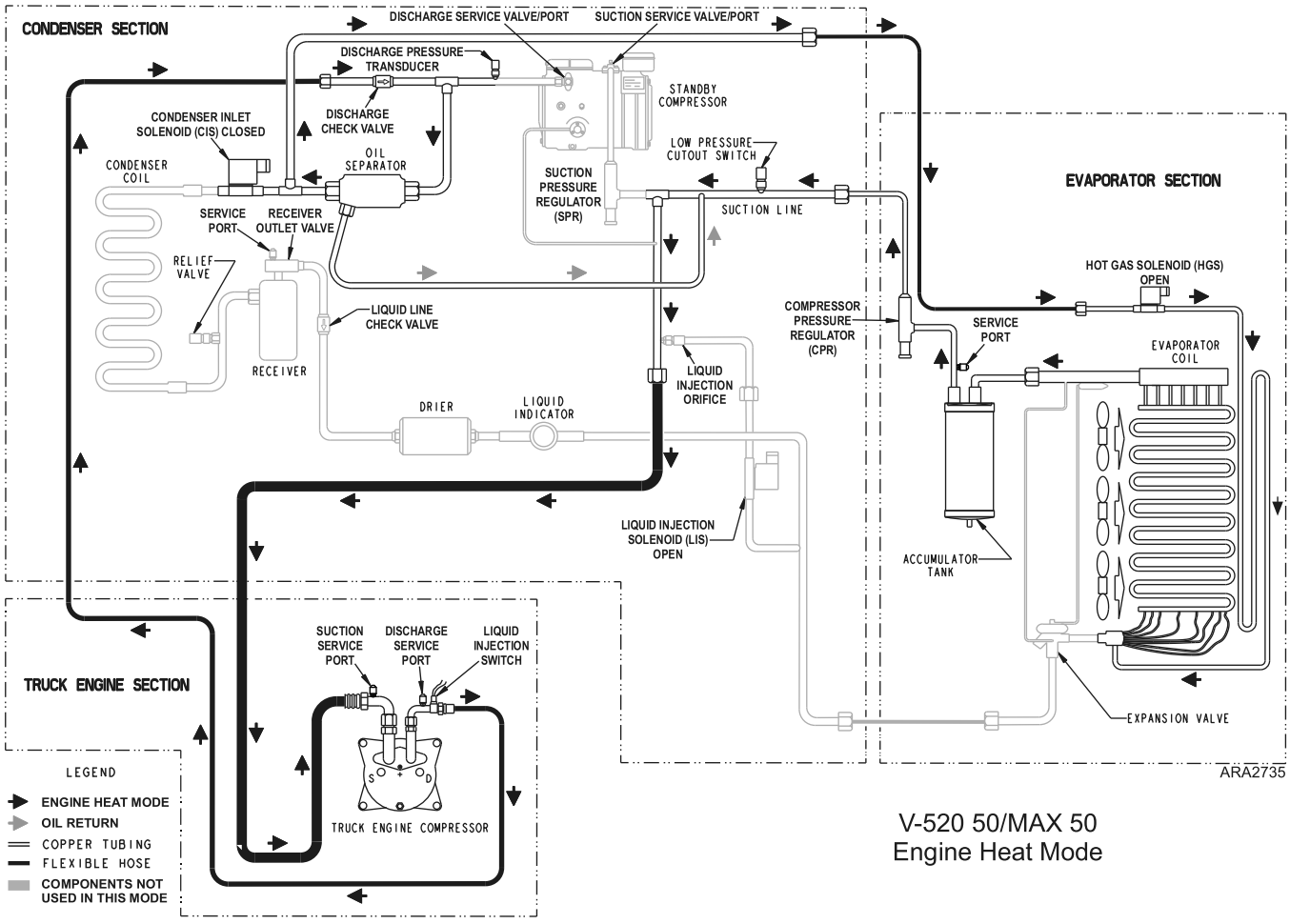
V-520 30/MAX 30
Heat Mode

Heat Mode Model 50 Engine Operation

High pressure refrigerant vapor leaves the engine driven compressor and flows through the discharge check valve and the oil separator where oil is separated and returned to the suction tube. The condenser inlet solenoid is closed and the hot gas solenoid is open so the refrigerant flows through the hot gas line and the drain pan heater to the evaporator. There, the refrigerant heats the evaporator. The refrigerant returns to the compressor through the accumulator and compressor pressure regulator.

- Discharge Check Valve – Open
- Condenser Inlet Solenoid – Closed/Energized. To control the discharge pressure the controller will open the CIS briefly if the discharge pressure rises to a certain level and will then close it when the discharge pressure drops to a lower level.
- Hot Gas Solenoid – Open/Energized
- Liquid Line Check Valve – Closed
- Liquid Injection Solenoid – Open/Energized

Figure 15. Heat Mode Model 50 Engine Operation



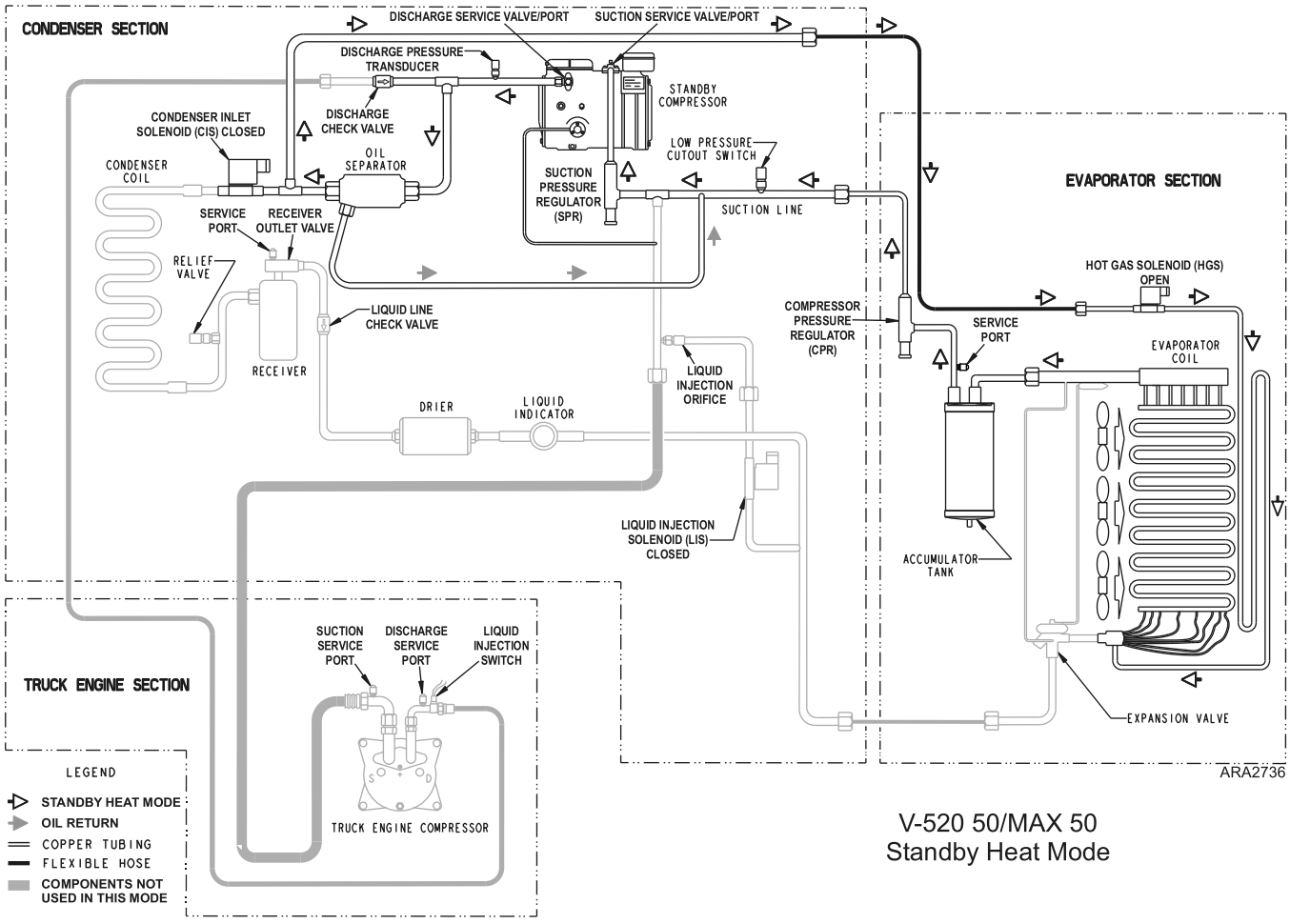
V-520 50/MAX 50
Engine Heat Mode

Heat Mode Model 50 Electric Standby Operation

High pressure refrigerant vapor leaves the electric standby compressor and flows through the oil separator where oil is separated and returned to the suction tube. The condenser inlet solenoid is closed and the hot gas solenoid is open so the refrigerant flows through the hot gas line and the drain pan heater to the evaporator. There, the refrigerant heats the evaporator. The refrigerant returns to the compressor through the accumulator, compressor pressure regulator, and suction pressure regulator.

- Discharge Check Valve – Closed
- Condenser Inlet Solenoid – Closed/Energized. To control the discharge pressure the controller will open the CIS briefly if the discharge pressure rises to a certain level and will then close it when the discharge pressure drops to a lower level.
- Hot Gas Solenoid – Open/Energized
- Liquid Line Check Valve – Closed
- Liquid Injection Solenoid – Open/Energized

Figure 16. Heat Mode Model 50 Electric Standby Operation



V-520 50/MAX 50
Standby Heat Mode

Heat Mode – Model 50 SPECTRUM Multi-Temp Units Only

SPECTRUM Model 50 Engine Operation Zone 1 Cool, Zone 2 Heat

High pressure refrigerant vapor leaves the engine driven compressor and flows through the discharge check valve and the oil separator where oil is separated and returned to the suction tube. The refrigerant flows into the hot gas line and through the open condenser inlet solenoid to the condenser where the refrigerant releases heat and condenses into high pressure liquid. The liquid refrigerant flows through the receiver, drier, and liquid indicator into the liquid lines.

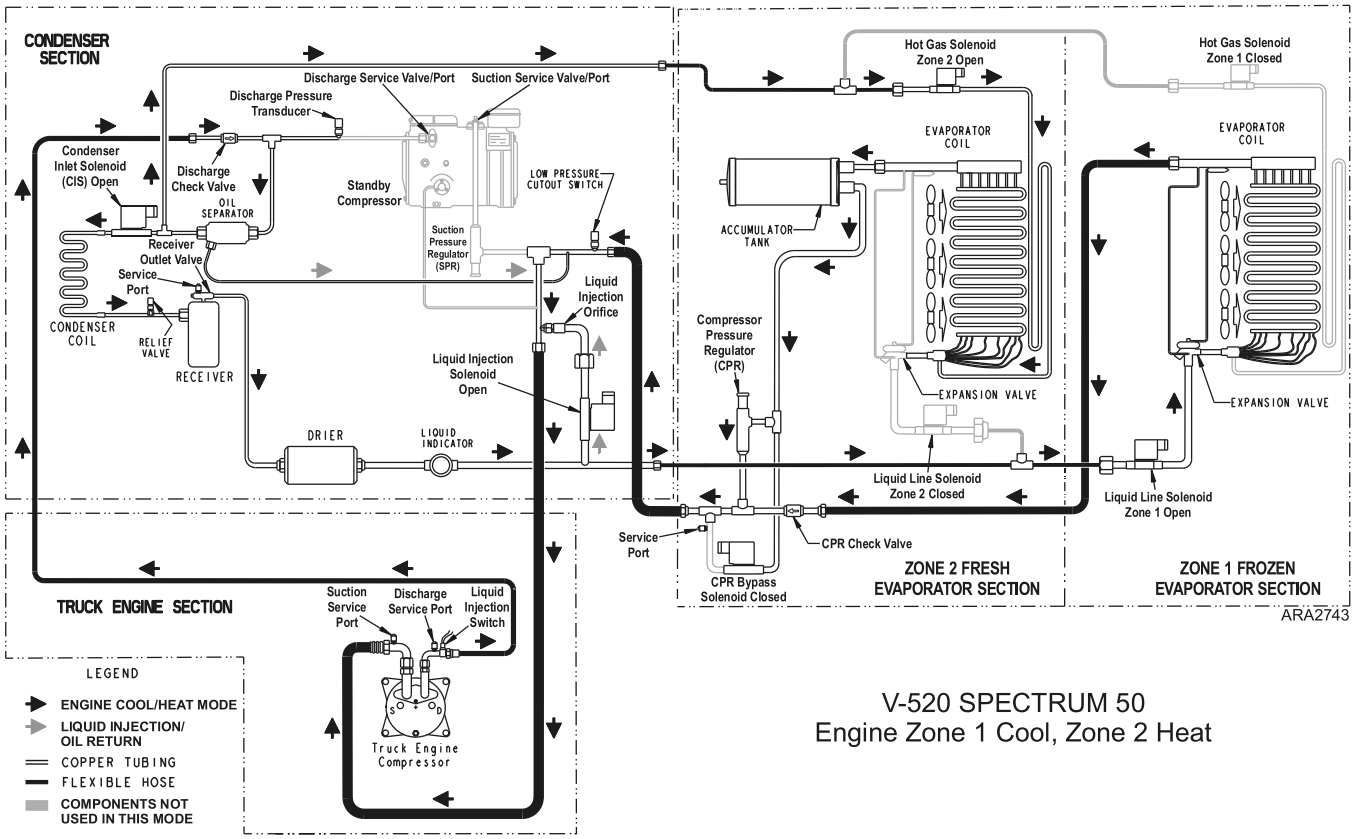
The Zone 1 liquid line solenoid is open so some of the refrigerant flows through the Zone 1 expansion valve into the evaporator. There, liquid refrigerant absorbs heat as it evaporates into low pressure vapor. The refrigerant returns to the compressor through the CPR check valve and suction lines.

The Zone 2 hot gas solenoid is open so some of the refrigerant flows through the hot gas line and drain pan heater to the Zone 2 evaporator. There, the refrigerant heats the evaporator. The CPR bypass solenoid is closed so the refrigerant returns to the compressor through the accumulator, compressor pressure regulator, and suction lines.

The liquid injection solenoid is open so some liquid refrigerant flows through the liquid injection line and liquid injection orifice into the suction tube to cool the compressor.

- Discharge Check Valve – Open
- Condenser Inlet Solenoid – Open/De-energized
- Zone 1 Liquid Line Solenoid – Open/Energized
- Zone 1 Hot Gas Solenoid – Closed/De-energized
- Zone 2 Liquid Line Solenoid – Closed/De-energized
- Zone 2 Hot Gas Solenoid – Open/Energized
- CPR Bypass Solenoid – Closed/Energized
- Liquid Injection Solenoid – Open/Energized

Figure 17. SPECTRUM Model 50 Engine Operation Zone 1 Cool, Zone 2 Heat



V-520 SPECTRUM 50
Engine Zone 1 Cool, Zone 2 Heat

SPECTRUM Model 50 Electric Standby Operation Zone 1 Null, Zone 2 Heat

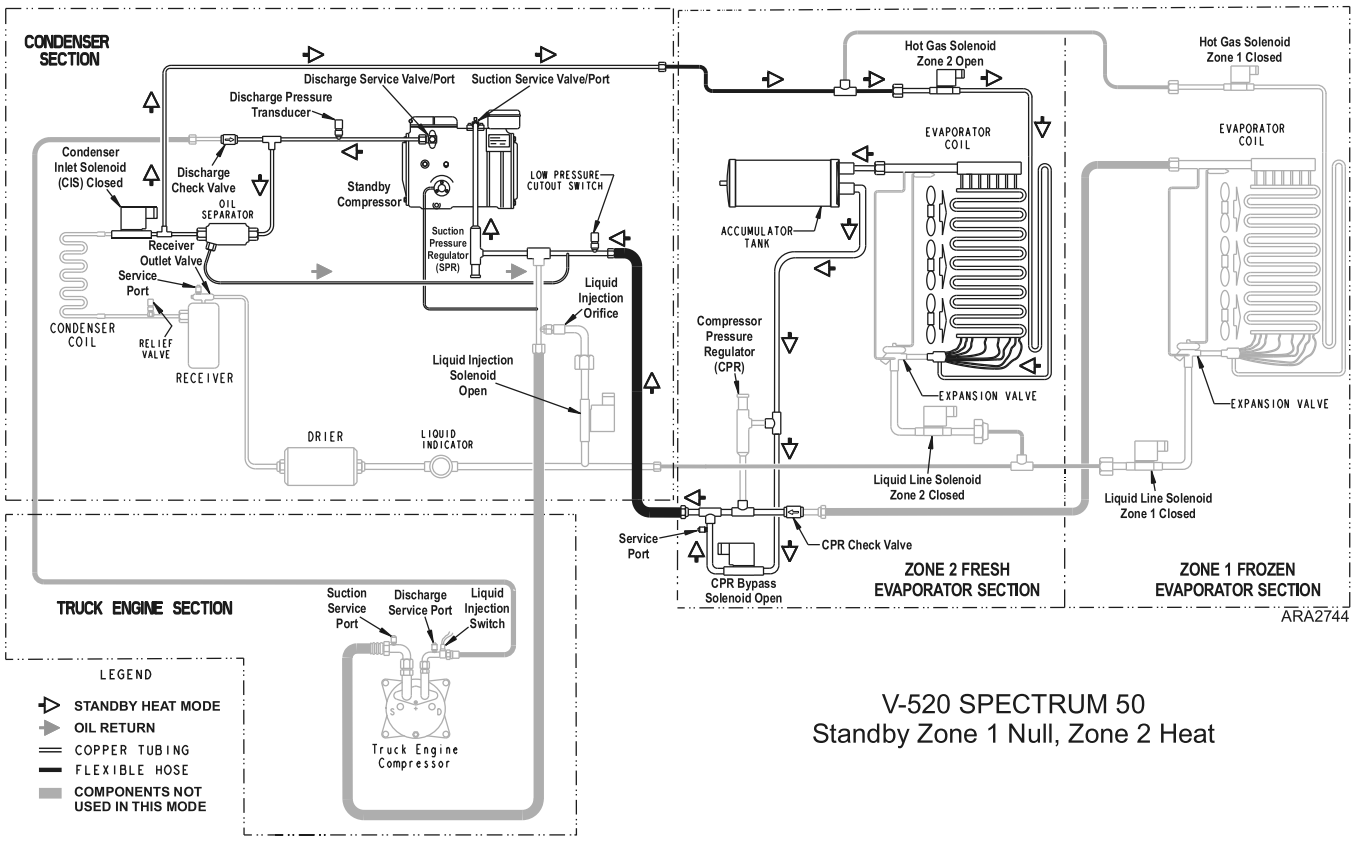
High pressure refrigerant vapor leaves the electric standby driven compressor and flows through the discharge check valve and the oil separator where oil is separated and returned to the suction tube. The condenser inlet solenoid is closed so the refrigerant flows into the hot gas line.

The Zone 1 liquid line and hot gas solenoids are closed so no refrigerant flows through the Zone 1 evaporator.

The Zone 2 hot gas solenoid is open so the refrigerant flows through the hot gas line and drain pan heater to the Zone 2 evaporator. There, the refrigerant heats the evaporator. The CPR bypass solenoid is open so the refrigerant returns to the compressor through the accumulator, CPR bypass solenoid, suction lines, and suction pressure regulator. It does not go through the compressor pressure regulator.

- Discharge Check Valve – Closed
- Condenser Inlet Solenoid – Closed/Energized
- Zone 1 Liquid Line Solenoid – Closed/De-energized
- Zone 1 Hot Gas Solenoid – Closed/De-energized
- Zone 2 Liquid Line Solenoid – Closed/De-energized
- Zone 2 Hot Gas Solenoid – Open/Energized
- CPR Bypass Solenoid – Open/De-energized
- Liquid Injection Solenoid – Open/Energized

Figure 18. SPECTRUM Model 50 Electric Standby Operation Zone 1 Null, Zone 2 Heat



V-520 SPECTRUM 50
Standby Zone 1 Null, Zone 2 Heat

Defrost Mode – Single Temperature Units

Defrost can be initiated any time the evaporator coil temperature is below 36 F (2.2 C), causing the defrost termination switch to close. Defrost is initiated automatically by the defrost timer, or manually using the In-Cab Control Box.

Defrost will continue until the evaporator coil temperature rises to 48 F (8.9 C) causing the defrost termination switch to open or the defrost termination timer has expired (whichever occurs first), ending the defrost cycle. Defrost cycle can be also terminated by pressing the On/Off Key to turn the unit off, and then pressing it again to turn the unit back on.

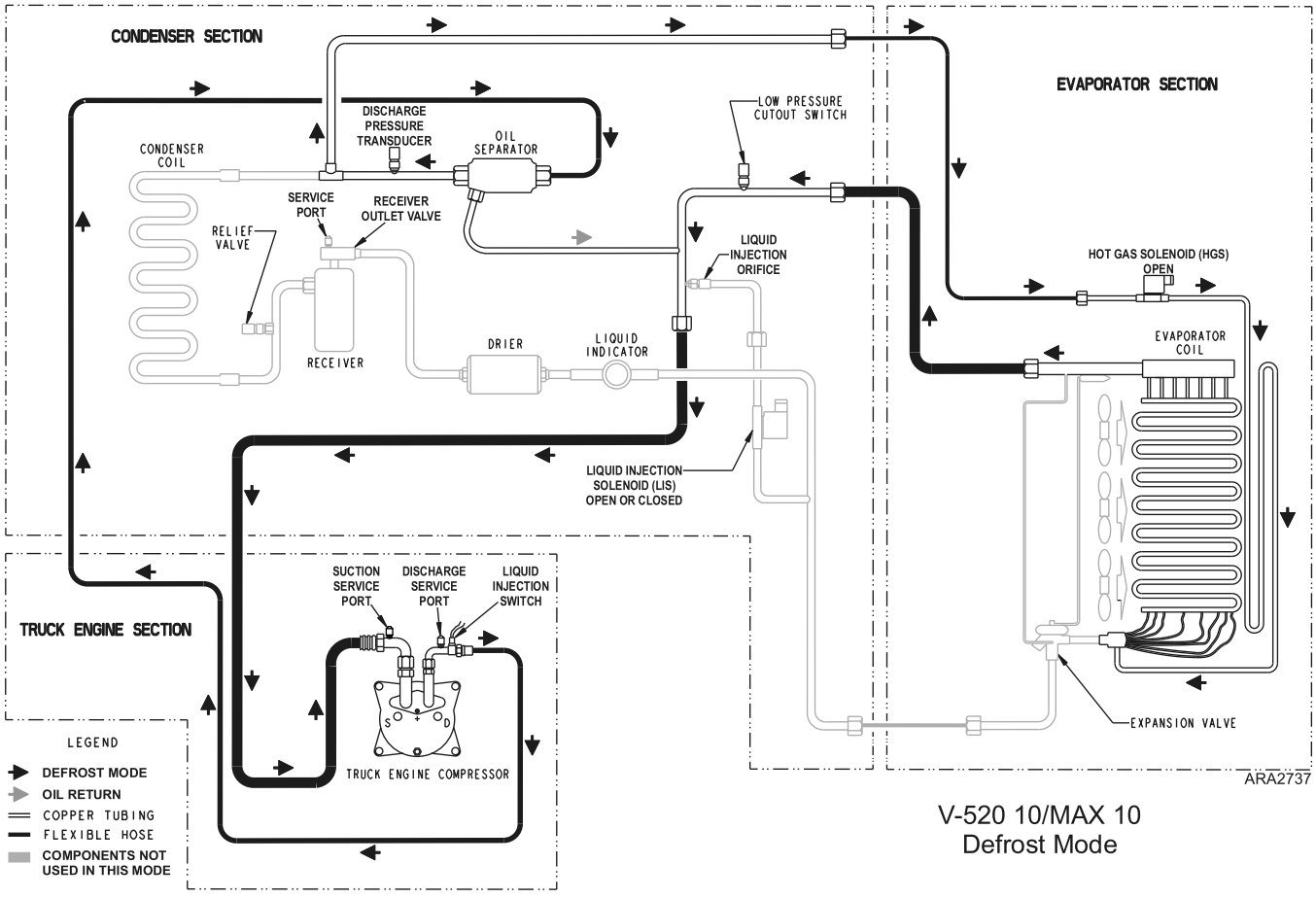
The drain hose heaters are also energized during defrost (if so equipped).

Defrost Mode Model 10

High pressure refrigerant vapor leaves the compressor and flows through the oil separator where oil is separated and returned to the suction tube. The hot gas solenoid is open so the refrigerant flows through the hot gas line and the drain pan heater to the evaporator. There, the refrigerant heats the evaporator. The refrigerant returns to the compressor through the suction line.

- Hot Gas Solenoid – Open/Energized
- Liquid Injection Solenoid – Closed/De-energized, but will open (energize) if the liquid injection switch closes.

Figure 19. Defrost Mode Model 10



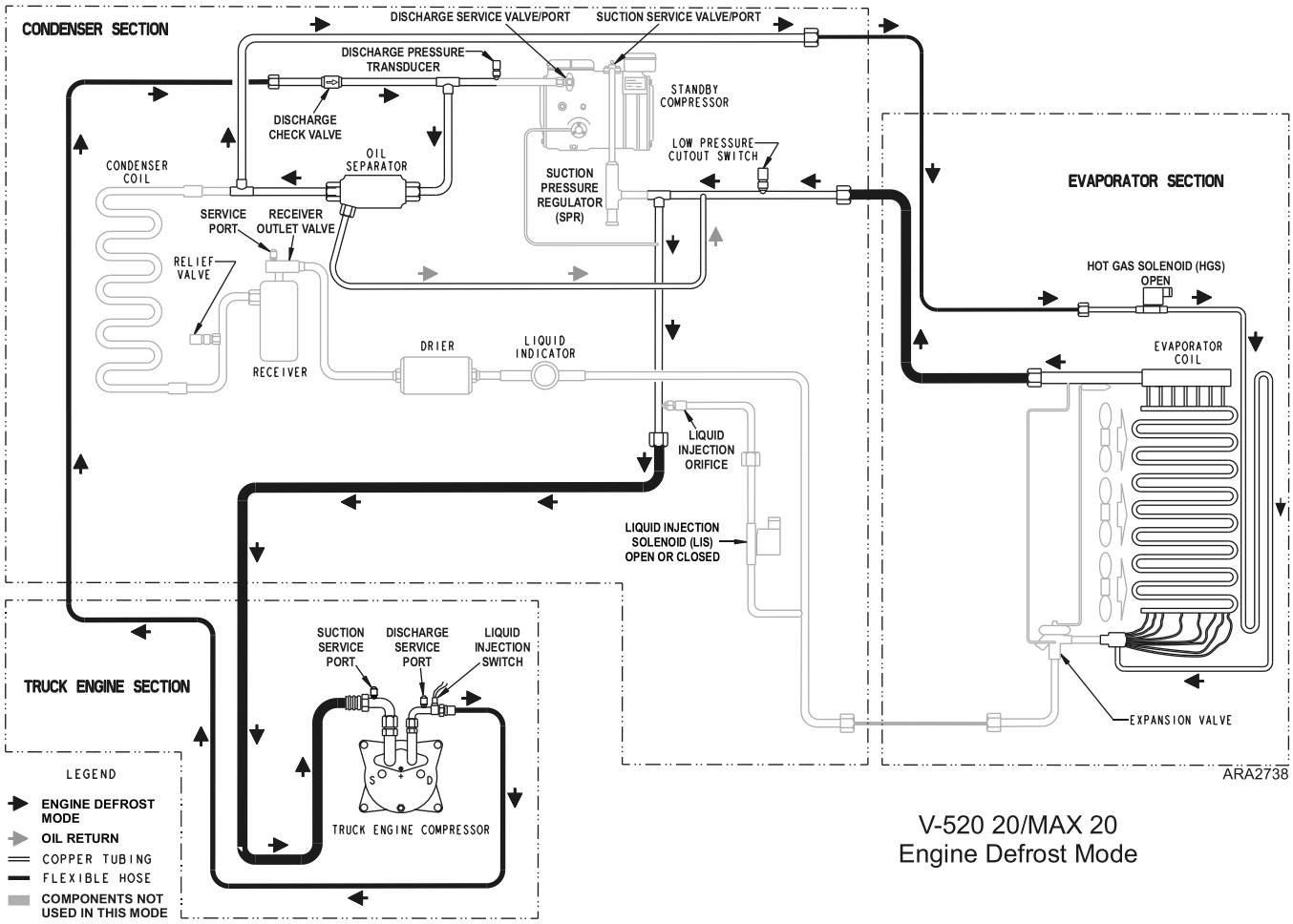
V-520 10/MAX 10
Defrost Mode

Defrost Mode Model 20 Engine Operation

High pressure refrigerant vapor leaves the engine driven compressor and flows through the discharge check valve and the oil separator where oil is separated and returned to a suction line. The the hot gas solenoid is open so the refrigerant flows through the hot gas line and the drain pan heater to the evaporator. There, the refrigerant heats the evaporator. The refrigerant returns to the compressor through the suction line.

- Discharge Check Valve – Open
- Hot Gas Solenoid – Open/Energized
- Liquid Injection Solenoid – Closed/De-energized, but will open (energize) if the liquid injection switch closes.

Figure 20. Defrost Mode Model 20 Engine Operation



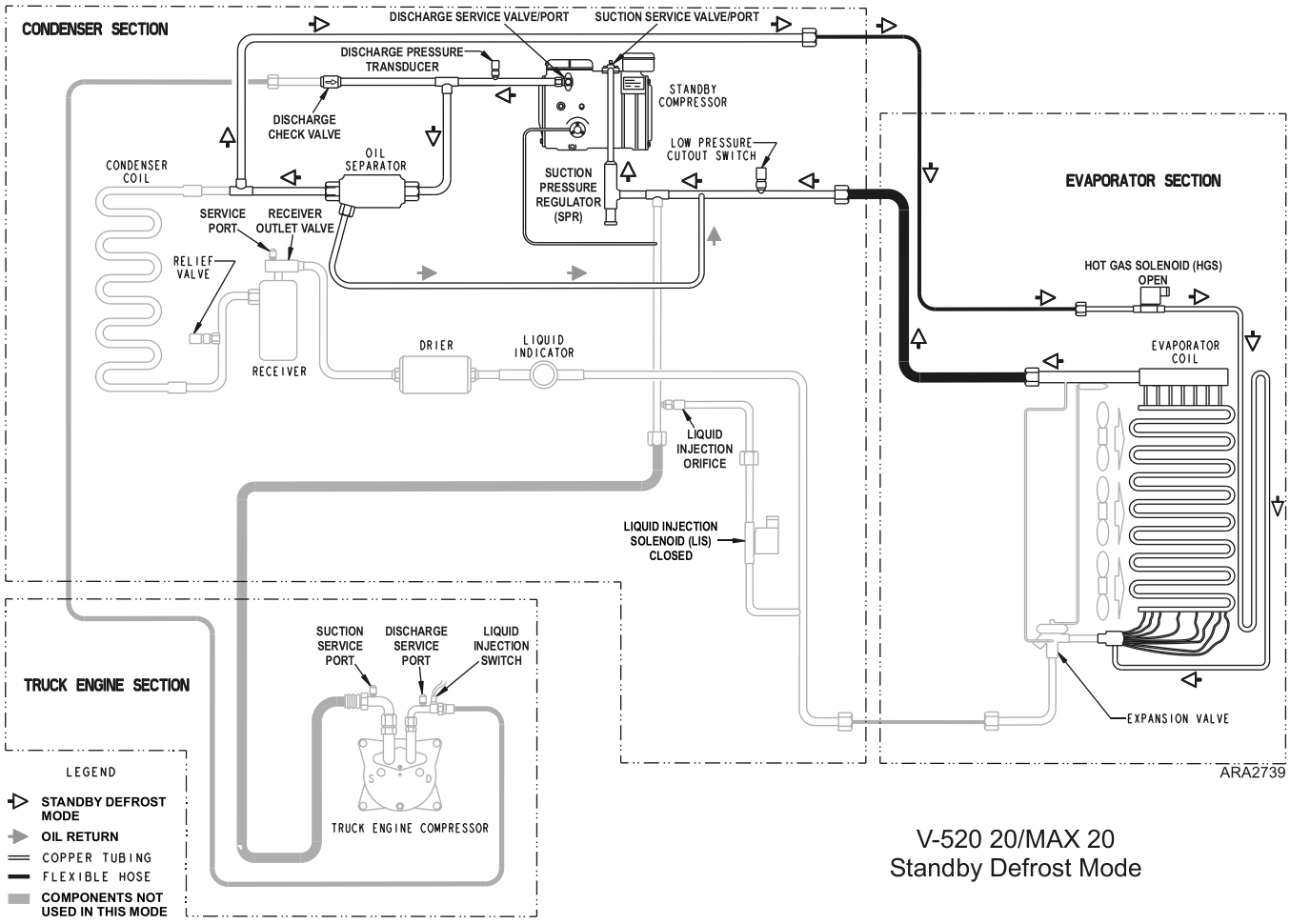
V-520 20/MAX 20
Engine Defrost Mode

Defrost Mode Model 20 Electric Standby Operation

High pressure refrigerant vapor leaves the electric standby compressor and flows through the discharge check valve and the oil separator where oil is separated and returned to a suction line. The hot gas solenoid is open so the refrigerant flows through the hot gas line and the drain pan heater to the evaporator. There, the refrigerant heats the evaporator. The refrigerant returns to the compressor through the suction pressure regulator.

- Discharge Check Valve – Closed
- Hot Gas Solenoid – Open/Energized
- Liquid Injection Solenoid – Closed/De-energized

Figure 21. Defrost Mode Model 20 Electric Standby Operation



V-520 20/MAX 20
Standby Defrost Mode

Defrost Mode Model 30 and 50 Units

Defrost in Model 30 and 50 units is basically the same as Heat mode in Model 30 and 50 units except the evaporator fans are not energized. The refrigerant flow is the same as shown previously in the Heat mode.

Defrost Mode – SPECTRUM Multi-Temp Units

Defrost can be initiated in a compartment any time its evaporator coil temperature is below 36 F (2.2 C), causing the defrost termination switch to close. Defrost is initiated automatically by the defrost timer, or manually using the In-Cab Control Box.

Defrost will continue until the evaporator coil temperature rises to 48 F (8.9 C) causing the defrost termination switch to open or the defrost termination timer has expired (whichever occurs first), ending the defrost cycle. Defrost cycle can be also terminated by pressing the On/Off Key to turn the unit off, and then pressing it again to turn the unit back on.

Defrost in one compartment turns all evaporator fans off. Effectively delaying cool in the other compartment.

SPECTRUM Model 10 Zone 1 Defrost, Zone 2 Delayed Cool

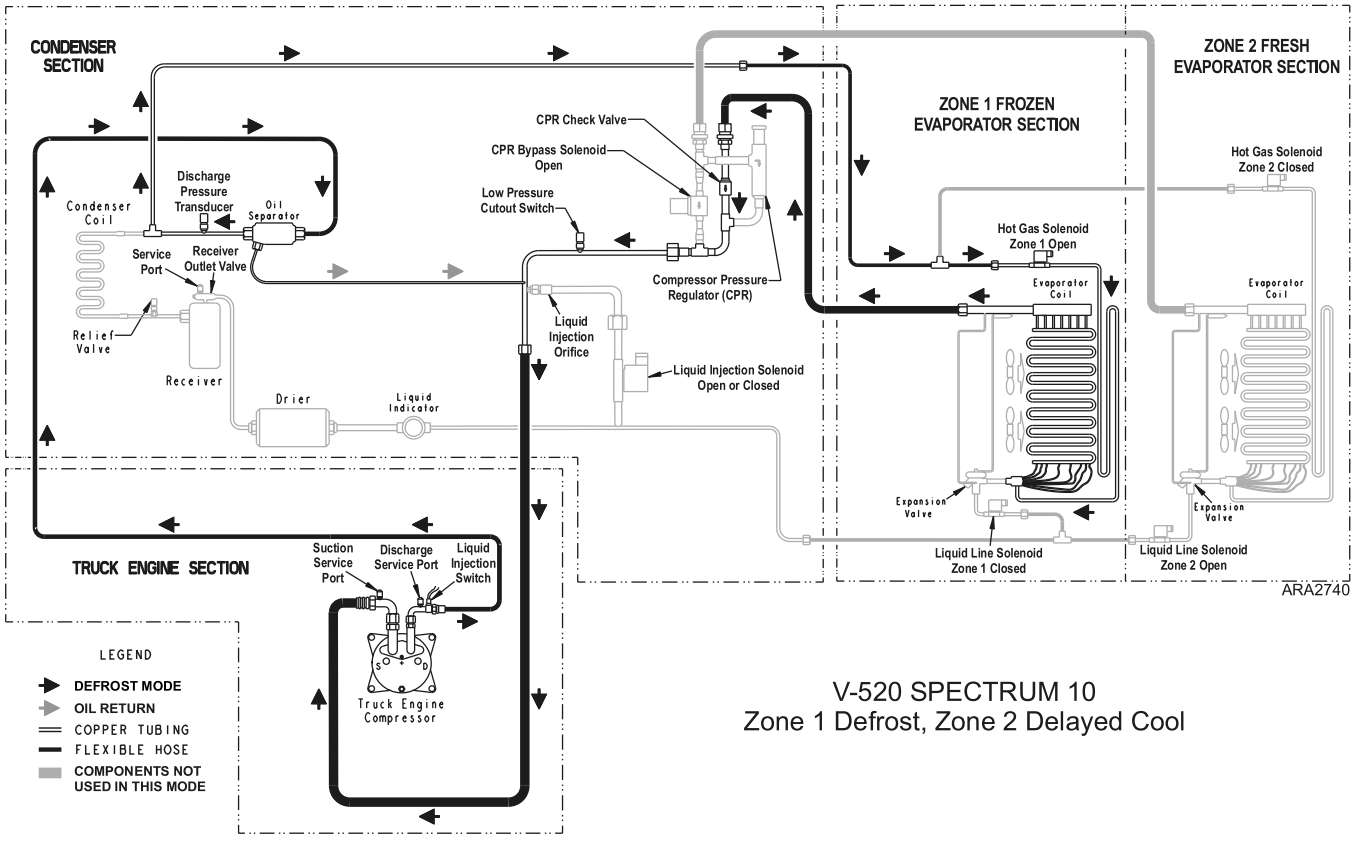
High pressure refrigerant vapor leaves the compressor and flows through the oil separator where oil is separated and returned to the suction tube. Most of the refrigerant flows into the hot gas line. An insignificant amount flows through the condenser, receiver, drier, and liquid indicator into the liquid lines.

The Zone 1 hot gas solenoid is open so the refrigerant flows through the hot gas line and drain pan heater to the Zone 1 evaporator. There, the refrigerant heats the evaporator. The refrigerant returns to the compressor through the CPR check valve and suction lines.

The Zone 2 liquid line solenoid is open but the pressure in the suction lines from the Zone 1 evaporator is high enough to keep refrigerant from flowing through the Zone 2 evaporator.

- Zone 1 Liquid Line Solenoid – Closed/De-energized
- Zone 1 Hot Gas Solenoid – Open/Energized
- Zone 2 Liquid Line Solenoid – Open/Energized
- Zone 2 Hot Gas Solenoid – Closed/De-energized
- CPR Bypass Solenoid – Open/De-energized
- Liquid Injection Solenoid – Closed/De-energized, but will open (energize) if the liquid injection switch closes.

Figure 22. SPECTRUM Model 10 Zone 1 Defrost, Zone 2 Delayed Cool



V-520 SPECTRUM 10
Zone 1 Defrost, Zone 2 Delayed Cool

SPECTRUM Model 20 Engine Operation Zone 1 Delayed Cool, Zone 2 Defrost

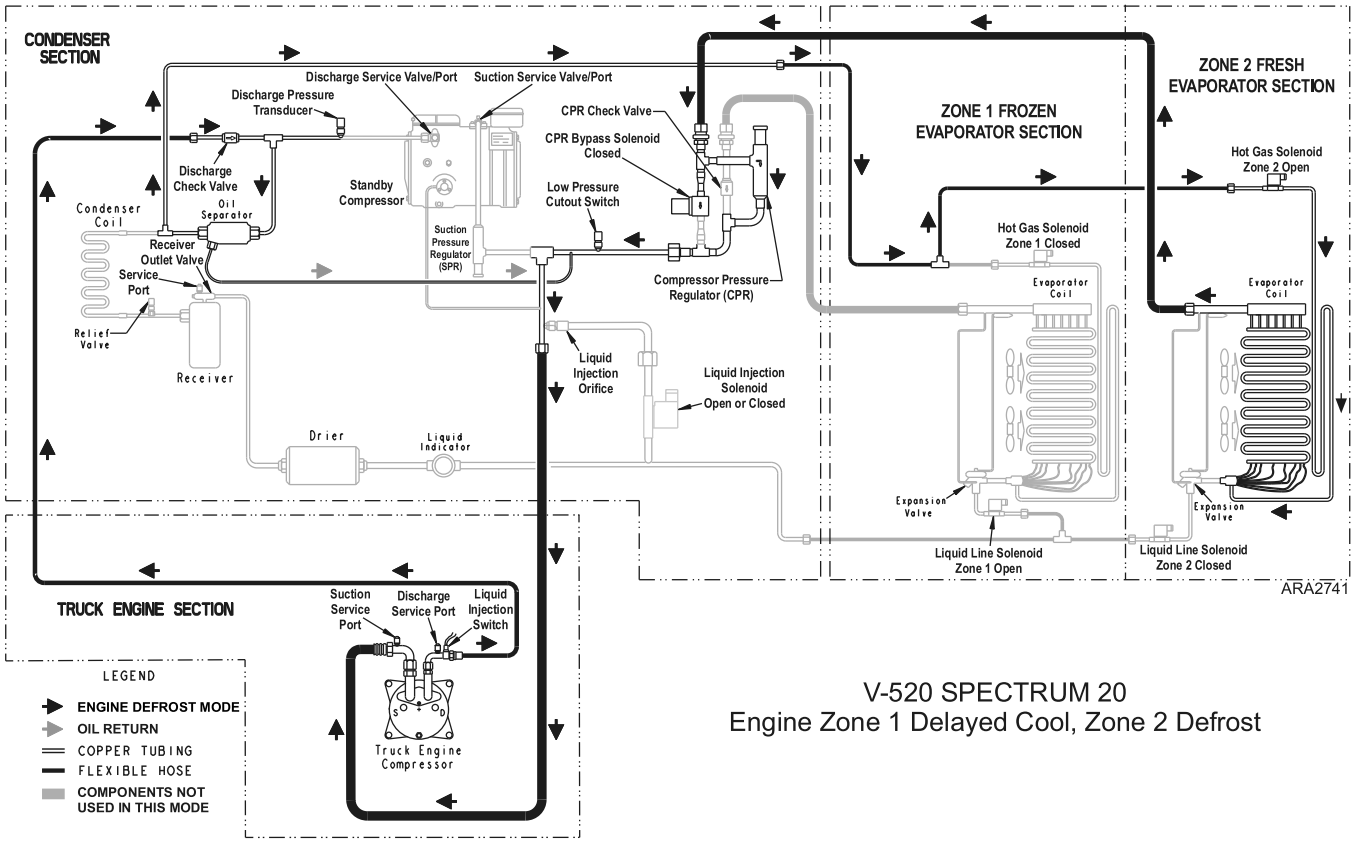
High pressure refrigerant vapor leaves the engine driven compressor and flows through the oil separator where oil is separated and returned to the suction tube. Most of the refrigerant flows into the hot gas line. An insignificant amount flows through the condenser, receiver, drier, and liquid indicator into the liquid lines.

The Zone 1 liquid line solenoid is open but the pressure in the suction lines from the Zone 2 evaporator is high enough to keep refrigerant from flowing through the Zone 1 evaporator.

The Zone 2 hot gas solenoid is open so the refrigerant flows through the hot gas line and drain pan heater to the Zone 2 evaporator. There, the refrigerant heats the evaporator. The CPR bypass solenoid is closed so the refrigerant returns to the compressor through the compressor pressure regulator and suction lines.

- Discharge Check Valve – Open
- Zone 1 Liquid Line Solenoid – Open/Energized
- Zone 1 Hot Gas Solenoid – Closed/De-energized
- Zone 2 Liquid Line Solenoid – Closed/De-energized
- Zone 2 Hot Gas Solenoid – Open/Energized
- CPR Bypass Solenoid – Closed/Energized
- Liquid Injection Solenoid – Closed/De-energized, but will open (energize) if the liquid injection switch closes.

Figure 23. SPECTRUM Model 20 Engine Operation Zone 1 Delayed Cool, Zone 2 Defrost



V-520 SPECTRUM 20
Engine Zone 1 Delayed Cool, Zone 2 Defrost

SPECTRUM Model 20 Electric Standby Operation Zone 1 Defrost, Zone 2 Delayed Cool

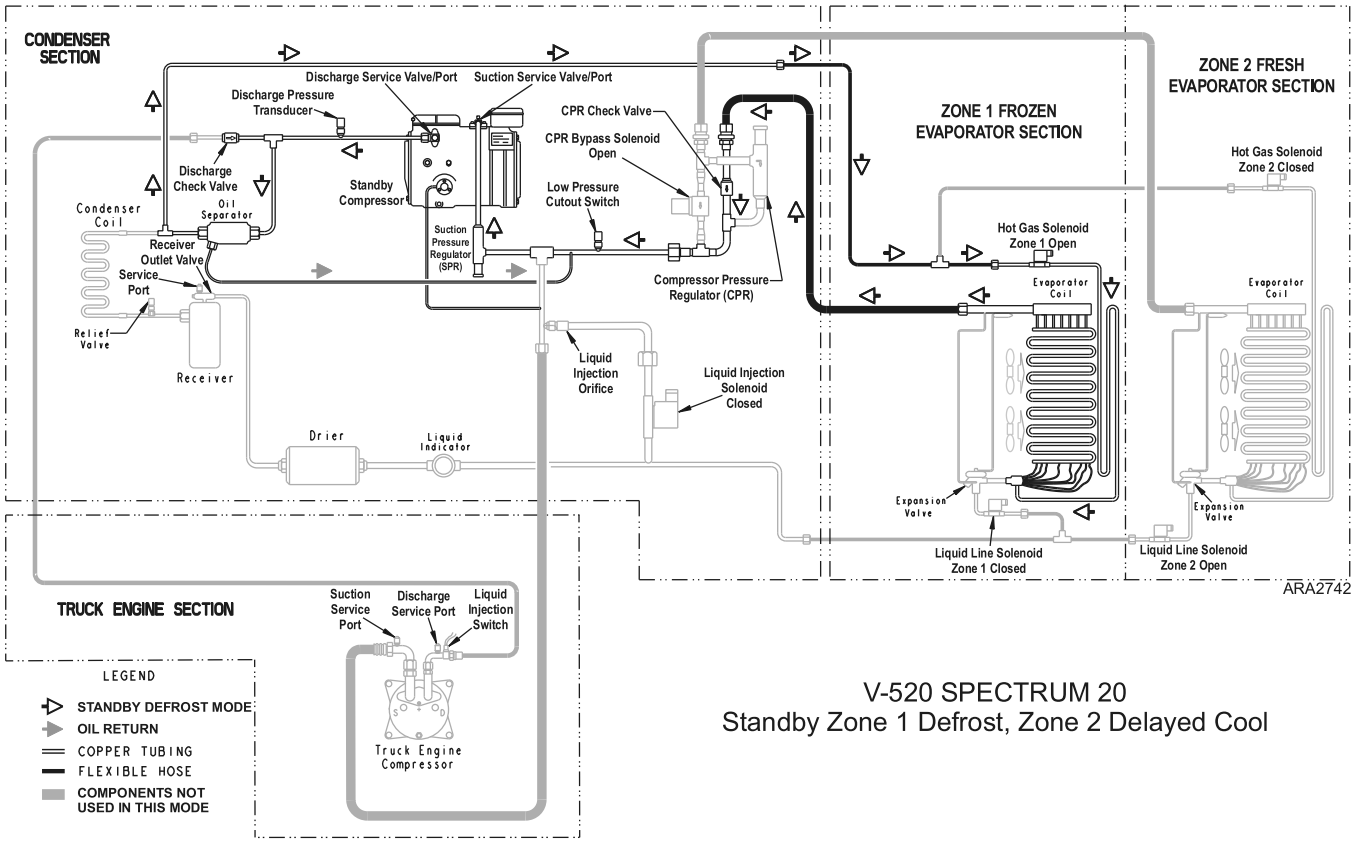
High pressure refrigerant vapor leaves the electric standby compressor and flows through the oil separator where oil is separated and returned to the suction tube. Most of the refrigerant flows into the hot gas line. An insignificant amount flows through the condenser, receiver, drier, and liquid indicator into the liquid lines.

The Zone 1 hot gas solenoid is open so the refrigerant flows through the hot gas line and drain pan heater to the Zone 1 evaporator. There, the refrigerant heats the evaporator. The refrigerant returns to the compressor through the CPR check valve, suction lines, and suction pressure regulator.

The Zone 2 liquid line solenoid is open but the pressure in the suction lines from the Zone 1 evaporator is high enough to keep refrigerant from flowing through the Zone 2 evaporator.

- Discharge Check Valve – Closed
- Zone 1 Liquid Line Solenoid – Closed/De-energized
- Zone 1 Hot Gas Solenoid – Open/Energized
- Zone 2 Liquid Line Solenoid – Open/Energized
- Zone 2 Hot Gas Solenoid – Closed/De-energized
- CPR Bypass Solenoid – Open/De-energized
- Liquid Injection Solenoid – Closed/De-energized

Figure 24. SPECTRUM Model 20 Electric Standby Operation Zone 1 Defrost, Zone 2 Delayed Cool



V-520 SPECTRUM 20
Standby Zone 1 Defrost, Zone 2 Delayed Cool

Defrost In SPECTRUM Model 50 Units

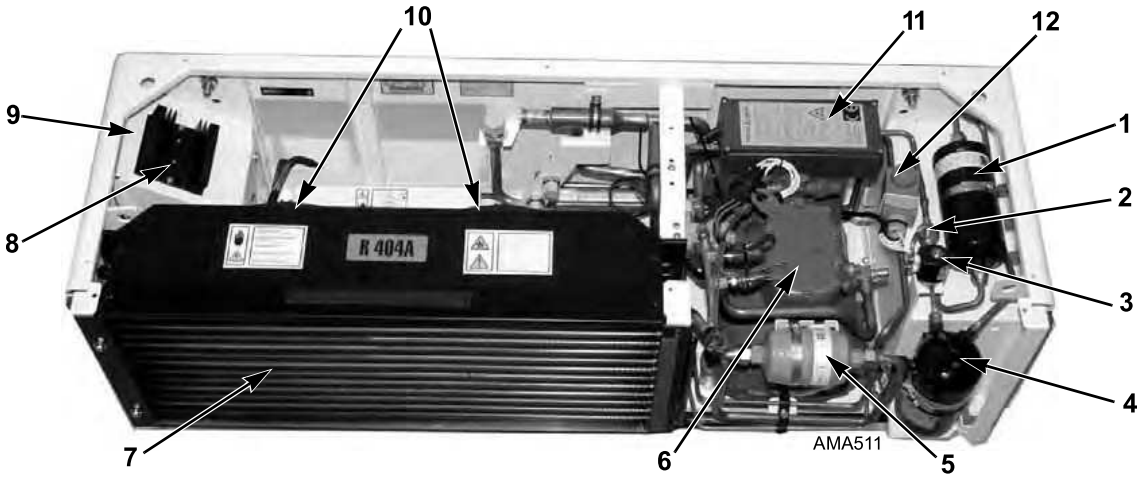
Defrost in SPECTRUM Model 50 units is similar to Heat modes in SPECTRUM Model 50 units except the evaporator fans are not energized and the condenser inlet solenoid is closed/energized. The refrigerant flow is the similar to that shown previously in “SPECTRUM Model 50 Electric Standby Operation Zone 1 Null, Zone 2 Heat”.

Serial Number Locations

1. **CONDENSER:** Nameplate located on the front inside edge of condenser frame (Cover needs to be removed).
2. **STANDBY COMPRESSOR:** 20 and 50 Models only. Nameplate located on standby compressor body. Standby compressor is located inside the Condenser.
3. **ENGINE DRIVEN COMPRESSOR:** Nameplate located on compressor body. Engine driven compressor is located in the vehicle's engine compartment.

Unit Components

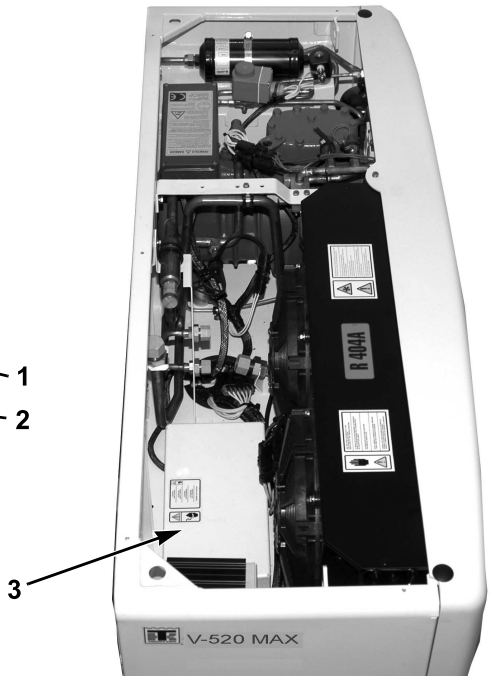
Figure 25. Unit Components (Model 20)



1.	Filter-Drier	5.	Oil Separator	9.	Transformer Cover
2.	Liquid Sight Glass	6.	Electric Standby Compressor	10.	Condenser Fans
3.	Liquid Injection Valve	7.	Condenser Coil	11.	AC Compressor Electric Box
4.	Receiver Tank	8.	Rectifier Heat Sink	12	Defrost Valve

Figure 26. Condenser Electric and Capacitor Boxes (Model 20 and 50)

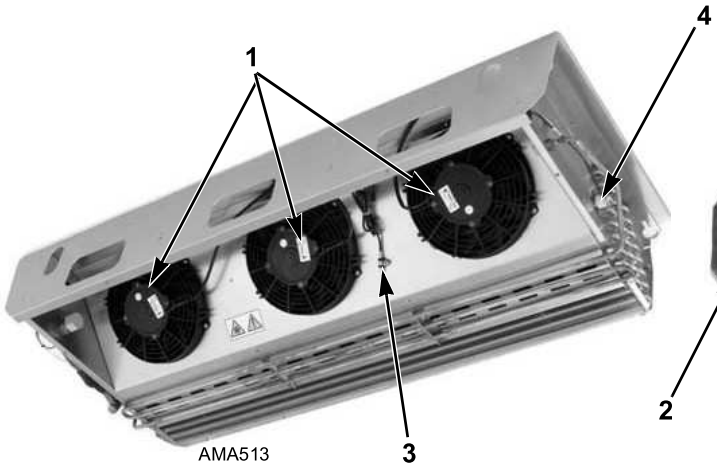
AMA1005



AMA1004

1.	Electronic Control Module (single temp shown)	2.	Motor Contactor	3.	Capacitor Box

Figure 27. Evaporator

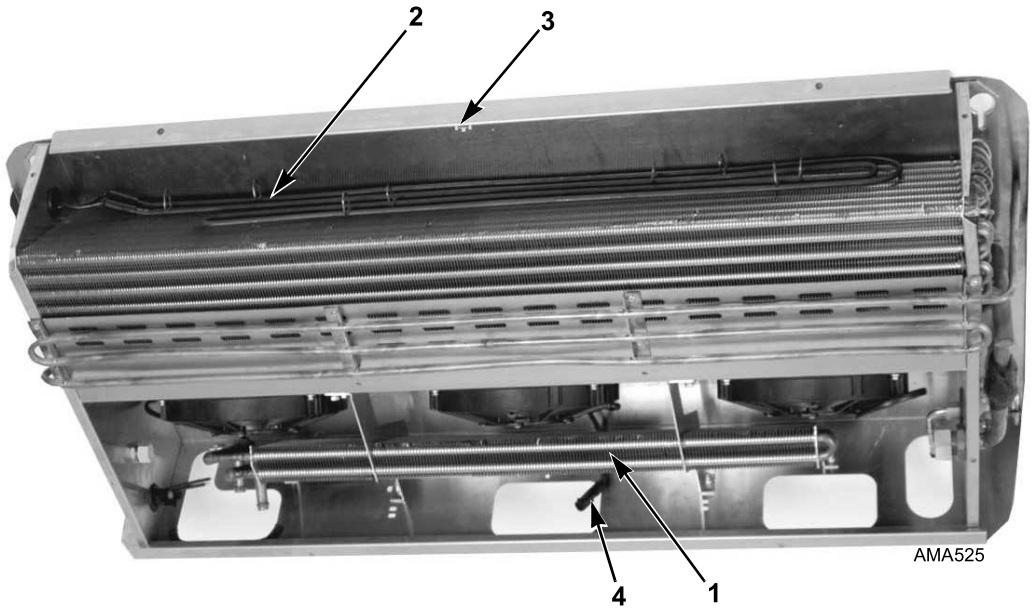


AMA513

AMA514

1.	Evaporator Fans	3.	Temperature Sensor
2.	Expansion Valve	4.	Defrost Switch

Figure 28. Evaporator with Hot Water and Electric Heat Options



1.	Hot Water Heat Defrost Coil	3.	High Temperature Limit Switch
2.	Electric Heat Element	4.	Air Temperature Sensor

Maintenance Inspection Schedule

Note: *Thermo King reserves the right to deny warranty coverage on claims due to lack of maintenance or neglect. Claims in question must be supported by maintenance records.*

Note: *See the appropriate chapter in this maintenance manual for instructions on how to correctly perform required maintenance.*

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

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

⚠ WARNING

Risk of Injury!

Take precautions to verify the unit will not accidentally start while servicing the system. Always turn off the unit On/Off Switch when inspecting or servicing any components.

Electrical

Daily	Weekly	12 Months or 2000 Hours	24 Months or 4000 Hours	Inspect/Check/Service These Items	Completed
•				Check unit for any active alarms.	
	•			Check unit for proper defrost operation.	
		•		Inspect wiring harnesses and connectors.	
		•		Check return air temperature sensor calibration.	
			•	Inspect ground terminals.	

Refrigeration/Heating

Daily	Weekly	12 Months or 2000 Hours	24 Months or 4000 Hours	Inspect/Check/Service These Items	Completed
		•		Inspect moisture indicator and refrigerant level.	
		•		Inspect refrigerant hoses.	
		•		Inspect refrigerant hose connections for leaks.	
			•	Check suction/compressor pressure regulator setting (20, 30, 50 Models Only).	
			•	Replace filter dryer.	

Structural

Daily	Weekly	12 Months or 2000 Hours	24 Months or 4000 Hours	Inspect/Check/Service These Items	Completed
•				Inspect exterior of evaporator and condenser.	
•				Inspect evaporator air inlet and outlet for blockage (dirt, debris, cargo, etc.).	
•				Inspect condenser air inlet and outlet for blockage (dirt, debris, etc.).	
•				Adequate air space above and around cargo.	
	•			Inspect evaporator drain hoses. (Verify water is not collecting in drain pan).	
		•		Clean evaporator drain hoses.	
		•		Clean evaporator and condenser coils. ***More frequent cleaning may be required based on operating environment (dusty conditions, etc.)***	
		•		Inspect roadside (engine driven) compressor drive belt condition and tension.	
			•	Inspect evaporator and condenser mounting hardware.	

Maintenance Inspection Schedule Checklist Authentication

Thermo King Dealership Name and Number	
Inspector / Technician's Name	
Date Inspection Completed	
Thermo King Unit / Model	
Unit Serial Number	
Current Hour Meter Reading	
Comments:	

Electrical Maintenance

Electronic Control System

Refer to the Direct Smart Reefer Microprocessor Control System Diagnostic Manual TK 52573 for complete service information about the Electronic Control System and the related components.

Defrost System

Defrost is initiated automatically by the programmable defrost timer, or manually by means of the In-Cab Control Box. If demand defrost is enabled, a demand defrost cycle occurs, based on the Defrost Initiation Timer (DIT) and the Defrost Termination Switch (S4/DTS1 or S6/DTS2) being closed. The evaporator coil temperature must be below 36 F (2.2 C) to allow defrost.

When defrost is required, the microprocessor output energizes the hot gas solenoid to supply hot refrigerant to the evaporator coil and de-energizes the evaporator fans. The Defrost Initiation Timer (DIT) has counted-down its required time-setting, and the Defrost Termination Switch (S4/DTS1 or S6/DTS2) is closed.

The unit remains in Defrost mode until the Defrost Termination Switch setpoint is reached (that is, when the evaporator coil temperature rises to 48.0 F (8.9 C), or until the Defrost Termination Timer (DTT) count is completed). If the evaporator coil temperature does not rise above 48.0 F (8.9 C) within the defrost duration time limit, the microprocessor terminates the defrost operation.

The startup of the evaporator fans is delayed for several seconds after Defrost mode ends to prevent water from the melting ice from being sprayed on the load.

On multi-temp units defrost is performed on both evaporators at the same time if both defrost termination switches are closed. An evaporator does not defrost if its defrost termination switch is not closed.

Defrost initiation and termination settings are accessed through the Guarded Access Menu. Refer to the Direct Smart Reefer Microprocessor Control System Diagnostic Manual TK 52573 for instructions on the use of Guarded Access Menu features.

The Defrost Initiation Timer offers programming choices of 0 to 480 minutes, in increments of 30 minutes. The factory setting is 240 minutes. This parameter allows maintenance personnel to set the Defrost Initiation Timer. When it times-out, it switches the unit from Cool mode to Defrost mode. The timer counts all the time that the unit is in Cool mode. The count resets when Defrost mode starts. If the timer is set at 0 (zero), this is a test position. Defrost mode starts in 15 seconds.

The Defrost Termination Timer offers programming choices of 5 to 50 minutes, in increments of 5 minutes. The factory setting is 30 minutes. This parameter allows maintenance personnel to set the Defrost Termination Timer, which begins counting from the initiation of a Defrost mode. When the timer times-out, the unit is switched from Defrost mode to Null mode. The timer resets at the end of a Defrost mode, or after the Defrost Termination Timer has timed-out. If the timer is set at 0 (zero), this is a test position. Defrost mode stops in 15 seconds.

Defrost Termination Switch

The switch is mounted in the evaporator coil and controls the defrost cycle in response to the evaporator coil temperature. The switch is closed when the evaporator coil temperature is below 36 F (2.2 C), which allows the unit to enter the defrost cycle.

When the unit does shift into a defrost cycle, the evaporator fan stops, and heat from the hot refrigerant gas melts the frost from the evaporator coil. The switch opens and terminates the defrost cycle when the evaporator coil temperature rises above 48 F (8.9 C).

Defrost Termination Switch Replacement

Removal

1. Remove the evaporator cover, and disconnect the evaporator fan motor wires as needed.
2. Disconnect the wires from the switch.
3. Remove the mounting hardware and remove the switch.

Installation

1. Place the switch in position and install the mounting hardware.

2. Connect the wires to the switch.
3. Connect the evaporator fan motor wires if needed and install the evaporator cover.

Liquid Injection System

The liquid injection switch (LISW) is a temperature sensitive switch located on the discharge fitting of the truck engine compressor. When the discharge temperature rises above 230 ± 5 F (110 ± 3 C), the switch closes to open the liquid injection solenoid valve. When the discharge temperature falls below 200 ± 5 F (93 ± 3 C), the switch opens to close the liquid injection solenoid valve.

Testing Liquid Injection Solenoid Valve and Metering Orifice

1. Disconnect the 2-pin connector with the LIS and CLU wires in main wire harness from wires to the LISW at the compressor.
2. Install a gauge manifold set on the engine driven compressor.
3. Set thermostat on the lowest setting.
4. Start and run the unit in Cool on the engine driven compressor until the suction pressure stabilizes.
5. Place a jumper between LIS and CLU wires in the 2-pin connector on the main wire harness that was disconnected in step 1. This simulates that the discharge temperature is higher than 230 F (110 C).
6. With the jumper wire in place the suction pressure should rise.
7. Remove the jumper. The suction pressure should return to the stabilized pressure in step 4.
8. If the suction pressure does not change, check the CLU wire for voltage, the LIS wire for continuity, the resistance of the liquid injection solenoid valve coil, and the metering orifice. See the Specifications chapter for the solenoid coil resistance.
9. Shut off the unit and the truck, remove the gauge manifold set, and reconnect the LIS and CLU wires to the LISW.

Testing Liquid Injection Switch (LISW)

1. Disconnect the 2-pin connector with the LIS and CLU wires in main wire harness from wires to the LISW at the compressor.
2. Check the continuity of the LISW. It should be open at temperatures below 230 ± 5 F (110 ± 3 C).
3. Install a gauge manifold set on the engine driven compressor.
4. Set thermostat on the lowest setting.
5. Start and run the unit in Cool on the engine driven compressor.
6. Cover the condenser to raise the discharge pressure and temperature.
7. Monitor the discharge temperature with a non-contact thermometer such as P/N 2041059, and monitor the continuity of the LISW. When the discharge temperature rises to 230 ± 5 F (110 ± 3 C) the LISW should close.
8. Shut off the unit and the truck, and continue to monitor the discharge temperature and the continuity of the LISW. When the discharge temperature falls to 200 ± 5 F (93 ± 3 C) the LISW should open.
9. Remove the gauge manifold set, and reconnect the LIS and CLU wires to the LISW.

Liquid Injection Switch (LISW) Replacement

Removal

1. Disconnect the 2-pin connector with the LIS and CLU wires in main wire harness from wires to the LISW at the compressor.
2. Remove the metal spring clip that holds the plastic clip of the LISW to the discharge fitting on the compressor.
3. Remove the LISW from the discharge fitting on the compressor.

Installation

Refer to Liquid Injection Temperature Sensor Installation Procedures in Section 5 – Compressor Selection and Installation Standards of the Vehicle Powered Truck Installation Standards and Procedures TK 56430 for detailed information about installing the LISW.

1. Inspect the alignment of sensing pad with respect to plastic clip of the LISW. The curves in the two parts should be perfectly aligned with each other.
2. Clip the LISW onto the straight portion of the compressor discharge fitting.
3. Verify the temperature sensing pad is touching the fitting by looking down the fitting. If a gap is present, thermal paste should be applied between the fitting and the temperature sensing pad. This will ensure the correct temperature is being read.
4. Place the metal spring clip over the plastic clip to ensure the LISW stays on the fitting.
5. Connect the 2-pin connector with the LIS and CLU wires in main wire harness from wires to the LISW at the compressor.

Condenser Fan Motor

Note: *Non-repairable fan motor assemblies are used. If a motor malfunctions, it must be replaced.*

⚠ WARNING

Risk of Injury!

Take precautions to verify the unit will not accidentally start while servicing the system. Always turn off the unit On/Off Switch when inspecting or servicing any components.

The condenser fan motors are maintenance free. If erratic or intermittent operation is observed, the current draw of the motor should be measured while proper voltage is applied. The current draw for a condenser fan motor is approximately 8.7 to 9.2 amps at 13 volts.

If the condenser fan motor does not run at all, check the fuses in the condenser fan motor circuit and the output to the condenser fan when it should be energized.

Condenser Fan Motor Removal and Installation

Removal

1. Turn the unit off.
2. Remove the fan guard / motor mounting screws (4).
3. Lift the fan motor and disconnect the motor power plug.
4. Remove the fan motor from the condenser.

Installation

1. Connect the fan motor power plug.
2. Place the fan motor in position. Install and tighten the fan motor mounting screws (4).
3. Install the fan shroud and condenser cover.
4. Start the unit and verify correct fan motor operation.

Evaporator Fan Motors

Note: *Non-repairable fan motor assemblies are used. If a motor malfunctions, it must be replaced.*

⚠ WARNING

Risk of Injury!

Take precautions to verify the unit will not accidentally start while servicing the system. Always turn off the unit On/Off Switch when inspecting or servicing any components.

The evaporator fan motors are maintenance free. If erratic or intermittent operation is observed, the current draw of the motor should be measured while proper voltage is applied. The current draw for a evaporator motor is approximately 5.7 to 6.2amps at 13 volts.

If any of the evaporator fan motors do not run at all, check the fuses in the evaporator fan motor circuits and the outputs to the evaporator fans when they should be energized.

Evaporator Fan Motor Removal and Installation

Removal

1. Turn the unit off.
2. Remove the evaporator cover. On multi-temp units also disconnect the motor power plugs.
3. Remove the fan motor screws (4).
4. On single temp units disconnect the motor power plug.
5. Remove the fan motor.

Installation

1. Attach the fan motor to the evaporator or evaporator cover and tighten the fan motor mounting screws (4).
2. Connect the fan motor power plug(s).
3. Ensure the wires do not contact the fan blades inside the evaporator.
4. Install the evaporator cover.
5. Start the unit and verify correct fan motor operation.

Drain Line Heaters

Drain line heaters are used on MAX units to prevent ice build-up in the evaporator drain pan and drain hoses. They are activated when the defrost termination switch is closed.

Check the operation of a drain line heater as follows:

1. Set the thermostat on the lowest setting.
2. Start and run the unit in Cool on the engine driven compressor until the return air temperature is below 32 F (0 C).
3. Disconnect the 2-pin wire connector from the drain line heater and check for 12 Vdc between the 27/27A and CHF/CHG wires on single temp units, and also the 27B/27C and CHF2/CHG2 wires on multi-temp units.
   - If voltage is present, check the resistance of the drain line heater. It should be approximately 14.0 ohms.
   - If voltage is not present, Check the continuity of the 27/27A/27B/27C circuit back to the ECM, Fuse F11, and also Fuse F8 (and F27 and F28 if used) on multi-temp units, and the continuity of the CHF/CHG/CHF2/CHG2 circuit to ground.

Drain Line Heater Replacement

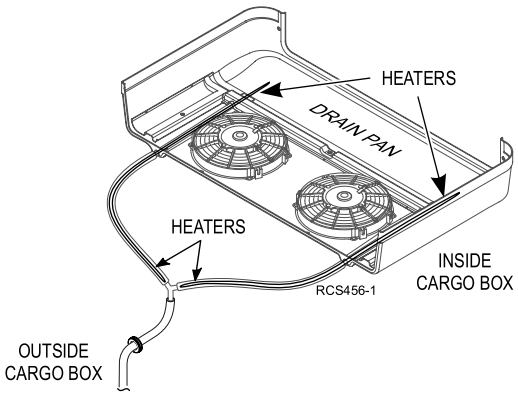
Removal

1. Remove the evaporator cover and disconnect the evaporator fan motor wires.
2. Disconnect the drain line heater wires from the wire harness.
3. Remove the heater wires from the drain hose.

Installation

1. Insert the heater wires into the drain hose drain hose as far as they will go. Note the following:
   - Heater wires must extended into drain pan and be inserted into each drain hose as far as they will go.
   - NEVER CUT HEATER RESISTANCE WIRES!
   - DO NOT install more than one heater wire into each drain tube.
   - DO NOT use band wraps to hold heater wires.
   - DO NOT cover or wrap heater wires.
   - DO NOT pinch the end of the heater wires tight.

Figure 29. Drain Line Heater Installation

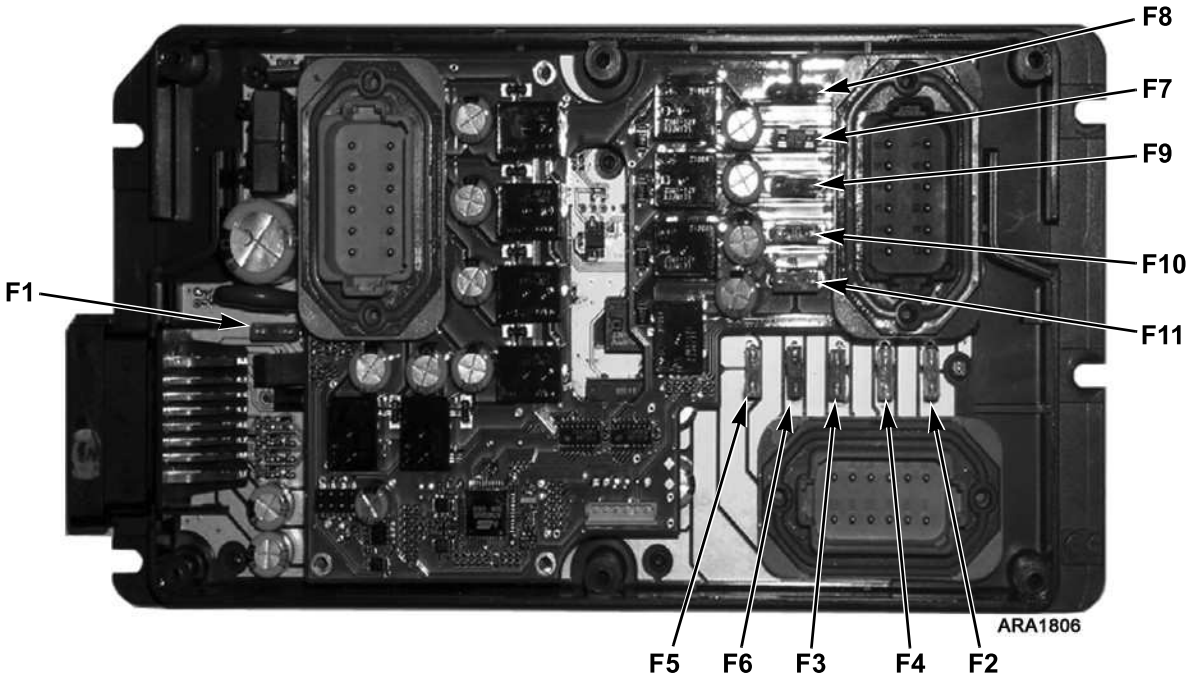


2. Connect the drain line heater wires to the wire harness.
3. Connect the evaporator fan motor wires and install the evaporator cover.

Fuses

Controller Fuses: These fuses are located on the controller.

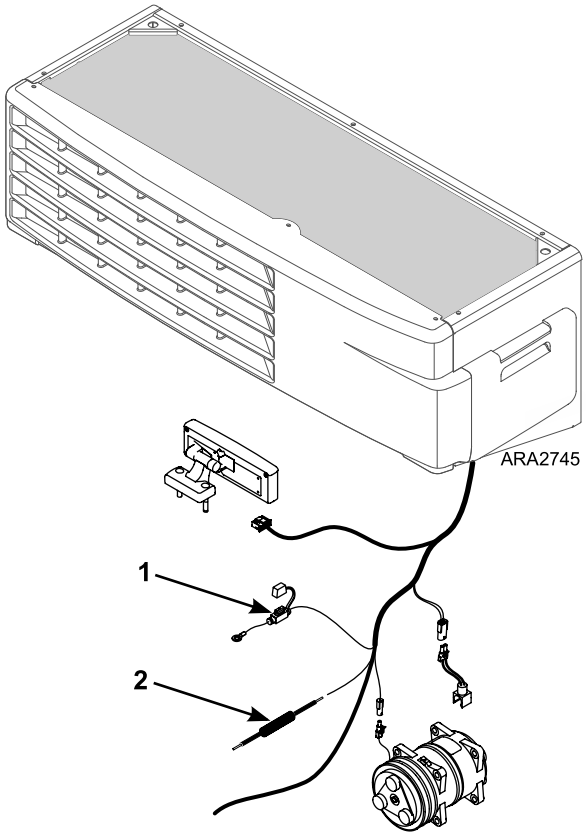
Figure 30. Controller Fuses



F1.	Fuse F1 - 5 amps	F4.	Fuse F4 - 15 amps	F7.	Fuse F7 - 15 amps	F10.	Fuse F10 - 15 amps
F2.	Fuse F2 - 15 amps	F5.	Fuse F5 - 20 amps	F8.	Fuse F8 - 20 amps	F11.	Fuse F11 - 2 amps
F3.	Fuse F3 - 15 amps	F6.	Fuse F6 - 10 amps	F9	Fuse F9 - 15 amps		

Harness Fuses: These fuses are located in wiring harnesses outside of the control box.

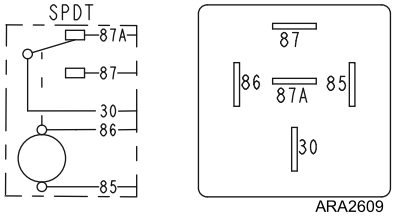
Figure 31. Harness Fuses



F1.	Fuse F22 - 10 amps
F2.	Fuse F21 - 40 amps (60 amps for Spectrum units)

Relays

Figure 32. Single Pole Double Throw (SPDT) Relay



Relay Testing

A relay is energized when 12 Vdc power is applied to the relay coil across pins 85 and 86. When energized the normally open (NO) contacts close and the normally closed (NC) contacts open.

1. Remove covers as needed to access the relays.
2. To check the battery power relay, turn the truck ignition switch on. To check the electric standby power relay and the battery disconnect relay, connect the unit to an appropriate electric standby power supply.
3. Remove the relay from its socket and check for 12 Vdc between pins 85 and 86 in the relay socket. If voltage is not present, check the circuits that supply power and ground to the relay coil.
4. Check the resistance between pins 85 and 86 on the relay. It should be approximately 90 ohms. If not, replace the relay.

5. On a SPDT relay, check the NC contacts by checking for continuity between pins 30 and 87A. If the continuity is not acceptable, replace the relay.
6. Use jumper wires and a 12 Vdc power supply to attached to pins 85 and 86 to energize the relay.
7. Check the NO contacts by checking for continuity between pins 30 and 87. If the continuity is not acceptable, replace the relay.

Relay Replacement

1. Turn the truck ignition switch off and disconnect the electric standby power supply if applicable.
2. Remove covers as needed to access the relays.
3. Remove the relay from its socket.
4. Insert the new relay into the relay socket.
5. Reinstall any covers that were removed.

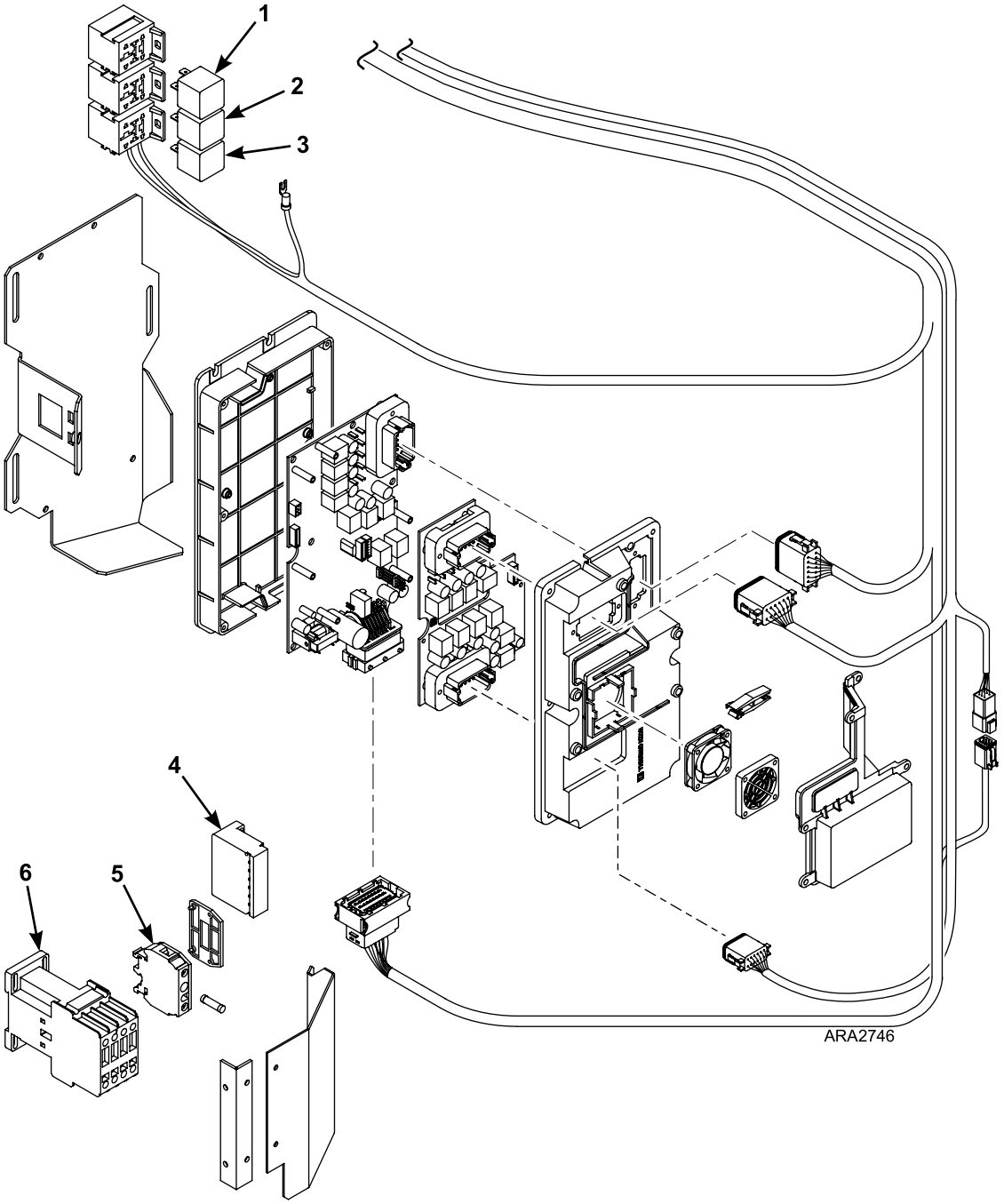
AC Components Model 20 and Model 50 Units Only

⚠ WARNING

Hazardous Voltage!

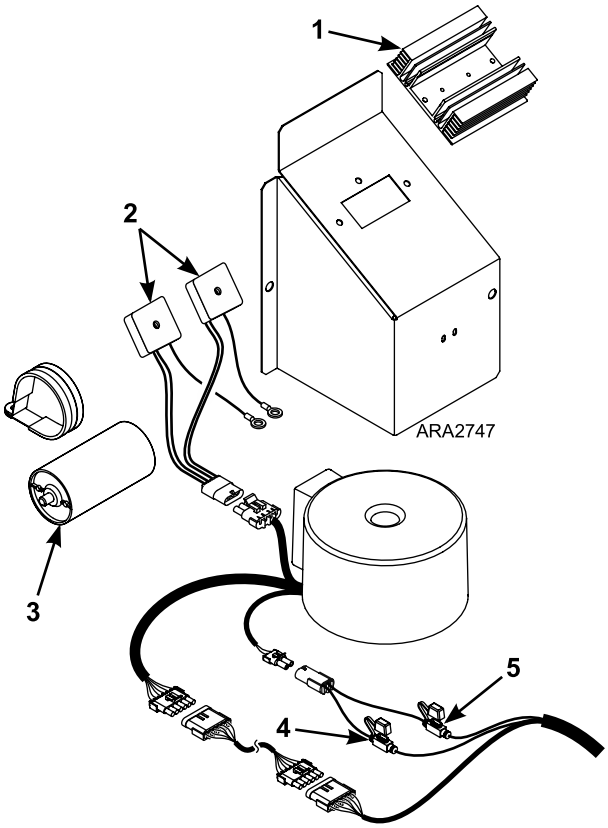
Model 20 and Model 50 units use high voltage AC for electric standby operation. Lethal voltage potentials can exist on connections in the high voltage circuits. Take appropriate precautions and use extreme care when testing the unit.

Figure 33. AC Components in Control Box



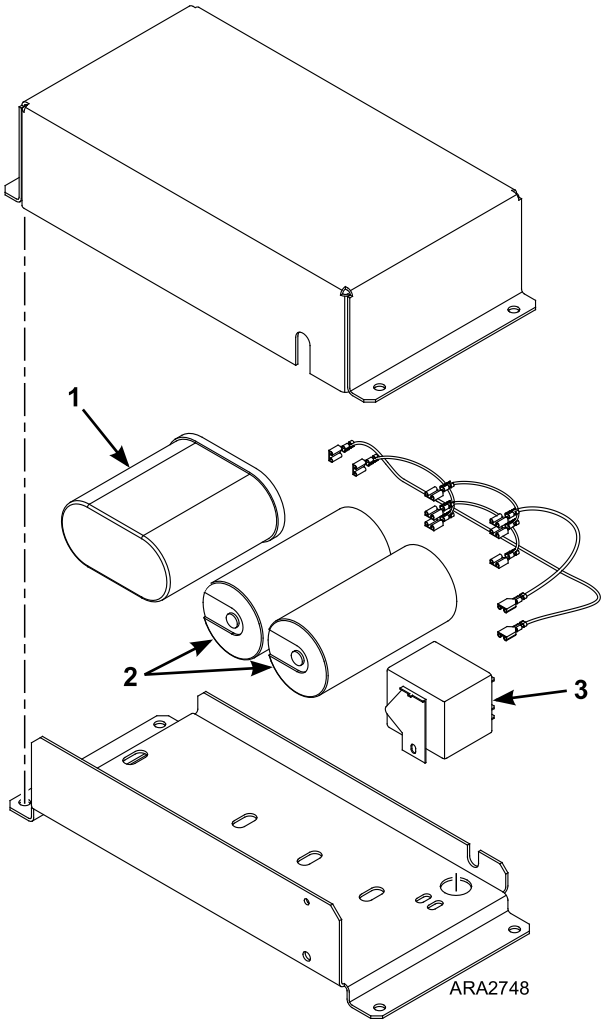
1.	Battery Disconnect Relay	4.	Thermal Motor Protector
2.	Standby Power Relay	5.	F23 Fuse Holder
3.	Battery Power Relay	6.	Compressor Motor Contactor

Figure 34. Transformer Components



1.	Rectifier Heat Sink	4.	Fuse F24 - 5 Amps
2.	Rectifiers	5.	Fuse F25 - 5 Amps
3.	Smoothing Capacitor		

Figure 35. Capacitor Box Components (Single Phase Units Only)



1.	Electric Motor Run Capacitor	3.	Start Relay
2.	Electric Motor Start Capacitors		

Electrical Contactors

Test the contact points by checking the voltage drop across each set of points when the contactor is energized and the system is operating. If the voltage drop across a set of points is more than 0.25 Vac, replace the contactor.

Test the contactor coil as follows:

1. Check the voltage to the coil. It should be at approximately 12 Vdc. If not, check for an open circuit.
2. Check the voltage after the coil. It should be 0 volts. If not, check for an open or high resistance in the circuit to ground. If the voltage is 0 but the contactor does not pull-in, the coil is probably open. Check the resistance to verify. It should be approximately ohms.

Compressor Motor Contactor

This contactor provides the AC power to the compressor motor. It is energized for Electric Standby Operation.

Compressor Motor Contactor Replacement

Removal

1. Turn the unit off and disconnect the electric standby power supply.

2. Remove the control box cover.
3. Disconnect the wires from the compressor motor contactor. Note which wires are attached to which terminals so they can be reattached correctly.
4. Remove the compressor motor contactor mounting hardware and remove the compressor motor contactor.

Installation

1. Place the compressor motor contactor in position and install the mounting hardware.
2. Connect the wires to the compressor motor contactor. Make sure to connect the wires to the same terminals from which they were removed.
3. Reinstall the control box cover.

Electric Heat Contactor – HC (Model 20 Option Only)

This contactor only used on Model 20 units with the Electric Heat Option. It provides AC power to the electric heat element. It is energizes in the Heat Mode during Electric Standby Operation.

Electric Heat Contactor Replacement

Removal

1. Turn the unit off and disconnect the electric standby power supply.
2. Remove the control box cover.
3. Disconnect the wires from the electric heat contactor. Note which wires are attached to which terminals so they can be reattached correctly.
4. Remove the electric heat contactor mounting hardware and remove the electric heat contactor.

Installation

1. Place the electric heat contactor in position and install the mounting hardware.
2. Connect the wires to the electric heat contactor. Make sure to connect the wires to the same terminals from which they were removed.
3. Reinstall the control box cover.

Thermal Motor Protector

The thermal motor protector protects the compressor motor. It opens the 69/CH9 circuit to de-energize the compressor motor contactor if the temperature of the motor exceeds the thermal motor protector setting. The thermal motor protector resets automatically.

Thermal Motor Protector Replacement

Removal

1. Turn the unit off and disconnect the electric standby power supply.
2. Remove the control box cover.
3. Disconnect the wires from the thermal motor protector. Note which wires are attached to which terminals so they can be reattached correctly.
4. Remove the thermal motor protector mounting hardware and remove the thermal motor protector.

Installation

1. Place the thermal motor protector in position and install the mounting hardware.
2. Connect the wires to the thermal motor protector. Make sure to connect the wires to the same terminals from which they were removed.
3. Reinstall the control box cover.

Transformer – T1

The transformer converts 230 Vac to 12 Vac to provide power to the rectifier bridge. The rectifier bridge converts the 12 Vac to 12 Vdc to supply power to the 12 Vdc control circuits.

Transformer Testing

Test the transformer as follows:

1. Disconnect the 6-pin connector in the wire harnesses to the transformer.
2. Connect the electric standby power receptacle to an appropriate AC power supply.
3. Check for AC voltage between the L1A and L2 wires in the 6-pin connector.
4. Approximately 230 Vac should be present between L1A and L2. If not, check the continuity of the L2 wire to the CMC, the continuity of the L1A wire to fuse F23, fuse F23, the continuity of the L1 wire to the CMC, the continuity of the standby power harness, and the power supply.
5. Disconnect the AC power supply.
6. Reconnect the 6-pin connector in the wire harnesses to the transformer.
7. Reconnect the AC power supply.
8. Check for AC voltage between the X1 and X4 wires at the rectifier.
9. Approximately 12 Vac should be present between X1 and X4. If not, check the continuity of the X1 and X4 wires to the transformer. If the X1 and X4 wires have continuity, the transformer is probably defective.

Transformer Replacement

Removal

1. Turn the unit off and disconnect the electric standby power supply.
2. Remove the transformer cover.
3. Disconnect the wire harnesses connected to the transformer.
4. Remove the transformer mounting hardware and remove the transformer.

Installation

1. Place the transformer in position and install the mounting hardware.
2. Connect the wire harnesses to the transformer.
3. Reinstall the transformer cover.

Rectifier Bridge

The rectifier bridge converts the 11.7 Vac power from the transformer to 11.7 Vdc to supply power to the 12 Vdc control circuits. The the rectifier bridge consists of two rectifiers that are attached to the heat sink on the transformer cover.

Test the rectifier bridge as follows:

1. Connect the electric standby power receptacle to an appropriate AC power supply.
2. Check for AC voltage between the A and B terminals, and between the C and D terminals in the 4-pin connector in the rectifier bridge harness.
3. Approximately 12 Vac should be present between A and B, and C and D. If not, check the continuity of the wires to the transformer, the transformer, and the AC circuits back to the power supply.
4. Check the rectifier output voltage (DC) between the 2R wire and the CH wire at the rectifier bridge. If this voltage is less than approximately 12 Vdc the rectifier bridge is defective.

Capacitors

Several capacitors are used in Model 20 and Model 50 units.

- Smoothing Capacitor (all voltages)
- Electric Motor Run Capacitors (two used in single phase units)
- Electric Motor Start Capacitor (single phase units)

⚠ WARNING

Hazardous Voltage w/Capacitors!

Be careful when working with electrical circuits that contain capacitors. Some capacitors hold a significant electrical charge that might cause burns or shocks if accidentally discharged. Capacitors must be discharged before working on electrical circuits. If there is a risk of energized electrical contact, arc, or flash, technicians MUST put on all PPE in accordance with OSHA, NFPA 70E, or other local, state, or country-specific requirements for arc flash protection PRIOR to servicing the unit. NEVER PERFORM ANY SWITCHING, DISCONNECTING, OR VOLTAGE TESTING WITHOUT PROPER ELECTRICAL PPE AND ARC FLASHING CLOTHING. ELECTRICAL METERS AND EQUIPMENT MUST BE PROPERLY RATED FOR INTENDED VOLTAGE.

To safely discharge a capacitor: Turn the unit off and disconnect the electric standby power supply. Connect a 20,000 ohm, 5-watt resistor across the capacitor terminals for five seconds. Use a multimeter to confirm the capacitor is fully discharged.

Capacitor Testing

1. Turn the unit off and disconnect the electric standby power supply.
2. Remove covers as needed to access the capacitor.
3. Visually check the capacitor for leaks, cracks, bulges or other signs of damage. If any damage is apparent, replace the capacitor.
4. Discharge the capacitor as described above.
5. Disconnect the wires from the capacitor to remove it from the circuit.
6. Use a digital multimeter such as a Fluke 77 set to the Capacitance Measurement Mode.
7. Connect the multimeter test leads to the capacitor terminals and keep them connected for a few seconds to allow the multimeter to obtain a reading.
8. The capacitance should be within 10% of the value listed in the Specifications chapter. If not, replace the capacitor.
9. Reconnect the wires that were disconnected and reinstall any covers that were removed when finished with the test.

Capacitor Replacement

Removal

1. Turn the unit off and disconnect the electric standby power supply.
2. Remove covers as needed to access the capacitor.
3. Discharge the capacitor as described above.
4. Disconnect the wires from the capacitor.
5. Remove the capacitor mounting hardware and remove the capacitor.

Installation

1. Place the capacitor in position and install the mounting hardware.
2. Connect the wires to the capacitor.
3. Reinstall any covers that were removed.

Start Relay

The start relay is a normally closed (NC) single pole single throw (SPST) relay. It is used to open the circuit between the start capacitors and the RED-02 circuit when the compressor motor gets up to speed after the compressor motor contactor is energized to supply AC power to the compressor motor.

Start Relay Testing

1. Turn the unit off and set thermostat so the unit will run in Cool.
2. Connect the electric standby power receptacle to an appropriate AC power supply.
3. Remove covers as needed to access the start relay.
4. Connect a voltmeter between the 1 and 5 terminals on the start relay.

5. Turn the unit on and watch the voltmeter. The voltage should go from 230 Vac to 0 Vac as the compressor comes up to speed. If not, check for AC voltage between the RED-01 and the T2-U wires at the 2 and 5 terminals on the start relay. If AC voltage is not present, check the continuity of the RED-01 and V wires to V terminal on the compressor motor, and check the continuity of the T2-U wire to the compressor motor contactor.
6. Turn the unit off and disconnect the AC power supply.
7. Disconnect the wires from the start relay.
8. Check for continuity between terminals 1 and 2 on the start relay. If the continuity is not acceptable, replace the start relay.
9. Check the coil resistance between pins 2 and 5 on the start relay. If the resistance not acceptable (see Specifications chapter), replace the start relay.

Start Relay Replacement

Removal

1. Turn the unit off and disconnect the electric standby power supply.
2. Remove covers as needed to access the start relay.
3. Disconnect the wires from the start relay. Note which wires are attached to which terminals so they can be reattached correctly.
4. Remove the start relay mounting hardware and remove the start relay.

Installation

1. Place the start relay in position and install the mounting hardware.
2. Connect the wires to the start relay. Make sure to connect the wires to the same terminals from which they were removed.
3. Reinstall any covers that were removed.

Compressor Motor

Testing 230/1/60 Units

1. Connect the electric standby power receptacle to an appropriate AC power supply.
2. Set the thermostat so the unit will run in Cool.
3. Start the unit and run it in Cool on electric standby.
4. Check for AC voltage between the T1-W and T2-U wires at the compressor motor contactor.
5. Approximately 230 Vac should be present. If not, check the compressor motor contactor, the continuity of the standby power harness, and the power supply. If the compressor motor contactor is not being energized (pulling down) see “Electric Standby Circuits” below.
6. Turn the unit off, disconnect AC power supply, and check the connections in the junction box on the compressor motor to verify they are clean and tight.
7. Check the continuity of the T1-W and T2-U wires from the compressor motor contactor to the compressor motor. If both wires have good continuity, check the start relay, the start capacitors, the run capacitor and the associated circuits. If those components are good, the compressor motor is most likely faulty.

Testing 230/3/60 Units

1. Connect the electric standby power receptacle to an appropriate AC power supply.
2. Set the thermostat so the unit will run in Cool.
3. Start the unit and run it in Cool on electric standby.
4. Check for AC voltage between the T1-W, T2-U, and T3-V wires at the compressor motor contactor.
5. Approximately 230 Vac should be present. If not, check the compressor motor contactor, the continuity of the standby power harness, and the power supply. If the compressor motor contactor is not being energized (pulling down) see “Electric Standby Circuits” below.
6. Turn the unit off, disconnect AC power supply, and check the connections in the junction box on the compressor motor to verify they are clean and tight.

7. Check the continuity of the T1-W, T2-U, and T3-V wires from the compressor motor contactor to the compressor motor. If all three wires have good continuity, the compressor motor is most likely faulty.

Electric Standby Circuits

If the unit does not run in the electric standby mode use the following procedure.

Make sure the unit is connected to the proper power source.

Check the power cable receptacle for power. If power is there, check for power at the unit terminal plug.

If the compressor motor contactor is pulled down but the compressor motor fails to start, the trouble is probably in the compressor motor.

If the compressor motor contactor is not pulling down proceed as follows:

1. Check the AC line voltage and the transformer input fuse F23. If the AC line voltage is acceptable and the transformer input fuse is intact, go to step 2.
2. Measure the transformer output voltage (AC). The voltage reading should be approximately 12 Vac. If not, the transformer is defective. If the transformer output voltage is acceptable, go to step 3.
3. Check the rectifier output voltage (DC) on the 2R wire at the smoothing capacitor (C1) and check for continuity to ground on the CH wire at the smoothing capacitor (C1). If this voltage is less than approximately 12 Vdc, and if the 2R circuits to the rectifiers and the 11.5V and 0V circuits from the rectifiers to the transformer have good continuity, the rectifier bridge is defective. If the rectifier bridge output voltage is acceptable go to step 4.
4. Check fuses F24 and F25 on the X1 and X4 wires at the transformer.
5. Check the rectifier output voltage (DC) on the X1 wire (pin B8 at Connector MP1-C1 on PCB1 in the ECM) and the X4 wire (pin C8 at Connector MP1-C1 on PCB1 in the ECM). If voltage is not present, check the continuity of the X1 and X4 wires from the transformer. If the rectifier output voltage is acceptable, go to step 6.
6. Check the voltage on 2R-01 wire at the standby power relay. If voltage is not present, check the continuity of the 2R-01 wire from the smoothing capacitor (C1). If the voltage on the 2R-01 wire at the standby power relay is acceptable, go to step 7.
7. Check the voltage on the 2RB and 2RB1 wires at the standby power relay. If voltage is not present, check the continuity of the 2RB wire. If the voltage on both the 2RB and 2RB1 wires is acceptable, go to step 8.
8. Check the voltage on the 2RB1 wire at the battery disconnect relay. If voltage is not present, check the continuity of the 2RB1 wire from the standby power relay. If the voltage on the 2RB1 wire at the battery disconnect relay is acceptable, go to step 9.
9. Check for continuity to ground on the CHX wire at the battery disconnect relay. If continuity to ground on the CHX wire at the battery disconnect relay is not present, check the continuity of the CHX wire from the battery disconnect relay to the chassis ground. If there is good continuity to ground on the CHX wire at the battery disconnect relay, go to step 10.
10. Check for continuity to ground on the SWS wire at the standby power relay. If continuity to ground is not present, check the continuity of the SWS wire, diode D1, and the SWD wire to the battery disconnect relay. If the SWS/D1/SWD wire has good continuity, go to step 11. If there is good continuity to ground on the SWS wire at the standby power relay, go to step 12.
11. Check for continuity to ground on the CHW wire at the battery disconnect relay. If the CHW wire has good continuity to ground, the battery disconnect relay is probably defective. If continuity to ground on the CHW wire at the battery disconnect relay is not present, check the continuity of the CHW wire from the battery disconnect relay to the chassis ground.
12. Check the voltage on the 2B wire at the standby power relay. If voltage is not present, the standby power relay is probably defective. If the voltage on the 2B wire at the standby power relay is acceptable, go to step 13.
13. Check the voltage on the PC wire at Pin 10 in the MP1-C2 Connector on PCB1 in the ECM. If voltage is not present, check the continuity of the PC circuit to junction connector JP1 and the 2B2/2B circuit to the standby power relay. If the voltage on the PC wire is acceptable, go to step 14.
14. Check the voltage on the CMC wire at the compressor motor contactor. If voltage is not present, check the continuity of the CMC circuit to Pin B1 in Connector MP1-C1 on PCB1 in the ECM and Fuse 5 on the ECM. If the CMC wire has good continuity and Fuse 5 is good, the ECM may be defective. If the voltage on the CMC wire is acceptable, go to step 15.

15. Check for continuity to ground on the 69 wire at the compressor motor contactor. If there is good continuity to ground on the 69 wire at the compressor motor contactor, the compressor motor contactor is probably defective. If continuity to ground on the 69 wire at the compressor contactor is not present, go to step 16.
16. Check the continuity of the 69 wire from the compressor motor contactor to the thermal motor protector chassis ground. If the 69 wire has good continuity, go to step 17.
17. Check for continuity to ground on the CH9 wire at the thermal motor protector. If there is good continuity to ground on the CH9 wire at the thermal motor protector, the thermal motor protector is probably defective. If continuity to ground on the CH9 wire at the thermal motor protector is not present, go to step 18.
18. Check the continuity of the CH9 wire from the thermal motor protector to the chassis ground.

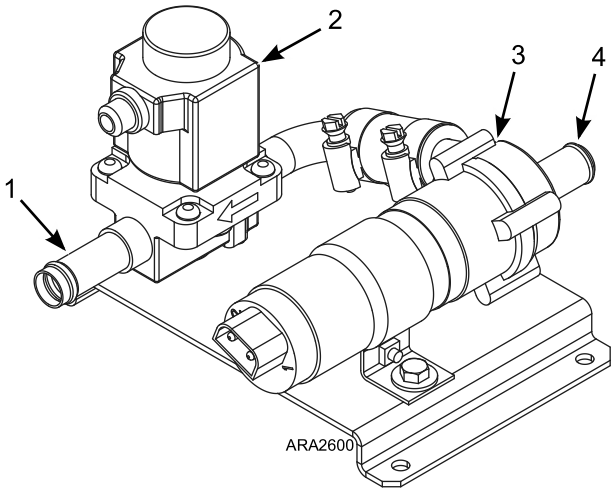
Heat Option – Truck Engine Coolant

This option is added to Model 10 and 20 units to allow the unit to use engine coolant to heat the cargo compartment as require during truck engine operation. The main components are the heater assembly, coolant pump assembly (coolant pump and coolant valve), and connecting hoses. The heater assembly is mounted on the bottom of the evaporator. The coolant pump assembly is typically mounted in the truck engine compartment. The connecting hoses connect the engine cooling system to the coolant pump assembly and the heater assembly.

Check the operation of Truck Engine Coolant Heat as follows:

1. Set the thermostat on the highest setting.
2. Start and run the unit in Heat on the engine driven compressor until the truck engine is warmed up.
3. Check the temperature of the coolant hoses connected to the inlet and outlet connections on the coolant pump assembly by hand. Both coolant hoses should be hot. If not, go to the next step.
4. Check the coolant pump by touching it to see if it is running. If it is running, go to the next step. If not go to step 6.

Figure 36. Coolant Pump Assembly



1.	Coolant Outlet	3.	Coolant Pump
2.	Coolant Valve	4.	Coolant Inlet

5. Disconnect the 2-pin wire connector from the coolant valve and check for 12 Vdc between the 26A-02 and CHN-02 wires. If voltage is present, the coolant valve is probably defective. If voltage is not present, check the continuity of the 26A circuit back to the ECM (and through the heat option relay if used), Fuse F5, and the continuity of the CH circuit to ground.
6. If the coolant pump is not running, Disconnect the 2-pin wire connector from the coolant pump and check for 12 Vdc between the 26A-2 and CHN-03 wires. If voltage is present, the coolant pump is probably defective. If voltage is not present, check the continuity of the 26A circuit back to the ECM (and through the heat option relay if used), Fuse F5, and the continuity of the CH circuit to ground.

Heat Option – Truck Engine Coolant and Electric Standby Heater Strip

This option is added to Model 20 units. It allows the unit to use engine coolant to heat the cargo compartment as require during truck engine operation, and to use an electric heater strip during electric standby operation. In addition to the engine coolant heat components (see "Heat Option – Truck Engine Coolant above), the main components are the electric heater strip, the over temperature switch, the heater contactor, the heat option relay, and the electric heating harness. The electric heater strip and the over temperature switch are mounted in the heater assembly, the heater contactor isand heat option relay are mounted in the in the control box, and the heater harness connects the heater assembly to the unit control box.

See "Heat Option – Truck Engine Coolant" above to check the operation of Truck Engine Coolant Heat.

Check the operation of Electric Standby Heater Strip as follows:

⚠ DANGER

Hazardous Voltage!

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

1. Set the thermostat on the highest setting.
2. Connect the electric standby power receptacle to an appropriate AC power supply.
3. Start and run the unit in Heat on electric standby operation.
4. Check the electric heater strip to see if it is hot. If not, go to the next step.
5. Check for AC voltage between the JUMP-L1 and JUMP-L2 wires at the heater contactor. Approximately 230 Vac should be present.
   a. If voltage is not present, check the continuity of the JUMP-L1 and JUMP-L2 wires to the compressor motor contactor, the continuity of the standby power harness, and the power supply.
   b. If voltage is present, go to the next step.
6. Check for AC voltage between the wires from the electric heater strip at the heater contactor. Approximately 230 Vac should be present.
   a. If voltage is present disconnect the electric heater strip and check the resistance. It should be approximately 35.3 ohms.
   b. If voltage is not present, go to the next step.
7. Check for DC voltage on the 26A-06 wire at the heater contactor. Approximately 12 Vdc should be present.
   a. If voltage is not present, check the continuity of the 26A-06 wire to the heat option relay. If the 26A-06 wire has good continuity, go to step 10.
   b. If voltage is present, go to the next step.
8. Check for continuity to ground on the 2R2-01 wire connected to the A2 terminal on the heater contactor.
   a. If there is good continuity to ground on the 2R2-01 wire at the heater contactor, check the resistance of the HC coil. See the Specifications chapter for the coil resistance.
   b. If continuity to ground on the 2R2-01 wire at the heater contactor is not present, go to the next step.
9. Check for continuity to ground on the 2R1-05 wire connected to the high temp limit switch.
   a. If there is good continuity to ground on the 2R1-05 wire at the high temp limit switch, check the continuity or the 2R1-05 wire back to the heater contactor. If the 2R1-05 wire has good continuity, check the continuity of the high temp limit switch. The high temp limit switch should have continuity (be closed) at temperatures below 90 ± 5 F (32 ± 3 C), and open at temperatures above 105 ± 5 F (41 ± 3 C).
   b. If continuity to ground on the 2R1-05 wire at the high temp limit switch is not present, check the continuity of the 2R1-05 and CHN-06 wires from the high temp limit switch to the chassis ground.
10. Check for DC voltage on the 26A-04 wire at the heat option relay. Approximately 12 Vdc should be present.
    a. If voltage is not present, check the continuity of the 26A circuit to Pin A1 in Connector MP1-C1 on PCB1 in the ECM and Fuse 5 on the ECM. If the 26A circuit has good continuity and Fuse 5 is good, the ECM may be defective.

b. If voltage is present, go to the next step.

11. Check for DC voltage on the 2RB3 wire at the heat option relay. Approximately 12 Vdc should be present.
    a. If voltage is not present, check the continuity of the 2RB3/2RB2 circuit to the battery disconnect relay.
    b. If voltage is present, go to the next step.
12. Check for continuity to ground on the CHU wire heat option relay.
    a. If there is good continuity to ground on the CHU wire, the heat option relay is probably defective.
    b. If continuity to ground on the CHU wire at the heat option relay is not present, check the continuity of the CHU wire from the heat option relay to the chassis ground.

Refrigeration Maintenance

Evacuating and Charging the Refrigeration System

Checking the Refrigerant Charge

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. Also, an insufficient charge does not circulate enough oil to properly lubricate the compressor. The charge can be determined by inspection of the refrigerant through the sight glass with the following conditions established:

Testing the Refrigerant Charge with an Empty Box

1. Install gauge manifold set on the on the engine driven compressor.
2. If the unit is equipped with Electric Standby, operate the unit in Cool on Electric Standby for 5 minutes.
   a. Connect the power cord.
   b. Turn the unit ON and place the unit in Cool Mode for 5 minutes.
   c. Turn the unit OFF and disconnect the power cord.
3. Start the vehicle's engine and operate it at 1000 RPM.
4. Turn the unit ON and place the unit in Cool Mode. Lower the setpoint(s) to the following:
   - R-134a: 25 degrees F (-4 degrees C)
   - R-404A: 0 degrees F (-18 degrees C)
   - R-452A: 0 degrees F (-18 degrees C)
5. Operate the unit until the following box temperature(s) are reached:
   - R-134a: 35 degrees F (2 degrees C)
   - R-404A: 10 degrees F (-12 degrees C)
   - R-452A: 10 degrees F (-12 degrees C)
6. Check to ensure the following discharge pressures are met or exceeded:
   - R-134a: 180 psig (1241 kPa)
   - R-404A: 275 psi (1896 kPa)
   - R-452A: 275 psi (1896 kPa)

   Note: *Partially blocking the condenser grille may be necessary to achieve these pressures.*
7. Inspect the sight glass.
   - NO BUBBLES PRESENT: The system is full of refrigerant. Proceed to Step 8.
   - BUBBLES PRESENT: The system is low on refrigerant. Proceed to the "Suction (Low Side) Bump Charging" procedure listed below.
8. Verify the unit is not over charged. Elevate engine RPM to 3000-4000 RPM for three minutes. Verify that the unit does not shutdown on high head pressure. If unit shuts down on high head pressure the system is overcharged. Reduce the refrigerant charge amount until the unit no longer shuts down on high head pressure.

   Note: *If the condenser coil was covered in previous Step 6 leave the condenser coil covered for Step 8.*

Testing the Refrigerant Charge with a Loaded Box

1. Install gauge manifold set on the on the engine driven compressor.
2. Run the unit in Cool on engine driven compressor operation.
3. Cover the condenser to drive any excess refrigerant from the condenser into the receiver tank.
4. As the head pressure rises, check the liquid line sight glass. There should be no bubbles in the flow of refrigerant through the liquid line sight glass. Bubbles in the refrigerant indicate the unit is low on refrigerant. Refer to the "Suction (Low Side) Bump Charging" procedure listed below to top-off the system.

Note: *If no bubbles are present, 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.*

Suction (Low Side) Bump Charging

Important: *Failure to properly charge the system with refrigerant will result in immediate damage to the compressor.*

1. Connect the gauge manifold set to the liquid port on the refrigerant bottle and purge the gauge manifold set (if not already completed in the previous procedure).
2. Connect the gauge manifold set Low Side, blue hose, to a Suction (Low Side) service port (if not already completed in the previous procedure).

   Note: *Select a service port that is as far away from the engine driven compressor as possible. Do NOT connect the Suction (Low Side) hose to the Suction service port at the engine driven compressor. Compressor damage may occur.*
3. Connect the gauge manifold set High Side, red hose, to a Discharge (High Side) service port (if not already completed in the previous procedure).
4. Start the vehicle's engine and operate it at 1000 RPM.
5. Turn the unit ON and place the unit in Cool Mode. Lower the setpoints) to the following:
   - R-134a: 25 degrees F (-4 degrees C)
   - R-404A: 0 degrees F (-18 degrees C)
   - R-452A: 0 degrees F (-18 degrees C)
6. Operate the unit until the following box temperature(s) are reached:
   - R-134a: 35 degrees F (2 degrees C)
   - R-404A: 10 degrees F (-12 degrees C)
   - R-452A: 10 degrees F (-12 degrees C)
7. Check to ensure the following discharge pressures are met or exceeded:
   - R-134a: 180 psig (1241 kPa)
   - R-404A: 275 psi (1896 kPa)
   - R-452A: 275 psi (1896 kPa)

   Note: *Partially blocking the condenser grille may be necessary to achieve these pressures.*
8. Open the Low Side valve on the gauge manifold set for one second and close.
9. **Wait a minimum of ten seconds.** Inspect the sight glass.
   - NO BUBBLES PRESENT: The system is full of refrigerant. Proceed to Step 10.
   - BUBBLES PRESENT: The system is low on refrigerant. Repeat Steps 8 and 9 until no bubbles are present in the sight glass.
10. Close the gauge manifold valves and refrigerant bottle valve. Turn off the unit and shut off the vehicle's engine.

Checking Compressor Oil Charge

The compressors are furnished with the amount of oil shown in the Specifications chapter. The oil level in the compressor will change after the compressor is initially run, making any level measurements inaccurate.

To ensure an adequate oil supply, the following procedure must be followed whenever the refrigerant charge is lost or removed from a unit:

1. Install a compressor on the system having a residual oil supply and self-lubricating system such as a TK 214 model. Connect an oil separator on the discharge or suction line to collect and drain out circulated oil.

   Note: *A suction line oil separator can be improvised by installing a suction filter upside down in the suction line near the compressor. Cap off both access ports, and use the lower one to drain off the accumulated oil.*
2. Place a normal amount of oil in the cleanup compressor before operating.
3. Charge with the recommended amount of refrigerant for your model. Refer to the Specifications Chapter for recommended refrigerant amount.
4. Operate at a low speed (600 to 800 rpm) for 2 hours, or until the compressor oil level reaches a minimum allowable

level, whichever occurs first. Drain the collected oil from the oil separator as it fills, taking care to not allow any collected oil to recirculate.

5. Prepare the original compressor that was removed from the unit (or a replacement) by draining out any existing oil and replacing the oil with the amount of oil shown in the Specifications chapter.
6. Install the original compressor (or its replacement), and proceed with the manual evacuation and refrigerant charging procedure.

Refrigeration System Checks

1. Connect a gauge manifold set to the suction and discharge service ports.

Cleanup Procedure for Small Truck Units

Note: *If a Van Steenburgh reclaimer is available, do not use this procedure. Follow procedure described in Service Bulletin T&T 134 or contact your Thermo King Service Representative.*

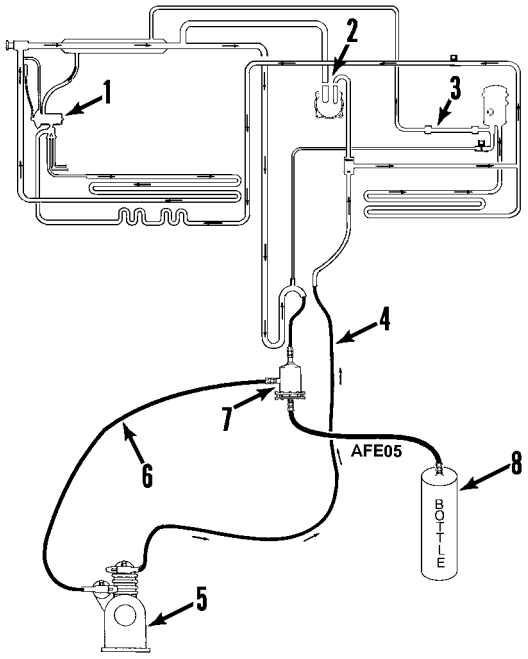
Tools Required

- Motor-driven TK 214 “Flushing Compressor”
- Suction Line Filter (P/N 2040498 with Filter P/N 662292)
- Pipes (In Place of Oil Separator, Check Valve, Oil Separator and Standby Compressor)

Clean-up Procedure

1. Make sure all hose routing is correct.
2. Make sure that the oil trap is correctly installed.
3. Recover the contaminated refrigerant from the system.
4. Remove the lines from the compressors (engine driven and standby).
5. Flush each compressor using the flushing compressor and an HFC refrigerant. (Always recover the refrigerant before disconnecting the flushing compressor.)

Figure 37. Connecting Flushing Compressor to Unit



1.	Remove Internal Parts From Expansion Valve
2.	Disconnect and Cap (If So Equipped)
3.	Replace Drier With Tube
4.	Discharge Line
5.	Flushing Compressor
6.	Suction Line
7.	Suction Line Filter
8.	Recovered Oil

6. Remove any check valves (or check valve seats) from system to ensure flow in all directions.
7. Remove the oil separator and install a connecting pipe.
8. Remove the internal parts from the expansion valve.
9. Open any suction pressure regulator valves to their highest setting.
10. Install a temporary suction line filter (P/N 2040498 and P/N 662292) in the suction line.
11. Install a connecting pipe in place of the standby compressor.
12. Connect the flushing compressor system to the engine driven compressor discharge and suction lines (see illustration).
13. Evacuate the system and check for leaks. Continue to evacuate to remove moisture and air.
14. Install HFC refrigerant and run the flushing compressor to flush the system. Energize (open) the defrost solenoid during 30% to 40% of the clean-up. Solid contaminants will collect in the suction line filter. Oil from the system and from the flushing compressor will drain out of the suction line filter. (Add compressor oil as required.) Refrigerant oil in the flushing compressor will absorb acids from the system.
15. Test the recovered compressor oil for acid contamination.
16. Continue flushing until the compressor oil is clean.

Putting the Unit Back Into Operation

1. Replace any check valves (or check valve seats).
2. Install a new oil separator.
3. Install a new liquid injection orifice.
4. Install a new drier.
5. Install a new expansion valve.
6. Install the compressors and lines.
7. Use dry nitrogen to pressurize the system to 150 psig (1034 kPa).
8. Use a bubble solution to check for leaks.
9. Install correct amount of oil.
10. If no leaks are found, evacuate the system. A leak-free and dry system will maintain a 1000 micron vacuum for five minutes or longer.
11. Charge the system with proper amount of the correct refrigerant.
12. Operate the unit and check for proper operation. (Adjust any suction pressure regulators.)
13. After two weeks of operation, change the drier.

Putting the Unit Back Into Operation

1. Replace any check valves (or check valve seats).
2. Install a new drier.
3. Install a new expansion valve.
4. Install the compressors and lines.

5. Use dry nitrogen to pressurize the system to 150 psig (1034 kPa).
6. Use a bubble solution to check for leaks.
7. Install correct amount of oil.
8. If no leaks are found, evacuate the system. A leak-free and dry system will maintain a 1000 micron vacuum for five minutes or longer.
9. Charge the system with proper amount of the correct refrigerant.
10. Operate the unit and check for proper operation. (Adjust any suction pressure regulators.)
11. After two weeks of operation, change the drier.

Refrigeration Service Operations

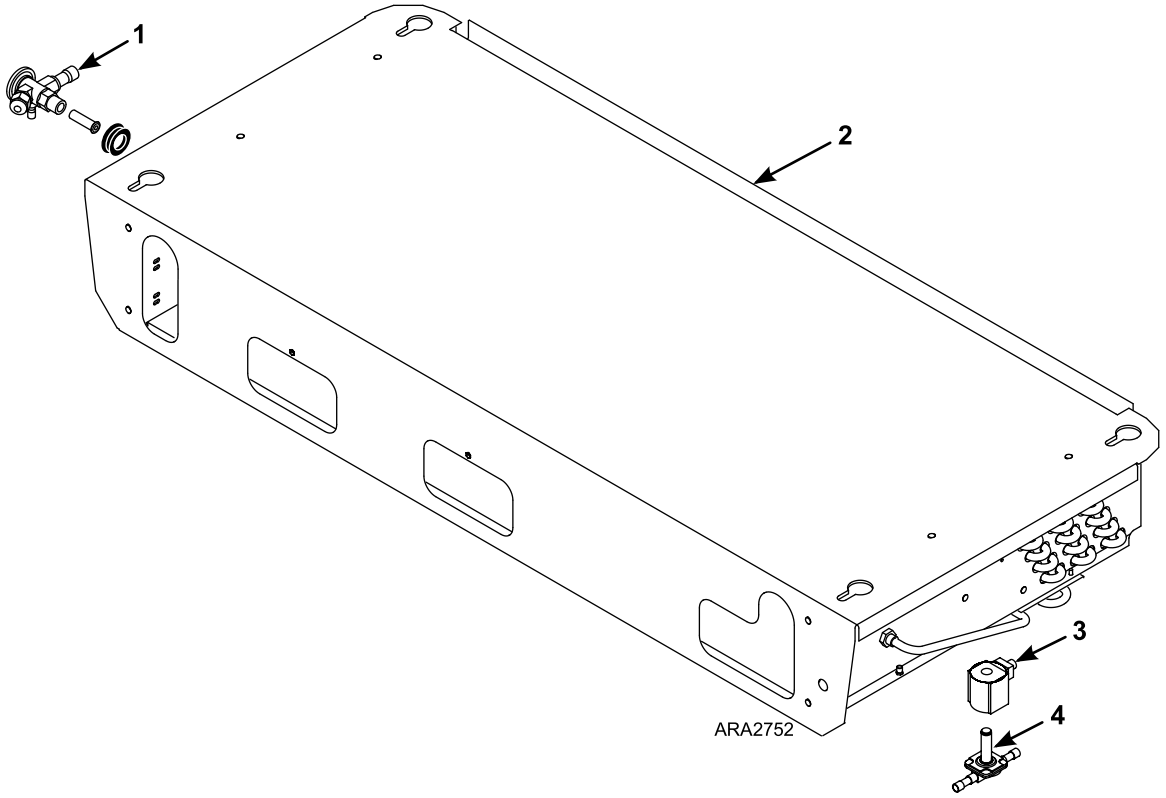
Note: *It is generally good practice to replace the filter drier whenever the high side is opened or when the low side is opened for an extended period of time.*

⚠ WARNING

Risk of Injury!

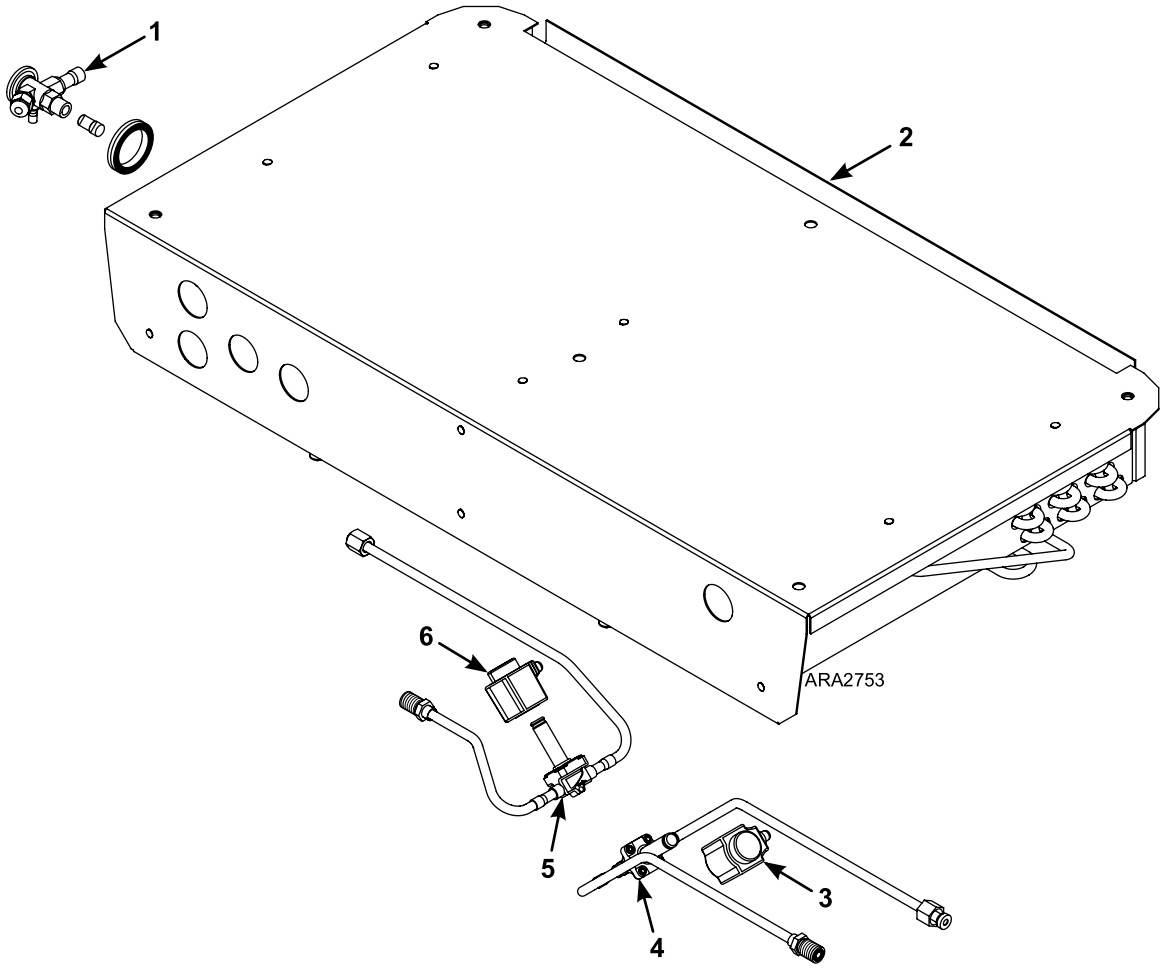
Disconnect the power supply before servicing the unit to prevent personal injury.

Figure 38. Single Temp Evaporator Components



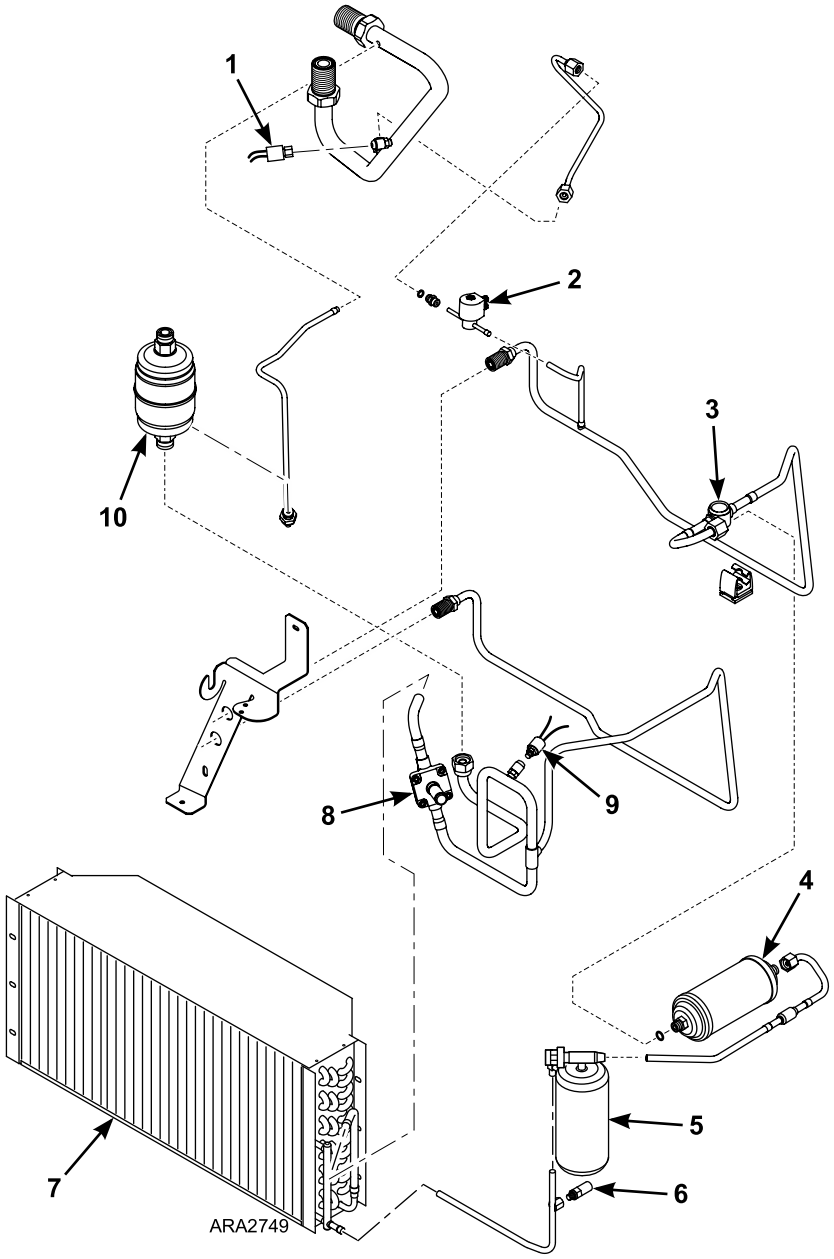
1.	Expansion Valve	3.	Hot Gas Solenoid Coil
2.	Evaporator Coil	4.	Hot Gas Solenoid

Figure 39. SPECTRUM Evaporator Components



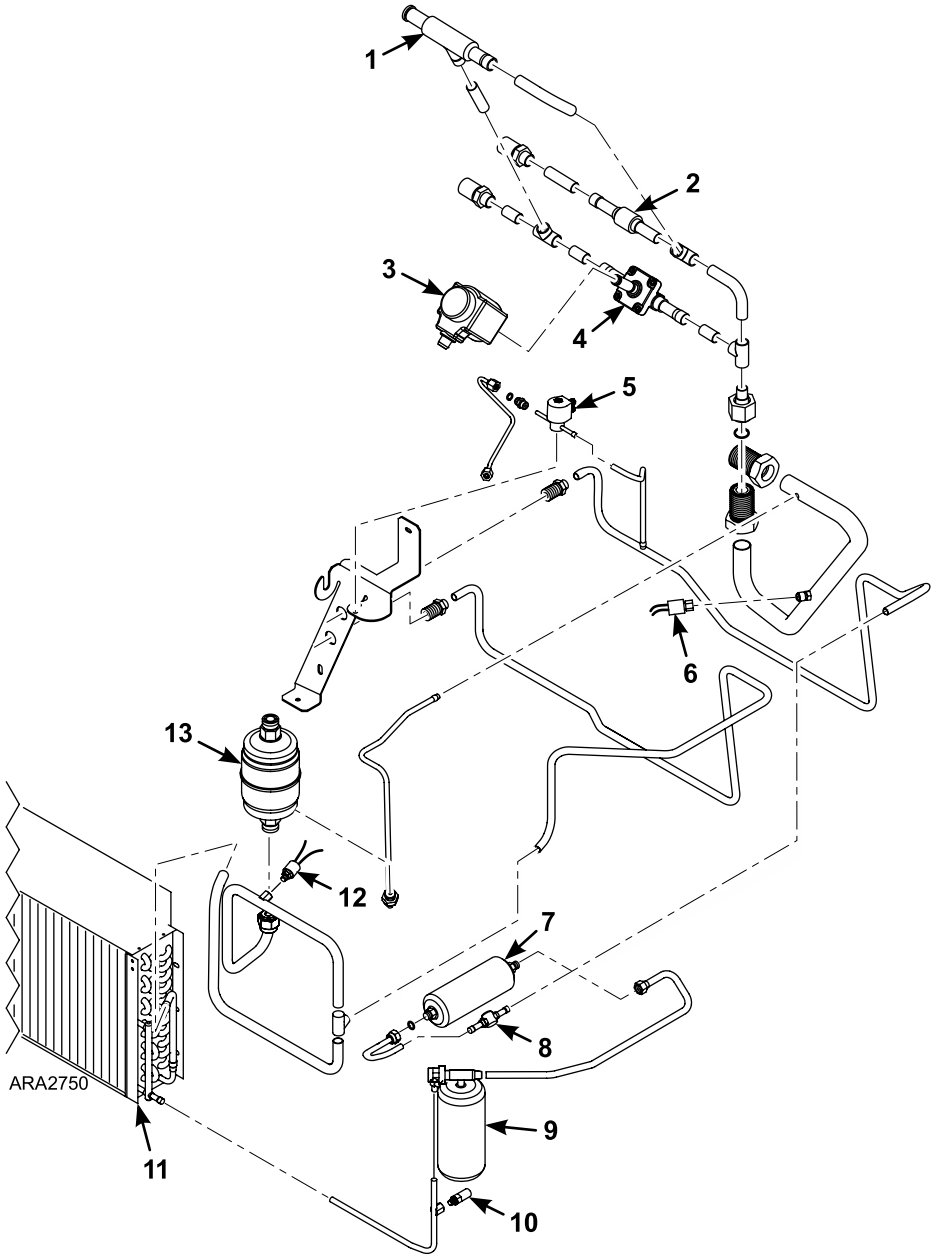
1.	Expansion Valve	4.	Hot Gas Solenoid
2.	Evaporator Coil	5.	Liquid Line Solenoid
3.	Hot Gas Solenoid Coil	6.	Liquid Line Solenoid Coil

Figure 40. Condenser Components Model 10 and Model 30 Single Temp



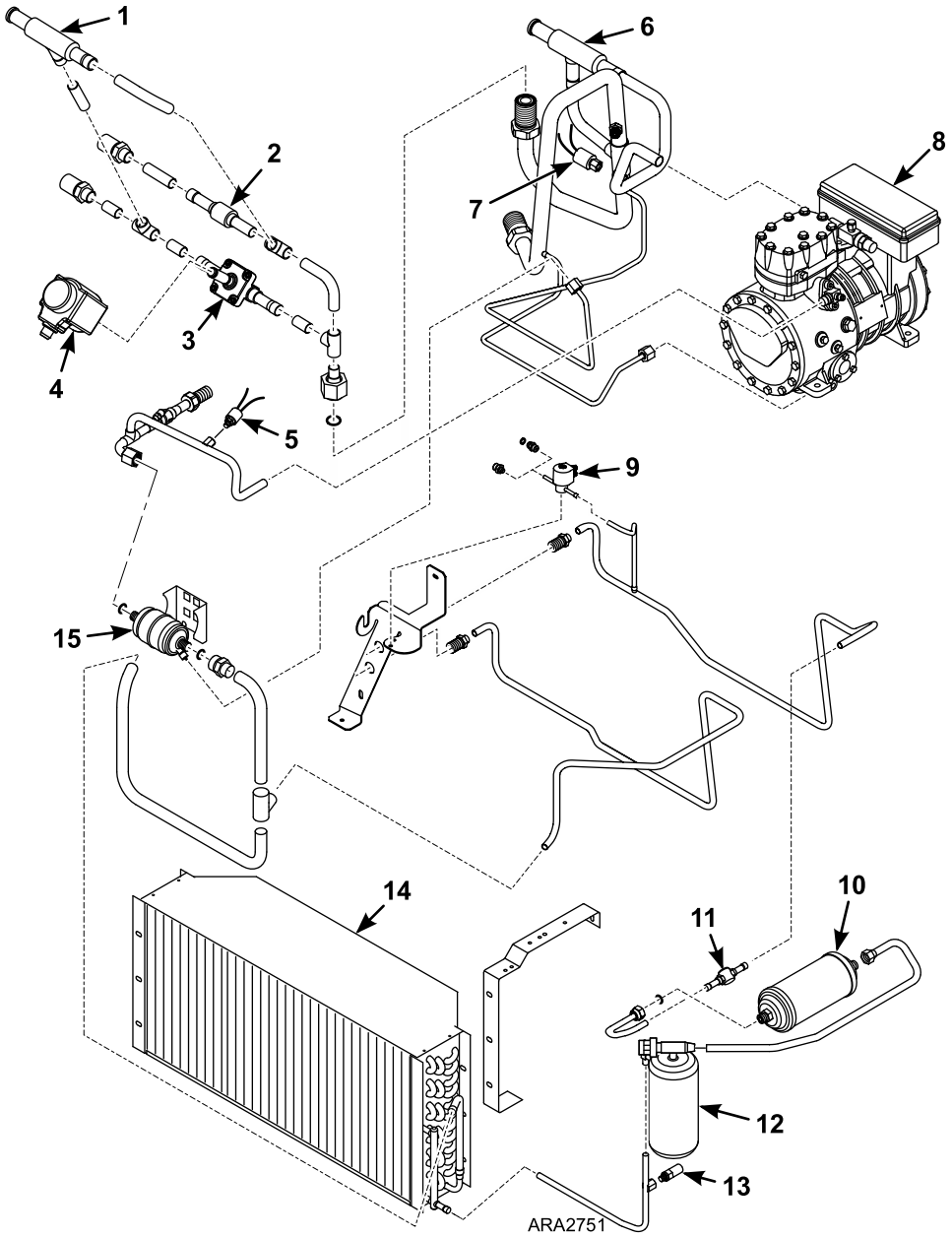
1.	Low Pressure Cutout Switch (LPCO)	6.	High Pressure Relief Valve
2.	Liquid Injection Solenoid Valve	7.	Condenser Coil
3.	Liquid Line Sight Glass	8.	Condenser Inlet Solenoid (Model 30 Units Only)
4.	Drier	9.	Discharge Pressure Transducer
5.	Receiver Tank	10.	Oil Separator

Figure 41. Condenser Components Model 10 SPECTRUM



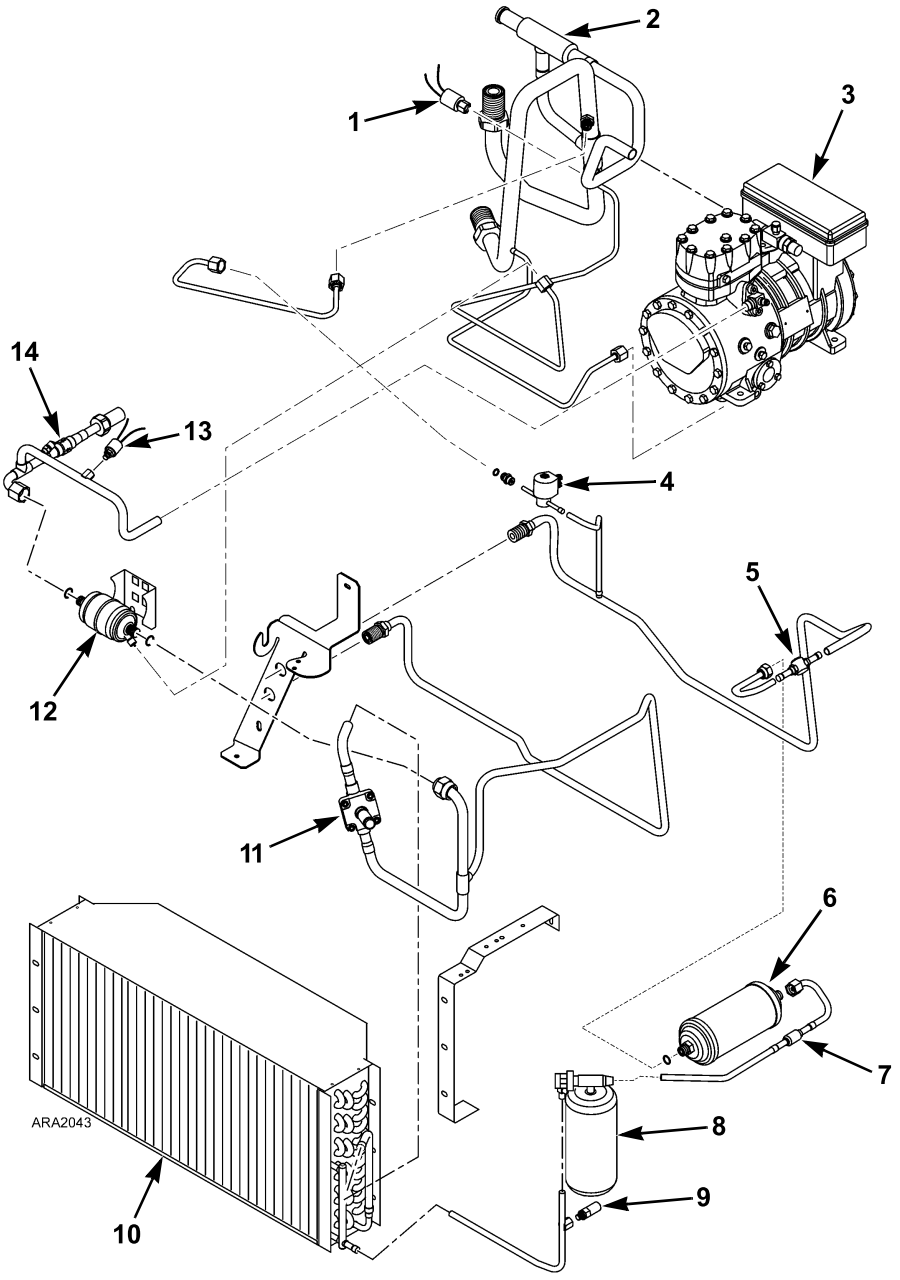
1.	Compressor Pressure Regulator (CPR)	8.	Liquid Line Sight Glass
2.	CPR Check Valve	9.	Receiver Tank
3.	CPR Bypass Solenoid Coil	10.	High Pressure Relief Valve
4.	CPR Bypass Solenoid	11.	Condenser Coil
5.	Liquid Injection Solenoid Valve	12.	Discharge Pressure Transducer
6.	Low Pressure Cutout Switch (LPCO)	13.	Oil Separator
7.	Drier		

Figure 42. Condenser Components Model 20 SPECTRUM



1.	Compressor Pressure Regulator (CPR)	9.	Liquid Injection Solenoid Valve
2.	CPR Check Valve	10.	Drier
3.	CPR Bypass Solenoid	11.	Liquid Line Sight Glass
4.	CPR Bypass Solenoid Coil	12.	Receiver Tank
5.	Discharge Pressure Transducer	13.	High Pressure Relief Valve
6.	Suction Pressure Regulator (SPR)	14.	Condenser Coil
7.	Low Pressure Cutout Switch (LPCO)	15.	Oil Separator
8.	Electric Standby Compressor		

Figure 43. Condenser Components Model 20 and Model 50 Single Temp, Model 50 SPECTRUM



1.	Low Pressure Cutout Switch (LPCO)	8.	Receiver Tank
2.	Suction Pressure Regulator (SPR)	9.	High Pressure Relief Valve
3.	Electric Standby Compressor	10.	Condenser Coil
4.	Liquid Injection Solenoid Valve	11.	Condenser Inlet Solenoid (Model 50 Units Only)
5.	Liquid Line Sight Glass	12.	Oil Separator
6.	Drier	13.	Discharge Pressure Transducer
7.	Liquid Line Check Valve	14.	Discharge Check Valve

Engine Driven Compressor

Removal

1. Recover the refrigerant charge from the system.
2. Loosen and remove the compressor drive belt.
3. Disconnect the clutch and liquid injection switch wires (if used).
4. Disconnect the discharge and suction lines.
5. Keep the compressor ports and the suction and discharge lines for the compressor covered to prevent contamination of system components.
6. Remove the compressor mounting screws and remove the compressor.

Installation

Note: *Any compressor installed in this system must contain of POE compressor oil. Always check to make sure that the compressor contains the proper amount and type of oil. Follow the system cleanup procedures to remove old oil from the system.*

1. Place the compressor in position and install the mounting screws and the belt.
2. Adjust the belt tension to the vehicle manufacturer specifications.
3. Connect clutch and liquid injection switch wires, and the refrigeration hoses. Pour the correct amount of oil for the unit (see Specifications chapter) into the suction hose before installation.
4. Pressurize the system and test for leaks.
5. Evacuate the system and recharge.

Electric Standby Compressor

Removal

1. Recover the refrigerant charge from the system.
2. Remove the condenser grille.
3. Disconnect the compressor wiring.
4. Disconnect the discharge and suction lines.
5. Keep the compressor ports and the suction and discharge lines for the compressor covered to prevent contamination of system components.
6. Remove the compressor mounting screws and remove the compressor.

Installation

Note: *Any compressor installed in this system must contain the proper amount of compressor oil. Always check to make sure that the compressor contains the proper amount of oil. Follow the system cleanup procedures to remove old oil from the system.*

1. Place the compressor in position and install the mounting screws.
2. Connect the discharge and suction lines.
3. Connect the compressor wiring.
4. Pressurize the system and test for leaks.
5. Reinstall the condenser grille.
6. Evacuate the system and recharge.

Condenser Coil

Removal

1. Recover the refrigerant charge.
2. Remove the condenser grille.

3. Remove the condenser fans.
4. Disconnect the inlet and liquid lines.
5. Remove the mounting hardware.
6. Remove the condenser coil.

Installation

1. Clean the tubes for soldering.
2. Place the coil in the unit and install the mounting hardware.
3. Connect the inlet and liquid line connections.
4. Pressurize the system and test for leaks.
5. Evacuate the system.
6. Reinstall the condenser fans.
7. Reinstall the condenser grille.
8. Recharge the unit.

Drier

Removal

1. Recover the refrigerant charge.
2. Disconnect the ORS nuts at the ends of the drier.
3. Loosen the mounting hardware and remove the drier.

Installation

1. Coat the new O-rings with refrigerant oil (same type that is used in the system) and place the new O-rings in the ORS fittings on the ends of the drier.
2. Install the new drier and tighten the mounting screws and nuts.
3. Install and tighten the ORS nuts. Hold the drier with a back-up wrench on the hex behind the ORS fitting.
4. Pressurize the system and test for leaks.
5. Evacuate and recharge the system.
6. Install the refrigeration module cover.

Discharge Pressure Transducer (DPT)

Removal

1. Remove the condenser grille if necessary.
2. Disconnect the wires and remove the transducer.

Installation

1. Install and tighten the transducer and reconnect the wires.
2. Pressurize the system and test for leaks.
3. Install the condenser grille (if removed).

Hot Gas Solenoid (HGS) Test

1. Install a gauge manifold set on the engine driven compressor.
2. Disconnect the 2-pin connector with the LIS and CLU wires in main wire harness from wires to the liquid injection switch at the engine driven compressor.
3. On Model 30 and 50 units disconnect the 2-pin connector with the 26A2 and CHS (or 26 and CHM depending on your unit) wires in main wire harness from the wires to the condenser inlet solenoid (PS5).

4. Set the thermostat(s) on the lowest setting(s).
5. Start and run the unit in Cool on the engine driven compressor until the suction pressure stabilizes.
6. Check the temperatures of the refrigeration lines on both sides of the hot gas solenoid (HGS) by hand. A temperature difference between the two sides of the hot gas solenoid (HGS) indicates it is leaking.
7. Use the In-Cab Control Box to place the unit in defrost.

   Note: *The defrost termination switch must be closed for the unit to enter defrost. Use a jumper wire to connect the 12 and CHB circuits in the main wire harness at the 2-pin connector for the defrost termination switch if the evaporator temperature is not low enough to close the defrost termination switch.*
8. The suction pressure should rise. If the suction pressure does not rise, the hot gas solenoid (HGS) is not opening. Check the continuity of the wiring and the resistance of the hot gas solenoid (HGS) coil before assuming the solenoid is faulty. See the Specifications chapter for the solenoid coil resistance.
9. Reconnect the wires that were disconnected and remove the gauge manifold set when finished with the test.

Liquid Injection Solenoid (LIS) Test

See “Testing Liquid Injection Solenoid Valve and Metering Orifice” under Liquid Injection System in the Electrical Maintenance Chapter.

Condenser Inlet Solenoid (CIS) Test

1. Install a gauge manifold set.
2. Set the thermostat(s) on the lowest setting(s).
3. Start and run the unit in Cool on the engine driven compressor until the suction pressure stabilizes.
4. Check the temperatures of the refrigeration lines on both sides of the condenser inlet solenoid (CIS) by hand. Both sides should be hot. If not, the CIS might be stuck closed.
5. Set the thermostat on the highest setting to make the unit shift to Heat. On SPECTRUM units set both zones to the highest setting.
6. The suction pressure should rise and the discharge pressure should fall as the condenser inlet solenoid (CIS) closes, and the hot gas solenoid (HGS) and liquid injection solenoid (LIS) open when the unit shifts to heat.
7. Let unit run in Heat until the suction and discharge pressures stabilize.
8. Check the temperatures of the refrigeration lines on both sides of the condenser inlet solenoid (CIS) by hand. Both sides should be about the same temperature, but should not be hot.
   - If both sides are hot, the condenser inlet solenoid (CIS) is probably not closing. Check the continuity of the wiring, the hot gas heat relay/heat option relay/RY5 relay, and the resistance of the condenser inlet solenoid (CIS) coil before assuming the solenoid is faulty. See the Specifications chapter for the solenoid coil resistance.
   - If the side of the condenser inlet solenoid (CIS) going to the condenser is significantly colder than the side coming from the oil separator, the condenser inlet solenoid (CIS) is probably leaking.
9. Remove the gauge manifold set when finished with the test.

Liquid Line Solenoid Test (SPECTRUM Only)

1. Install a gauge manifold set on the engine driven compressor.
2. Set the thermostat for the compartment being tested to the lowest setting so it will run in Cool. Set the thermostat for the other compartment to the compartment temperature so it will be in Null.
3. Start and run the unit on the engine driven compressor until the suction pressure stabilizes.
4. Check the temperatures of the refrigeration lines on both sides of the liquid line solenoid by hand. Both sides should be warm. If not, the liquid line solenoid might be stuck closed.
5. Set the thermostat for the compartment being tested to the compartment temperature to make that compartment shift to Null.
6. The suction pressure should fall because the liquid line solenoid closes when the compartment shifts to Null. Check the continuity of the wiring and the resistance of the liquid line solenoid coil before assuming the solenoid is faulty. See the Specifications chapter for the solenoid coil resistance.

7. Check the temperatures of the refrigeration lines on both sides of the liquid line solenoid by hand. A temperature difference between the two sides of the liquid line solenoid indicates it is leaking.
8. Remove the gauge manifold set when finished with the test.

CPR Bypass Solenoid Test (SPECTRUM Only)

1. Install a gauge manifold set on the engine driven compressor.
2. Set the thermostat for Zone 1 (frozen compartment) to the highest setting so it will be in Null. Set the thermostat for Zone 2 (fresh compartment) to the lowest setting so it will run in Cool.
3. Start and run the unit on the engine driven compressor until the suction pressure stabilizes
4. Set the thermostat for Zone 1 (frozen compartment) to the lowest setting to make it shift to Cool.
5. The suction pressure should fall because the CPR bypass solenoid closes when for Zone 1 (frozen compartment) shifts to Cool. Check the continuity of the wiring and the resistance of the CPR bypass solenoid coil before assuming the solenoid is faulty. See the Specifications chapter for the solenoid coil resistance.
6. Check the temperatures of the refrigeration lines on both sides of the CPR bypass solenoid by hand. A temperature difference between the two sides of the CPR bypass solenoid indicates it is leaking.
7. Remove the gauge manifold set when finished with the test.

Solenoid Valve Replacement

Note: *Valves that have nylon seats must be disassembled before soldering.*

Removal

1. Recover the refrigerant charge.
2. Remove covers and/or condenser grille as necessary to access the solenoid valve.
3. Remove the coil and disassemble the valve if unsoldering the valve.
4. Unsolder or disconnect the refrigeration lines from the valve, and remove the valve from the unit. Note the direction of the flow arrow on the valve.

NOTICE

Equipment Damage!

Use a heat sink to prevent damaging the valve when soldering.

Installation

1. Clean the tubes for soldering if necessary.
2. Remove the coil and disassemble the valve if soldering.
3. Place the valve in position with the flow arrow pointing in the direction noted when removed.
4. Solder or connect the inlet and outlet connections. After the valve cools, assemble the valve and install the coil.

NOTICE

Equipment Damage!

Use a heat sink to prevent damaging the valve when soldering.

5. Pressurize the refrigeration system and test for leaks.
6. Evacuate the system.
7. Reinstall any covers and/or the condenser grille (if removed).
8. Recharge the unit with the proper refrigerant.

Oil Separator

The oil separator must be replaced if a compressor has failed and is being replaced. Also check the oil return line to make sure it is not plugged by blowing air through it when replacing the oil separator.

Removal

1. Recover the refrigerant charge.
2. Remove the condenser cover / grille.
3. Disconnect the ORS nuts at the ends of the oil separator.
4. Loosen the mounting hardware and remove the oil separator.

Installation

1. Coat the new O-rings with refrigerant oil (same type that is used in the system) and place the new O-rings in the ORS fittings on the ends of the oil separator.
2. Install and tighten the inlet and outlet ORS nuts. Hold the oil separator with a backup wrench on the hex behind the ORS fitting.
3. Pressurize the system and check for leaks.
4. Evacuate the system.
5. Reinstall the condenser cover / grille.
6. Recharge the unit with the proper refrigerant.

Liquid Injection Metering Orifice

Removal

1. Recover the refrigerant charge.
2. Disconnect the refrigeration line from the metering orifice and remove the metering orifice from the suction tube fitting.

   Note: *This orifice can become plugged with dirt. The refrigeration line / hose and solenoid valve must be kept clean.*

Installation

1. Install the metering orifice on the suction tube fitting.
2. Connect the refrigeration line to the metering orifice fitting.
3. Pressurize the system and check for leaks.
4. Evacuate the system.
5. Recharge the unit with the proper refrigerant.

Liquid Line Check Valve (Model 30 and 50 Single Temp Only)

The liquid line check valve is located in the condenser between the receiver and the drier. The liquid line check valve prevents refrigerant from moving into the condenser when a Model 30 or 50 single temp unit is running in Heat of Defrost.

Liquid Line Check Valve Test

1. Install a gauge manifold set on the engine driven compressor.
2. Set the thermostat on the lowest setting.
3. Start and run the unit in Cool on the engine driven compressor until the suction pressure stabilizes.
4. Check the temperatures of the refrigeration lines on both sides of the liquid line check valve by hand. A temperature difference between the two sides of the liquid line check valve indicates it is not opening completely.
5. Set the thermostat on the highest setting to make the unit shift to Heat.
6. Let unit run in Heat until the suction and discharge pressures stabilize.
7. Check the temperatures of the refrigeration lines on both sides of the liquid line check valve by hand. A temperature difference between the two sides of the liquid line check valve indicates it is leaking.
8. Remove the gauge manifold set when finished with the test.

Liquid Line Check Valve Replacement

Removal

1. Recover the refrigerant charge.
2. Disconnect the ORS nut at the end of the liquid line check valve tube assembly, unsolder the other end, and remove the tube assembly from the unit.

Installation

1. Coat the new O-ring with refrigerant oil (same type that is used in the system) and place the new O-ring in the ORS fitting on the end of the drier.
2. Place the liquid line check valve tube assembly in position and tighten the ORS nut. Use a backup wrench on the hex on the drier.
3. Solder the connection on the other end of the liquid line check valve tube assembly.
4. Pressurize the system and test for leaks.
5. If no leaks are found, evacuate the system.
6. Recharge the unit with the proper refrigerant.

Discharge Check Valve (Model 20 and 50 Only)

Testing the Discharge Check Valve

Model 20 and 50 units are equipped with a discharge check valve. It isolates the engine driven compressor from the electric standby compressor, ensuring the compressor oil and refrigerant do not migrate between compressors. The check valve should be tested when the system is initially charged and operating, and anytime the system has been opened for service or repair. Testing the check valve requires two gauge manifold sets.

1. Disconnect the liquid injection solenoid valve wires.
2. With the unit off, install a gauge manifold set on each compressor.
3. Observe the gauge manifold readings of the electric compressor. If the high side and low side readings are not the same, open the gauge manifold valves and equalize the pressures. Close the gauge manifold valves.
4. Set the thermostat(s) so the unit will run in cool.
5. Start the truck and run the unit in Cool on the engine driven compressor.
6. Observe the gauge manifold readings of the engine driven compressor. The head pressure should increase and the suction pressure should decrease.
7. Observe the gauge manifold readings of the electric standby compressor. The pressures should be approximately equal to those on the engine driven compressor.
8. Turn the unit off and shut off the truck engine. Connect the remote control box to an appropriate electric power source.
9. Observe the gauge manifold reading of the engine driven compressor. If the high side and low side readings are not the same, open the gauge manifold valves and equalize the pressures. Close the gauge manifold valves.
10. Set the thermostat(s) so the unit will run in cool.
11. Start the unit and run it in Cool on electric standby.
12. Observe the gauge manifold readings of the electric standby compressor. The head pressure should increase and the suction pressure should decrease.
13. Observe the gauge manifold readings of the engine driven compressor. The high side pressure should remain the same as the pressure in step 9 after the high and low sides were equalized. If the high side pressure is increasing or has increased noticeably, the discharge check valve is leaking internally. Stop the unit.
14. Remove the gauge manifold sets and the electric standby power source. Connect the wires to the liquid injection solenoid valve.
15. If the discharge check valve is leaking internally it should be replaced, refer to the replacement procedure.

Discharge Check Valve Replacement

Removal

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

Installation

Note: *A heat sink must be used on the in-line check valve when it is being soldered in place to prevent damage to the neoprene seal.*

1. Clean the tubes for soldering.
2. Place the check valve in position. The arrow on the valve body indicates the direction of refrigerant flow through the valve.
3. Place a heat sink on the check valve.
4. Solder the inlet and outlet connections.
5. Pressurize the system and test for leaks.
6. Reinstall the condenser grille.
7. Evacuate and recharge the system.

Suction Pressure Regulator Valve (Model 20 and 50 Only)

Model 20 and 50 units are equipped with a suction pressure regulator valve. The suction pressure regulator valve is used to limit the load on the electric standby compressor. This also affects the current draw of the compressor motor. If the suction pressure gets too high, it can cause the thermal motor protector to open. Monitor the current drawn of the compressor motor when making this adjustment and keep it at least 1.5 amps below the Full Load (Amps) rating for the compressor motor (see the Specifications chapter).

Suction Pressure Regulator Valve Test

1. Install a gauge manifold set on the electric standby compressor. Attach an additional compound gauge to the suction service port on the engine driven compressor to monitor suction pressure at the inlet to the suction pressure regulator.
2. Connect the unit power receptacle to an appropriate electric power source.
3. Place a jumper wire between the 12 and CHB wires at the defrost termination switch to ensure the unit will run in Defrost.
4. Start the unit and run it in Defrost on the electric standby compressor until the pressure on the additional compound gauge attached to the suction service port stabilizes at a pressure above 45 psig (310 kPa).
5. Remove the gauge manifold set, the additional compound gauge, and the jumper wire when finished with the test.

Suction Pressure Regulator Valve Replacement

Removal

1. Recover the refrigerant charge.
2. Remove the mounting hardware from the suction pressure regulator valve.
3. Unsolder the suction pressure regulator valve from the suction tubes.

Installation

1. Clean the tubes for soldering.
2. Place the valve in position and solder the connections.
3. Install the mounting hardware.
4. Pressurize the refrigeration system and test for leaks.
5. If no leaks are found, evacuate the system.

6. Recharge the unit with the proper refrigerant.

Evaporator Coil

Removal

1. Recover the refrigerant charge.
2. Remove the evaporator cover (and fans on SPECTRUM units).
3. Disconnect the refrigeration lines.
4. Disconnect the expansion valve from the distributor.
5. Remove the evaporator fans (on single temp units).
6. Remove the temperature sensor.
7. Remove the defrost termination switch.
8. Remove the defrost termination switch.
9. Remove the mounting bolts and remove the evaporator coil.

Installation

1. Place the evaporator coil in position, and install and tighten the mounting bolts.
2. Install the defrost termination switch.
3. Install the temperature sensor.
4. Install the evaporator fans (on single temp units).
5. Clean the tubes for soldering.
6. Connect the expansion valve to the distributor.
7. Connect the refrigeration lines.
8. Pressurize the system and test for leaks.
9. Install the evaporator cover (and fans on SPECTRUM units).
10. Evacuate and recharge the system.

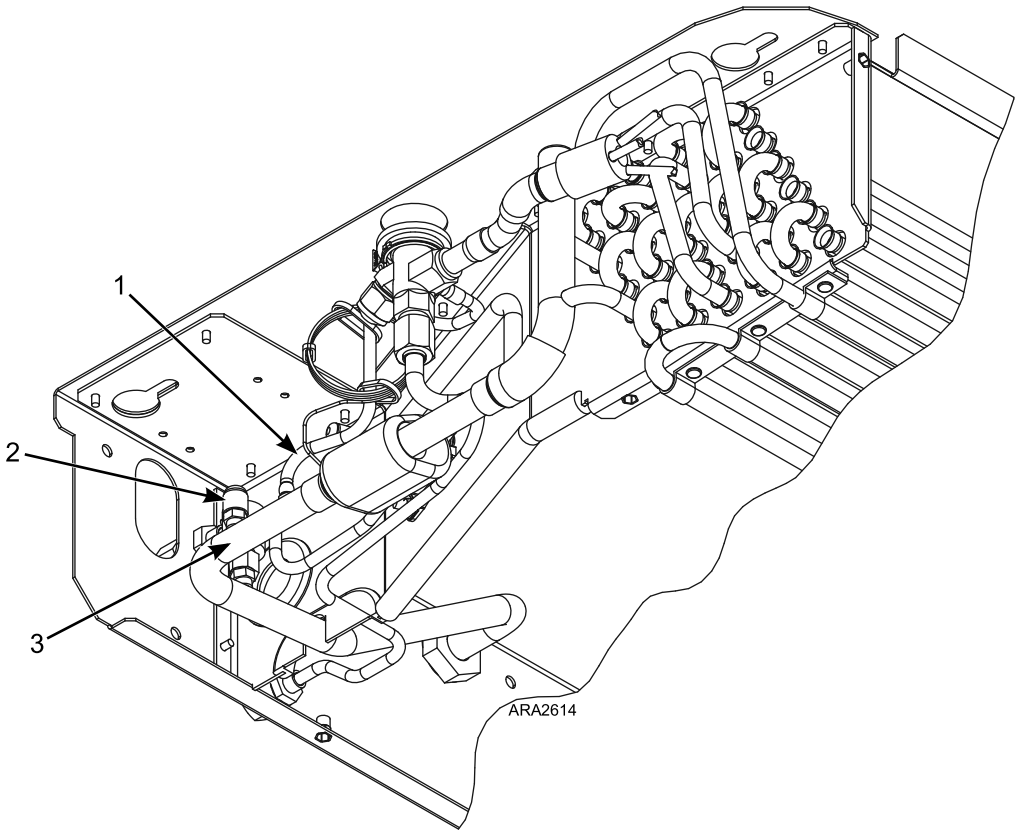
Expansion Valve Assembly

Refer to Expansion Valve Check/Adjustment in Diagnosing Thermo King Truck and Trailer Refrigeration Systems TK 5984 for information checking and adjusting the expansion valve.

Checking Superheat

1. Examine and/or clean the evaporator and condenser coils.
2. Attach an accurate compound gauge to the suction access port nearest to where the equalizer line is connected to the suction line. See the drawing below, which shows a typical evaporator.
3. Attach an accurate thermometer sensor to the suction line beside the suction access port. Secure it and insulate it well.

Figure 44. Checking Superheat



1.	Equalizer Line
2.	Attach Compound Gauge to Suction Access Port
3.	Attach Thermometer Sensor Here and Insulate

4. Defrost the evaporator.
5. Run the unit in Cool until the box temperature approaches 0 F (-18 C).
6. Cover the condenser as needed to maintain a discharge pressure of 160-175 psig (1103-1207 kPa) for R-134a, or 290-310 psig (1999-21337 kPa) for R-404A/R-452A.
7. Read the suction line pressure and temperature simultaneously. Make several readings approximately every 2 minutes.
8. The superheat should be between 6 °F (-3 °C) and 12 °F (-7 °C) at 0 °F (-18 °C) box temperature.

   Calculate superheat according to the sample below for R-134a.

   22 °F (-6 °C) = Suction Line Temperature

   12 psig (83 kPa) = Suction Line Pressure

   Convert equalizer line pressure to temperature using a pressure/temperature chart. **For R-134a 12 psig (83 kPa) = 10 °F (-12 °C)**

   Superheat = 22 °F - 10 °F = 12 °F

   Superheat = -6 °C - (-12 °C) = 6 °C

Expansion Valve Replacement

Removal

1. Recover the refrigerant charge.

2. Remove the evaporator cover. Disconnect the evaporator fan motor wires (if needed).
3. Remove the feeler bulb from the suction line clamps. Note the position of the feeler bulb on the suction line.
4. Disconnect the equalizer line from the expansion valve.
5. Disconnect the liquid line and the distributor from the expansion valve.
6. Remove the expansion valve from the unit.

Installation

1. Install the expansion valve assembly in the unit.
2. Connect the liquid line and the distributor to the expansion valve.
3. Connect 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 operation will be faulty. Wrap the bulb with insulating tape.

Figure 45. Location of Expansion Valve Bulb with Evaporator Installed on Ceiling

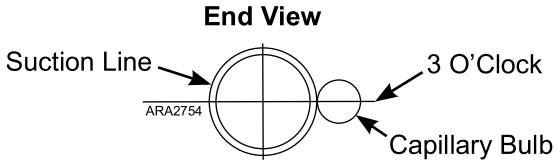
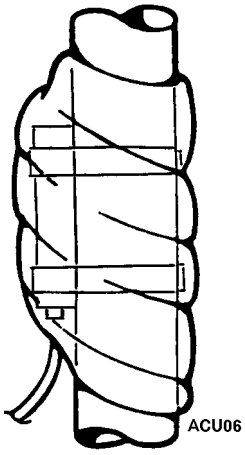


Figure 46. Completely Wrap Bulb with Tape



5. Pressurize the refrigeration system and test for leaks.
6. If no leaks are found, evacuate the system.
7. Connect the evaporator fan motor wires (if needed). Install the evaporator cover.
8. Recharge the unit with the proper refrigerant.

Low Pressure Cutout Switch (LPCO)

The low pressure cutout switch is located on the suction line in the condenser.

If the suction pressure drops below 5 to 11 in. Hg of vacuum (-17 to -37 kPa), it opens the LPCO circuit to the controller to stop the unit.

Low Pressure Cutout Switch Test

1. Install a gauge manifold at the compressor.
2. Disconnect the 2-pin connector with the LPCO and CHV/CHJ (depending on unit) wires in main wire harness from wires to the low pressure cutout switch.

3. Set the thermostat(s) on the lowest setting.
4. Start and run the unit in Cool.
5. Check the continuity between the low pressure cutout switch wires. The low pressure cutout switch should be closed when the suction pressure is above 5 to 11 in. Hg of vacuum (-17 to -37 kPa). If the suction pressure falls below 5 to 11 in. Hg of vacuum (-17 to -37 kPa), the low pressure cutout switch should open.
6. Reconnect the wires that were disconnected and remove the gauge manifold set when finished with the test.

Low Pressure Cutout Switch Replacement

Removal

1. Recover the refrigerant charge.
2. Remove the evaporator cover.
3. Disconnect the wires and remove the switch.

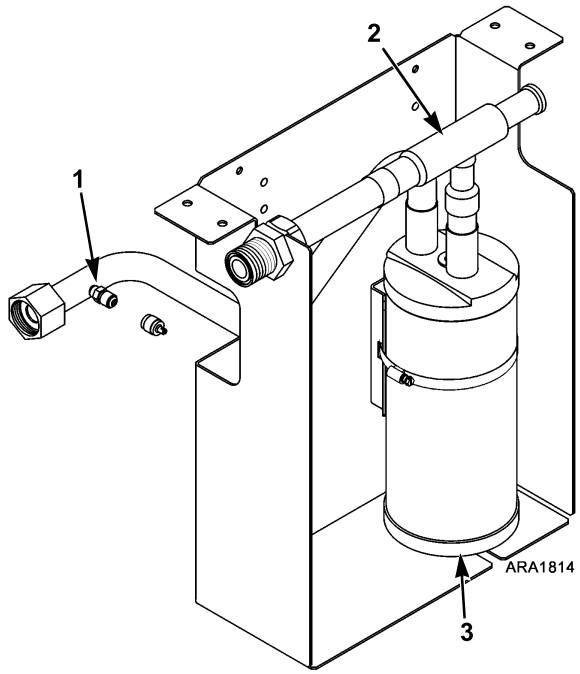
Installation

1. Install and tighten the switch and reconnect the wires.
2. Pressurize the refrigeration system and test for leaks.
3. If no leaks are found, evacuate the system.
4. Connect the evaporator fan motor wires and install the evaporator cover.
5. Recharge the unit with the proper refrigerant.

Compressor Pressure Regulator Valve in Model 30 and 50 Single Temp Units

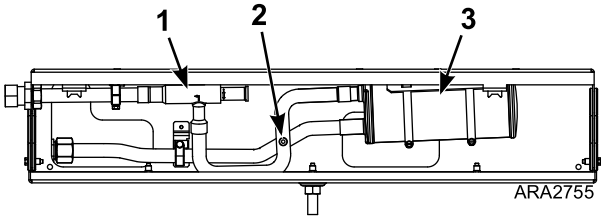
The compressor pressure regulator valve is located in the accumulator module, which is mounted on the back of the evaporator.

Figure 47. Vertical Accumulator Module Components



1.	Evaporator Suction Service Port
2.	Compressor Pressure Regulator Valve
3.	Accumulator Tank

Figure 48. Horizontal Accumulator Module Components



1.	Compressor Pressure Regulator Valve
2.	Evaporator Suction Service Port
3.	Accumulator Tank

Compressor Pressure Regulator Valve Test

1. Install a gauge manifold set on the engine driven compressor. Attach an additional compound gauge to the evaporator suction service port to monitor suction pressure in the evaporator.
2. Set the thermostat on the highest setting.
3. Start and run the unit in Heat on the engine driven compressor until the pressure on the additional compound gauge attached to the evaporator suction service port stabilizes at a pressure above 60 psig (414 kPa).
4. Check the suction pressure on the gauge attached to the suction service port at the compressor. See the Specifications chapter for the correct settings. If the setting is incorrect, remove the protective cap and try to adjust the compressor pressure regulator valve to the correct setting before assuming it is faulty.
5. Remove the gauge manifold set and the additional compound gauge when finished with the test.

Compressor Pressure Regulator Valve Replacement

Removal

1. Recover the refrigerant charge.
2. Remove the mounting hardware from the compressor pressure regulator valve.
3. Unsolder the compressor pressure regulator valve from the accumulator.

Installation

1. Clean the tubes for soldering.
2. Place the valve in position and solder the connection.
3. Install the mounting hardware.
4. Pressurize the system and test for leaks.
5. Evacuate and recharge the system.

Compressor Pressure Regulator Valve in SPECTRUM Units

SPECTRUM Advanced Control System

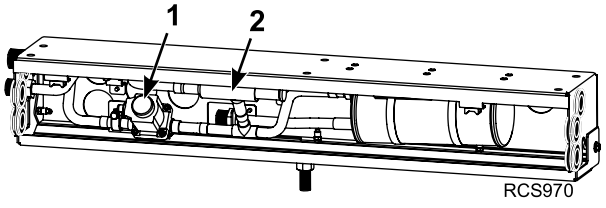
In multi-temp refrigeration systems the frozen evaporator has lower suction pressure than the fresh evaporator because temperature is relative to pressure. If both evaporators are calling for cool at the same time, the fresh evaporator takes the major portion of the capacity because it has a higher pressure to feed into the common suction line. With multiple door openings and the fresh compartment taking most of the capacity, the frozen department can loose control of the temperature and rise above the desired setpoint.

The advanced control system balances the suction pressure between the fresh and frozen evaporators to allow both evaporators to have equal capacity to control the two zones. This system gives priority to the frozen section. It also keeps refrigerant from migrating into the frozen evaporator when it is not running.

Advanced Control System Components and Operation

- The advanced control system components are located in the condenser on Model 10 and Model 20 SPECTRUM units. They are located in a module attached to the back of the fresh evaporator in Model 50 SPECTRUM units.
- The advanced control system contains a CPR bypass solenoid (normally open), a compressor pressure regulator (CPR) valve, and a check valve. The CPR bypass solenoid is a bypass around the CPR valve. When the CPR bypass solenoid is not energized, it allows full flow of suction gas to the compressor from the fresh compartment.
- The CPR bypass solenoid is connected to the same electrical control circuit as the liquid line solenoid in the frozen evaporator. When this circuit is energized (frozen compartment calling for Cool), the CPR bypass solenoid closes and causes the fresh evaporator suction gas to go through the CPR valve. This matches the capacity between the two compartments.
- The check valve keeps refrigerant from backing into the frozen evaporator when the frozen compartment is in Null and the fresh compartment is in the Cool.

Figure 49. Advanced Control System Module (Model 50 SPECTRUM Units)



1.	CPR Bypass Solenoid
2.	Compressor Pressure Regulator (CPR) Valve

Compressor Pressure Regulator Valve Setup Procedure

The following procedure is used to set the compressor pressure regulator valve when the unit is installed. It can also be used to check the compressor pressure regulator valve setting.

1. Install a gauge manifold set on the engine driven compressor.
2. Shut off the fresh compartment by raising its setpoint to the highest setting.
3. Start the unit on the engine driven compressor at 1800 to 2000 RPM.
4. Bring the frozen compartment to 5 to 7 F (3 to 4 C) above setpoint. Record the suction pressure and then shut the unit off.
5. Remove the CPR bypass solenoid coil and install a magnet (P/N 2041074) to close valve.
6. Raise the frozen compartment setpoint to the highest level and lower the fresh compartment setpoint to 35 F (2 C) and start the unit.
7. With the unit running, set the suction pressure to the recorded value from step 4 by adjusting the compressor pressure regulator valve. Once the suction pressure has been set, turn the unit off.
8. Remove magnet and reinstall the coil on the CPR bypass solenoid.
9. Remove the gauge manifold set.
10. Start the unit with both compartments set to desired setpoints and let the unit pull down.

Note: *The frozen compartment will pull down faster on first start up than the fresh compartment.*

Compressor Pressure Regulator Valve Replacement

Removal

1. Recover the refrigerant charge.
2. Remove the mounting hardware from the compressor pressure regulator valve.
3. Unsolder the compressor pressure regulator valve.

Installation

1. Clean the tubes for soldering.
2. Place the valve in position and solder the connection.
3. Install the mounting hardware.
4. Pressurize the system and test for leaks.
5. Evacuate and recharge the system.
6. Perform the “Compressor Pressure Regulator Valve Setup Procedure” above.

Accumulator

The accumulator is located in the accumulator module or in the advanced control system module, which are mounted on the back of an evaporator.

Removal

1. Recover the refrigerant charge.
2. Remove the mounting hardware from the accumulator.
3. Unsolder the accumulator and remove it from the accumulator module.

Installation

1. Clean the tubes for soldering.
2. Place the accumulator in position and solder the connections.
3. Install the mounting hardware.
4. Pressurize the system and test for leaks.
5. Evacuate and recharge the system.

Replacing Refrigerant Hoses (Speedy Clip System)

Refer to the Vehicle Powered Truck Installation Standards and Procedures Section 6 – Refrigerant Hose and Fittings Standards for service information about replacing refrigerant hoses.

Engine Driven Compressor Maintenance

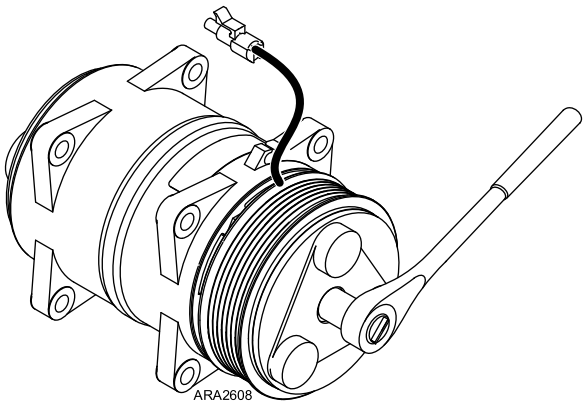
Compressor Failures

Whenever a compressor fails check the compressor speed to verify it is within our guidelines. If the compressor speed exceeds guidelines, a larger pulley needs to be install on the compressor. See Service Bulletin SB644 and the Vehicle Powered Truck Installation Standards and Procedures Section 5 – Compressor Selection and Installation Standards for detailed information.

Compressor Test

1. Rotate the compressor shaft by hand. It should rotate smoothly without catching or binding. If not, replace the compressor.

   Figure 50. Rotate Compressor Shaft

2. Spin the pulley with the clutch de-energized. The pulley should spin freely with no wobbling or roughness. If not, it should be replaced.
3. Check the clutch air gap. It should be 0.012-0.03 inches (0.3-0.8 mm). The clutch might not engage if the air gap is excessive. See Setting Clutch Air Gap later in this chapter for details.
4. Check the clutch coil resistance. See the Specifications chapter for the coil resistance.
5. Check for voltage between the CLU (or CLU1 depending on your unit) wire at the compressor clutch and the compressor body when the unit is in Cool and the compressor should be running. A minimum of 11.5 Vdc should be present. If not, check the CLU circuit back to the ECM and fuse F5. Also check that there is good continuity between the compressor body and the chassis ground (CH).

   Note: *The engine driven compressor must be equipped with a ground strap when installed. Refer to Ground Strap Installation in Section 5 – Compressor Selection and Installation Standards of the Vehicle Powered Truck Installation Standards and Procedures TK 56430 for detailed information about the ground strap.*
6. Check the compressor discharge pressure. A good compressor should be able to raise the discharge pressure to 200 psig (1379 kPa) for R-134a, or 350 psig (2413 kPa) for R-404A/R-452A, with the condenser covered.

   Important: *This test must be performed with a full system charge. Confirm the system is fully charged before proceeding.*

   a. Install a gauge manifold set on the compressor being tested.
   b. Set thermostat on the lowest setting.
   c. Start and run the unit in Cool with the compressor being tested.
   d. Cover the condenser to raise the discharge pressure.
   e. A good compressor should be able to raise the discharge pressure to the following:
      - R-134a: 200 psig (1379 kPa)
      - R-404A/R-452A: 350 psig (2413 kPa)

Important: *This test should only be run for a short time. Shut the system down immediately once the target pressure is reached.*

Engine Driven Compressor Belt and Pulleys

Correct pulley alignment and proper belt tension are very important factors in compressor installation. The compressor clutch must be perfectly aligned with the engine pulley and any auxiliary idler or belt adjustment pulley components. Check the pulley and belt alignment by referring to “Belt Alignment” in Section 5 of the Vehicle Powered Truck Installation Standards and Procedures TK 56430. Double check by making sure the belt goes from pulley to pulley in perfect alignment with no indication of a sideward bend.

Adjust the belt tension to vehicle manufacturer specifications. Check the belt tension again after 36 to 48 hours of initial operation of the unit because the belt may stretch slightly during the first hours of use. Remember, good alignment and proper belt tension ensure long belt life

Structural Maintenance

Condenser and Evaporator Coils

Clean the coils during scheduled maintenance inspections. Remove any debris (e.g., leaves or plastic wrap) that reduces the air flow. Clean dirty coils as described in Coil Cleaning Recommendations below. Be careful not to bend the fins when cleaning a coil. Repair bent fins and any other noticeable damage.

NOTICE

Equipment Damage!

The air pressure should not be high enough to damage coil fins.

Coil Cleaning Recommendations

Cleaning Intervals

- The coils should be cleaned a Minimum of once a year.
- It is recommended that any time the unit is in for service or maintenance that the coils be inspected and cleaned if needed.
- The coil should be cleaned if there are visible accumulations that obstruct the view of the fins or tubes of the coil.
- The coils should be cleaned if there is debris imbedded in the tubes and fins.

The area and conditions in which the unit operates will dictate the cleaning intervals and method(s) needed.

Cleaning Methods

⚠ CAUTION

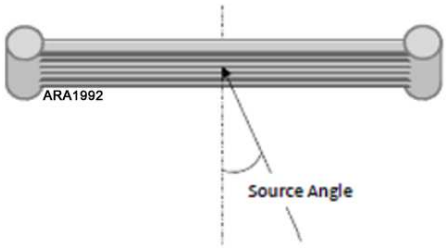
Sharp Edges!

Use extreme care when working with exposed coil fins. Contact with fins can cause painful lacerations. Use gloves while handling coils.

Note: *Listed in order of recommended method.*

- Take a cloth or towel and wipe the air side of the coil going with the fins, across the tubes. The coil will clean in a manner similar to the way lint cleans from the lint trap of a household clothes dryer.
- Use a soft bristled brush (DO NOT USE A WIRE BRUSH) and brush the coil going with the fins, across the tubes. The coil will clean in a manner similar to the way lint cleans from the lint trap of a household clothes dryer.
- A vacuum with a soft attachment can be used to suck the debris off the face as well as in the fins and tubes from the air side of the coil.
- Compressed air can be used and will work best when blown thru the coil from the non-air side when possible. Blowing thru from the airside may imbed debris in the coil that was only on the surface. It is recommended to start with one of the first three options before using compressed air if the non-air side is not accessible. The angle at which the air should be directed at the coil should not be less than 75 degrees.

Figure 51. Source Angle for Cleaning with Air



Chemicals to aid in cleaning WILL VOID WARRANTY and are NOT RECOMMENDED.

In some instances, it may take a combination of two methods to result in a clean coil. Such as, first wiping the coil to clean the surface and then using a vacuum or compressed air to clean down in the fins. This will depend on the type of debris that needs to be cleaned from the coil.

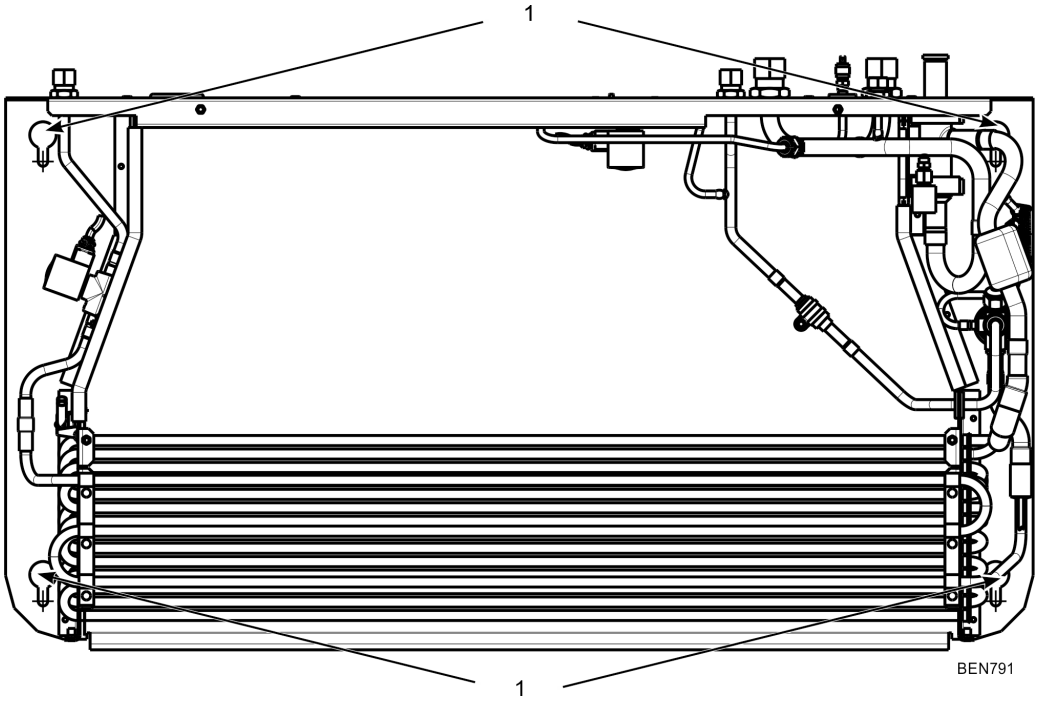
Do not contact the coil with any hard vacuum nozzle, air nozzle, or any other tool. This will damage the tubes of the coil.

Unit Mounting Bolts

Periodically check and torque the unit mounting bolts.

Figure 52. Evaporator

Figure 53. ES Evaporator Mounting Bolts (Cover Removed)



Over-the-Road Mechanical Diagnosis

CONDITION	POSSIBLE CAUSE	REMEDY
Unit turned On—In-Cab Control Box display does not come on	Vehicle ignition switch is not on	Turn the vehicle ignition switch on
	Vehicle Ignition Switch Fuse F22 blown	Check for short circuits and replace fuse
	Power Supply Circuit Fuse F1 blown	Replace fuse
	Dead or disconnected vehicle battery	Service the vehicle battery
	In-Cab Control Box harness disconnected or faulty	Check In-Cab Control Box harness and repair or replace
	In-Cab Control Box faulty	Repair or replace
	ECM faulty	Repair or replace
Unit turned On—In-Cab Control Box display comes on but unit does not operate	Battery Power Supply Fuse F21 blown	Check for short circuits and replace fuse
	Battery Power Relay faulty	Check Battery Power Relay
	Standby Power Relay faulty	Check Standby Power Relay
	Battery Disconnect Relay faulty	Check Battery Disconnect Relay
	Fuse F5 blown	Check for short circuits and replace fuse
	Compressor clutch faulty	Check compressor clutch
	ECM faulty	Repair or replace

Electric Standby Mechanical Diagnosis

CONDITION	POSSIBLE CAUSE	REMEDY
Unit turned On—In-Cab Control Box display does not come on	Unit not connected to Standby power or Standby power is turned off.	Connect power cord. Verify that the Electric Standby power is turned on and is the correct voltage.
	Transformer Input Fuse F23 blown	Check for short circuits and replace fuse
	Faulty transformer	Check transformer
	Faulty rectifier bridge	Check rectifier bridge
	Transformer Output Fuse F24 blown	Check for short circuits and replace fuse
	Power Supply Circuit Fuse F1 blown	Replace fuse
	In-Cab Control Box harness disconnected or faulty	Check In-Cab Control Box harness and repair or replace
	In-Cab Control Box faulty	Repair or replace
	ECM faulty	Repair or replace
Unit turned On—In-Cab Control Box display comes on but compressor motor does not run	No standby power to compressor motor	Provide power to unit; check power at: 1. Motor contactor hot side 2. Motor contactor load side (contactor closed) 4. Motor terminals
	Standby Power Relay faulty	Check Standby Power Relay
	Battery Disconnect Relay faulty	Check Battery Disconnect Relay
	Fuse F5 blown	Check for short circuits and replace fuse
	Compressor Motor Contactor faulty	Check Compressor Motor Contactor
	Open or faulty thermal motor protector	Determine cause and reset or thermal motor protector
	Compressor motor faulty	Check compressor motor
	ECM faulty	Repair or replace
Compressor motor hums but does not run	Locked rotor (overload relay will open after a period of time)	Remove interference or replace motor
	Locked compressor	Replace compressor
	Low line voltage or no voltage on one leg	Check power source for correct voltage, phase, and frequency. Bring voltage up to within 10% of motor rating
	Capacitor faulty	Check capacitors (on single phase units)
	Start Relay faulty	Check Start Relay (on single phase units)

Refrigeration Diagnosis

CONDITION	POSSIBLE CAUSE	REMEDY
Unit short cycles	Shortage of refrigerant (low pressure cutout)	Repair leak and recharge
	Restricted expansion valve	Clean expansion valve
	Refrigerant overcharge (high discharge pressure)	Remove excess charge
	Cycling on high discharge pressure	Check condenser air flow and fan
	Dirty condenser coil	Clean coil
	Defrost timer set too low for application.	Adjust timer to higher interval
Unit operates long or continuously	Shortage of refrigerant	Repair leak and recharge
	Dirty condenser	Clean condenser
	Air in system	Evacuate and recharge system
	Compressor inefficient	Replace compressor
	Plugged expansion valve	Clean expansion valve
	Iced or plugged evaporator coil	Defrost or clean coil
	Defective truck body insulation	Correct or replace
	Too many door openings	Keep doors closed, install plastic curtains
	Load too warm	Precool hot product
	Door seals worn	Repair/replace
	Excessive superheat at expansion valve	Adjust superheat
	ECM faulty	Repair or replace
Box temperature too high	Thermostat setpoint too high	Reset thermostat
	Refrigerant shortage	Repair leak and recharge
	Expansion valve or strainer plugged	Clean or replace
	Restricted lines	Clean restriction. Tubing pinched shut
	Hot load	Precool hot product
	Expansion valve superheat too high or too low	Adjust superheat
Head pressure too high	Refrigerant overcharge	Remove excess
	Air in system	Evacuate and recharge system
	Dirty condenser	Clean
	Restricted condenser	Clean condenser
	Condenser fan not running	Check fan motor
	Condenser fan rotation	Check fan motor polarity
	Restricted dehydrator	Replace
Head pressure too low	Refrigerant shortage	Repair leak and recharge
	Expansion valve or strainer plugged	Clean or replace
	Compressor inefficient	Replace compressor

CONDITION	POSSIBLE CAUSE	REMEDY
Noisy unit	Insufficient compressor oil	Add oil to proper level
	Mounting bolts loose	Tighten
	Refrigerant flooding back	Adjust oil level or refrigerant charge. Check expansion valve for proper superheat
Compressor loses oil	Shortage of refrigerant	Repair leak and recharge
	Plugged expansion valve or strainer	Clean expansion valve
	Wrong oil viscosity	Use proper oil
	Short cycling	Refer to unit "short cycling"
	Superheat too high	Adjust expansion valve
Frosted or sweating suction line	Expansion valve set too low, admitting excess refrigerant	Adjust expansion valve
Hot liquid line	Shortage of refrigerant	Repair leak and recharge
	Condenser fan not running	Check fan motor
	Dirty condenser coil	Clean condenser
Frosted liquid line	Restricted dehydrator	Replace
Condenser coil is cool when unit is in cool operation	Refrigerant undercharge	Repair leak and recharge
	Compressor inefficient	Replace compressor
Unit in vacuum, frost on expansion valve only	Ice plugging expansion valve orifice	Apply hot wet cloth to expansion valve. Moisture indicated by increase in suction pressure. Replace drier
	Plugged expansion valve strainer	Clean strainer
	Sensor bulb lost charge	Replace expansion valve

Refrigeration Diagnosis Chart

Unit Not Heating (Model 30/50)	Rapid cycling	Unit cools in defrost cycle	High head pressure	Low head pressure	No head pressure	High suction pressure	Low suction pressure	No suction pressure	Unit operating in vacuum	Sight glass / empty	Suction line frosting back	Noisy compressor	Unit not refrigerating	Unit not 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
	•														Air short cycling around evaporator coil
							•		•	•	•				Air through evaporator restricted
							•		•	•	•	•	•		Evaporator needs defrosting
					•								•		Broken/loose engine driven compressor belt
				•											Compressor discharge valves leaking
							•					•	•		Too much compressor oil in system
												•			Compressor bearing loose or burned out
				•		•						•	•		Broken valve plate in compressor
							•		•				•		Expansion valve power element lost its charge
						•					•		•		Expansion valve feeler bulb improperly mounted
						•					•		•		Expansion valve feeler bulb making poor contact
						•				•	•				Expansion valve open too much
							•						•		Expansion valve closed too much
						•					•				Expansion valve needle eroded or leaking
				•			•		•				•		Expansion valve partially closed by ice, dirt or wax
						•					•	•	•		Liquid refrigerant entering compressor
							•		•				•		Restricted line on the low side
			•				•		•				•		Restricted line on the high side
			•				•		•				•		Restricted dehydrator
•		•											•	•	Loose or broken electrical connections

Unit Not Heating (Model 30/50)	Rapid cycling	Unit cools in defrost cycle	High head pressure	Low head pressure	No head pressure	High suction pressure	Low suction pressure	No suction pressure	Unit operating in vacuum	Sight glass / empty	Suction line frosting back	Noisy compressor	Unit not refrigerating	Unit not defrosting	SYMPTOM POSSIBLE CAUSES
			•												Condenser fan motor not operating
•							•		•		•	•	•		Evaporator fan motor not operating
	•		•	•			•				•		•		Reverse fan rotation
•		•											•	•	Faulty Hot Gas Solenoid
•													•	•	Faulty Condenser Inlet Solenoid
						•						•			Faulty Liquid Injection Solenoid
						•	•					•			Faulty CPR Bypass Solenoid
•														•	Faulty Liquid Line Check Valve
•							•						•	•	Faulty Liquid Line Solenoid (SPECTRUM Units)

Diagram Index

The following table lists the diagrams that are relevant to these units.

The diagrams are available on TSA Info Central and in the V-520 Series Diagrams Manual TK 56674-18-DM.

Drawing No.	Drawing Title
2E54898	V-520 10/30, V-520 MAX 10/30 Schematic Diagram
2E54899	V-520 10/30, V-520 MAX 10/30 Wiring Diagram
2E54900	V-520 20/50 1PH, V-520 MAX 20/50 1PH Schematic Diagram
2E54901	V-520 20/50 1PH, V-520 MAX 20/50 1PH Wiring Diagram
2E54902	V-520 20/50 3PH, V-520 MAX 20/50 3PH Schematic Diagram
2E54903	V-520 20/50 3PH, V-520 MAX 20/50 3PH Wiring Diagram
1E49423	V-520 MAX 10 SPECTRUM Schematic Diagram
1E49424	V-520 MAX 10 SPECTRUM Wiring Diagram
1E49440	V-520 MAX 20 SPECTRUM 1PH Schematic Diagram
1E49441	V-520 MAX 20 SPECTRUM 1PH Wiring Diagram
1E49442	V-520 MAX 20 SPECTRUM 3PH Schematic Diagram
1E49443	V-520 MAX 20 SPECTRUM 3PH Wiring Diagram
1E53769	V-520 MAX 20 SPECTRUM 3PH, 50/60 Hz Wiring Diagram
2E54904	V-520 MAX 50 SPECTRUM 1PH Schematic Diagram
2E54905	V-520 MAX 50 SPECTRUM 1PH Wiring Diagram
2E54906	V-520 MAX 50 SPECTRUM 3PH Schematic Diagram
2E54907	V-520 MAX 50 SPECTRUM 3PH Wiring Diagram

Notes

Thermo King – by Trane Technologies (NYSE: TT), a global climate innovator – is a worldwide leader in sustainable transport temperature control solutions. Thermo King has been providing transport temperature control solutions for a variety of applications, including trailers, truck bodies, buses, air, shipboard containers and railway cars since 1938. For more information, visit www.thermoking.com or www.tranetechnologies.com.

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