THERMO KING

Refrigeration Procedures

Truck and Trailer Edition

Diagnosing Thermo King Refrigeration Systems

Revision A

March 2018

TK 5984-7-RP-EN

TRANE TECHNOLOGIES

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 Corporation 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.

Recover Refrigerant

Note: *In the USA, EPA Section 609 Certification is required to work on motor vehicle air conditioning systems (MVAC).*

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.

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Safety

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.

⚠ DANGER	Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.
⚠ WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
⚠ CAUTION	Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury and unsafe practices.
NOTICE	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!

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.

⚠ 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.

⚠ DANGER

Confined Space Hazards!

Avoid engine operation in confined spaces and areas or circumstances where fumes from the engine could become trapped and cause serious injury or death.

⚠ 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 when working on a unit. Refrigerant liquid, oil, and battery acid can permanently damage your eyes. See “First Aid”.

⚠ 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.

⚠ WARNING

Strong Magnetic Field!

Separation of the generator and its stator during disassembly will create a strong magnetic field that can interfere with cardiac implants such as pacemakers and defibrillators.

⚠ CAUTION

Sharp Edges!

Exposed coil fins can cause lacerations. Service work on the evaporator or condenser coils is best left to a certified Thermo King technician.

NOTICE

Equipment Damage!

All mounting bolts must be the correct length for their applications and torqued to specification. Incorrect bolt lengths and improper torque specifications can damage equipment.

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.

- **Conventional Batteries**

⚠ 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.

- **Lithium Ion Batteries**

⚠ WARNING

Personal Protective Equipment (PPE) Required!

A battery can be dangerous. Lithium Ion batteries are potentially hazardous and can present a serious FIRE HAZARD if damaged, defective or improperly used. A battery stores enough electricity to burn you if it discharges quickly. Always wear goggles or safety glasses and personal protective equipment when working with a battery. Do not replace the battery with any type other than the one approved by Thermo King for this unit.

⚠ 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 unit from starting unexpectedly and causing personal injury.

NOTICE

Equipment Damage!

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

Battery Removal

⚠ WARNING

Hazard of Explosion!

When removing battery cables, ALWAYS disconnect the negative battery terminal first. Then remove the positive terminal. When reconnecting the battery terminals, connect the positive terminal (+) first, and connect the negative (-) terminal last.

This order is important because the frame is grounded to the negative battery terminal. If the negative terminal is still connected, a complete circuit exists from the positive terminal of the battery to the frame. Metal objects contacting the positive side and the frame simultaneously will cause sparks or arcing. If there are sufficient hydrogen gases emitted from the battery, an explosion might occur, causing equipment damage, serious injury, even death.

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.

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.

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

Important: *All Precedent units utilize nominal 230 Vac power supplied from the diesel engine driven generator to operate the condenser fans and evaporator blower when the unit is operating in Diesel Mode.*

Important: *Do not move the vehicle if the power cable or the electric standby icon is illuminated.*

⚠ DANGER

Hazardous Voltage!

Lethal amounts of voltage are present in some electrical circuits. Use extreme care when working on an operating refrigeration unit.

⚠ DANGER

Hazardous Voltage!

Dangerous three phase AC electric power is present whenever the unit is operating in either Diesel Mode or Electric Mode and whenever the unit is connected to a source of external standby power. Voltages of this magnitude can be lethal. Exercise extreme caution when working on the unit.

⚠ DANGER

Hazardous Voltage!

Dangerous three phase AC electric power is present whenever the unit is operating in either Diesel Mode, Electric Mode or Holdover Mode and whenever the unit is connected to a source of external standby power. Voltages of this magnitude can be lethal. Exercise extreme caution when working on the unit.

⚠ WARNING

Hazardous Voltage!

Units featuring optional Electric Standby utilize 460, 400, or 230 volt 3 phase AC electrical power any time the unit is operating in Electric Mode. This voltage potential is also present any time the unit is connected to a source of external standby power. Extreme care must be used when working on the unit, as these voltages are capable of causing serious injury or death.

⚠ WARNING

Hazardous Voltage!

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

⚠ WARNING

Risk of Injury!

On SmartPower electric standby equipped units, the power supply voltage and vehicle voltage requirements must be the same before connecting the electric standby power cable. Refer to the electric standby voltage label located near the vehicle power connector.

⚠ WARNING

Risk of Injury!

On SmartPower electric standby equipped units, always turn off the external standby power source before handling, connecting, or disconnecting the power cable. Always disconnect the standby power cord before servicing the unit.

⚠ 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.

⚠ 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.

⚠ WARNING

Personal Protective Equipment (PPE) Required!

Safety glasses, rubber-insulated gloves, and cable cutters should be near your work area in the event of an electrical accident.

⚠ 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 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.

Low Voltage

Important: *Some components are connected directly to un-switched battery power. All connections and circuits labeled with a “2” prefix are connected directly to battery power. Always disconnect the battery before servicing the unit.*

⚠ WARNING

Live Electrical Components!

Control circuits used in refrigeration units are low voltage (12 to 24 volts dc). 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.

Microprocessor Service Precautions

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

Observe the following precautions when servicing a microprocessor control system to avoid damaging electronic components. Refer to the appropriate microprocessor diagnosis manual for more information.

- If the microprocessor has a power 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’s ground terminal. 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 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. Disconnect the ECU and the battery charger if so equipped.
- 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.

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

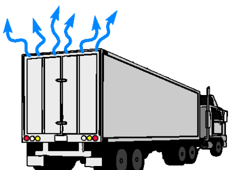
Move victim to fresh air and use Cardio Pulmonary Resuscitation (CPR) or mouth-to-mouth resuscitation to restore breathing, if necessary. Stay with victim until emergency personnel arrive.

Diagnostics and Service Tools

Non-Mechanical Cooling Problems

Excess Cooling Load

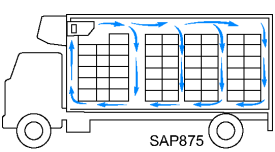
1. Open doors
2. Air leaks in trailer
3. Trailer wall damage
4. Product loaded warm
5. Damaged, deteriorated insulation
6. Trailer insulation saturated with moisture



SAP874

Incorrect Air Circulation

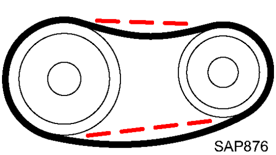
1. Air must circulate freely over, under, around, and through the load.
2. Improper loading can prevent effective load temperature control.



SAP875

Incorrect Belt Tension

1. Slipping belts will reduce air flow and unit capacity.

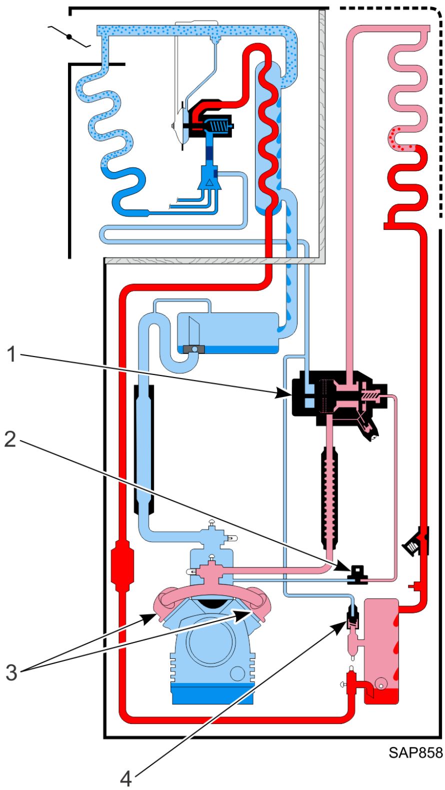


SAP876

Internal Seal Points (Trailer Unit Three-Way Valve System)

Refrigeration Cycle

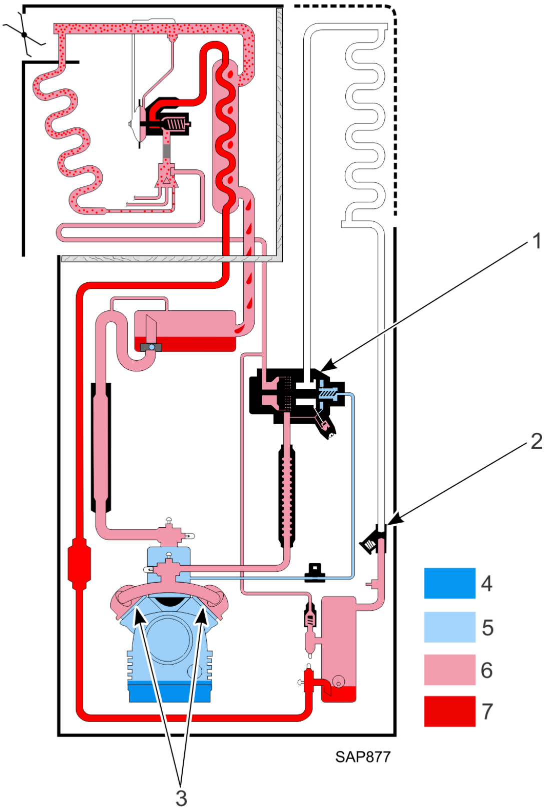
Thermo King three-way valve system showing the pressure separation points on **COOL** refrigeration cycle.



1.	Evap Side of Three-Way Valve	3.	Comp Valve Plates and Piston Reeds
2.	Pilot Solenoid	4.	Bypass Check Valve

Heat/Defrost Cycle

Thermo King three-way valve system showing the pressure separation points on **HEAT/DEFROST** refrigeration cycle.



1.	Cond Side of Three-Way Valve	5.	Low Pressure Vapor
2.	Condenser Check Valve	6.	High Pressure Vapor
3.	Comp Valve Plates and Piston Reeds	7.	High Pressure Liquid
4.	Low Pressure Liquid		

Normal System Pressures Refrigeration Cycle

1. Operate the unit in high speed cool.
2. Maintain discharge pressure for 100°F (38°C)38°C ambient.

3. Maintain box temperature near 35°F (2°C) or 0°F (-18°C)2°C or -18°C.
4. Compare unit suction pressure with normal expected readings. Determine if it is higher or lower than expected normal pressures.
5. Check the suction line at the accumulator. A cool, moist line is normal. A frosted or abnormally dry line and out-of-range pressures indicate refrigeration problems.

The table below gives approximate suction and discharge pressure for common refrigerants with a 0°F (-18°C) or 35°F (2°C)-18°C or 2°C box temperature and 100°F (38°C)38°C ambient temperatures.

Table 1. Refrigerant Type and Recommended Pressures

Refrigerant Type	Suction Pressure PSIG 32°F (2°C) Box	Discharge Pressure PSIG 35°F (2°C) Box	Suction Pressure PSIG 0°F (-18°C) Box	Discharge Pressure PSIG 0°F (-18°C) Box
R-134a	5–12	180–200	0–1	160–175
R-401B (MP 66)	10–16	220–240	3–8	190–200
R-402A (HP 80)	18–25	335–360	10–20	305–340
R-404A (Hp 62) (FX 70)	20–25	320–340	12–20	290–310
R-452A	20–25	320–340	12–20	290–310

Table 2. Refrigerant Type and Recommended Pressures

Refrigerant Type	Suction Pressure PSIG 2°C Box	Discharge Pressure PSIG 2°C Box	Suction Pressure Bar 2°C Box	Discharge Pressure Bar 2°C Box
R-134a	5–12	180–200	0.3–0.8	12.2–13.6
R-401B (MP 66) CUT OUT	10–16	220–240	0.7–1.1	15.0–16.3
R-402A (HP 80) CUT OUT	18–25 (*)	335–360	1.2–1.7 (*)	22.8–24.5
R-404A (Hp 62) (FX 70)	20–25 (*)	320–340	1.4–1.7 (*)	21.8–23.1
R-452A	20–25 (*)	320–340	1.4–1.7 (*)	21.8–23.1

Table 3. Refrigerant Type and Recommended Pressures

Refrigerant Type	Suction Pressure PSIG -18°C Box	Discharge Pressure PSIG -18°C Box	Suction Pressure Bar -18°C Box	Discharge Pressure Bar -18°C Box
R-134a	0–1	160–175	0.0–0.1	10.9–11.9
R-401B (MP 66) CUT OUT	3–8	190–200	0.2–0.5	12.9–13.6
R-402A (HP 80) CUT OUT	10–20	305–340	0.7–1.4	20.8–23.1
R-404A (Hp 62) (FX 70)	12–20	290–310	0.8–1.4	19.7–21.1
R-452A	12–20	290–310	0.8–1.4	19.7–21.1

Control condenser air flow to maintain condenser temperature near 100°F (38°C)38°C ambient while reading either discharge or suction pressure.

Suction pressure is most accurate when it is below the influence of the throttle valve or ETV. For greatest accuracy, suction pressure on units with high pressure refrigerant must be taken with a box temperature at 0°F (-18°C)-18°C. Examples of high pressure refrigerants are R-402A, R-404A, and R-452A.

Units with modulation may have suction pressure affected by the modulation valve or ETV. This occurs while operating near setpoint with a box temperature above 24°F (-4°C)-4°C.

Primary System Evaluation

LOW SUCTION PRESSURE - FROSTED LINE

Basic Problem: Insufficient Evaporator Air Flow

1. Evaporator coil iced.
2. Evaporator air flow restricted (Dirt, bags, loose belts, damper door closed, plugged air inlets, etc).
3. Evaporator fan motor or belt failure.

LOW SUCTION PRESSURE - UNFROSTED LINE

Basic Problem: Insufficient Refrigerant Flow

1. Low refrigerant charge.
2. Expansion valve screen restricted.

3. Restricted drier or liquid line.
4. Expansion valve restricted or defective.
5. Expansion valve adjusted too far closed (low superheat).
6. Restricted throttling valve. Pressure measured at gauge port of throttling valve below the influence of the valve.
7. Frozen expansion valve.
8. Modulation valve or ETV closed or partially closed (units with modulation).
9. Defective Transducers.

HIGH SUCTION PRESSURE - FROSTED LINE

Basic Problem: High Pressure Internal Liquid Leak to Low Side

1. Poor expansion valve bulb contact with suction line or bulb not insulated with cork insulation tape.
2. Expansion valve adjustment too far open (high superheat).
3. Internal heat exchanger leak.
4. TherMax solenoid leaking (if equipped).

HIGH SUCTION PRESSURE - UNFROSTED LINE

Basic Problem: High Pressure Internal Vapor Leak to Low Side

1. Three-way valve evaporator seat leaks to the low side.
2. Leaking bypass check valve.
3. Compressor valve plates leak.
4. Compressor piston or cylinder wear.
5. Compressor piston reeds leak.
6. Hot Gas Bypass Valve leak (units with modulation or ETV).
7. Low compressor RPM.

Conditions That Can Cause High Discharge Pressure:

1. Air or non-condensables in system.
2. Restricted air flow across condenser (Dirty condenser fins, etc).
3. A restriction in the high pressure line between the compressor and the receiver tank.
4. Overcharge of refrigerant during warm ambients.
5. Fan drive belt slippage.
6. Incorrect refrigerant.

7. High ambient temperature.
8. High box temperature.

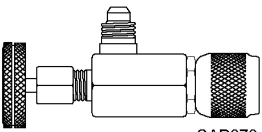
Conditions That Can Cause Low Discharge Pressure:

1. Low refrigerant charge.
2. Low suction pressure.
3. Worn compressor.
4. Cold ambient temperature.
5. Incorrect refrigerant.
6. Low box temperature.
7. Low compressor RPM.

Refrigeration System Access Tools

Access Valve Actuator (TK 204-625)

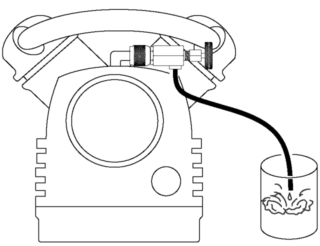
Use the access valve actuator to remove refrigerant or oil from 1/4 inch male flare fittings.



SAP878

Compressor Oil Sample

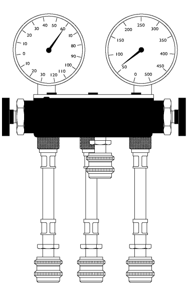
Taking a compressor oil sample into a clear container to examine color.



SAP879

Gauge Manifold

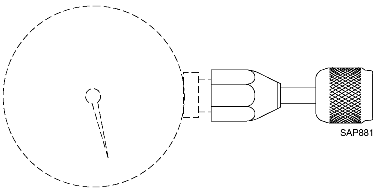
Always use low loss fittings with the gauge manifold to minimize refrigerant loss to the atmosphere.



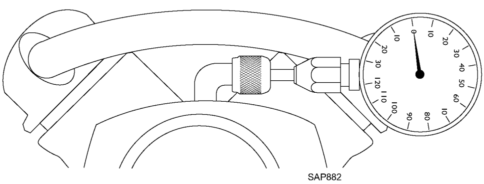
SAP880

Gauge Adapter Fitting (TK 204-626)

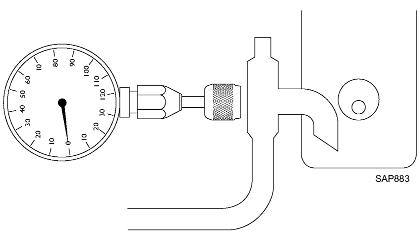
Use the gauge adapter fitting with pressure gauges to read pressures with minimal refrigerant or oil loss.



Compressor Oil Pressure

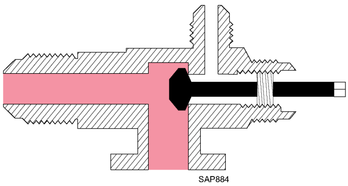


Receiver Tank Pressure

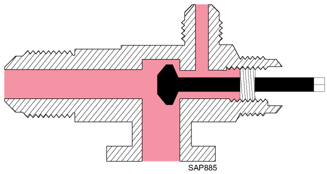


Compressor Service Valves

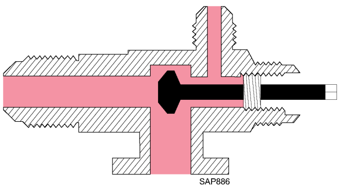
Full Out - Valve Back Seated



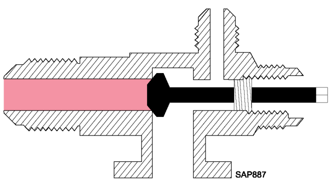
"Cracked" - Open to Service Port



In 1/2 Way - Valve Mid Seated



Full In - Valve Front Seated



Note: *Service valve stems and service ports must be properly capped and torqued with seals or O-rings installed. STEMS AND PORTS NOT PROPERLY CAPPED WILL LEAK REFRIGERANT.*

Gauge Manifold

Installation and Purging with Low Loss Fittings

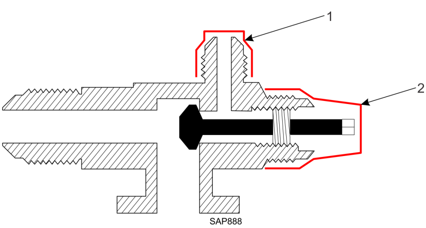
Purpose: To properly install gauges with low loss fittings.

1. Remove both the discharge and suction service valve stem caps. Save and re-use the caps and sealing washers or gaskets.
2. Verify both service valves are back seated.
3. Remove the service port caps for both the suction and discharge service valves. Save and re-use the caps and sealing washers or gaskets.
4. Attach the high pressure gauge line to the discharge service port and secure the line fitting finger tight.
5. Turn the discharge service valve stem 1/4 turn to open the service port.

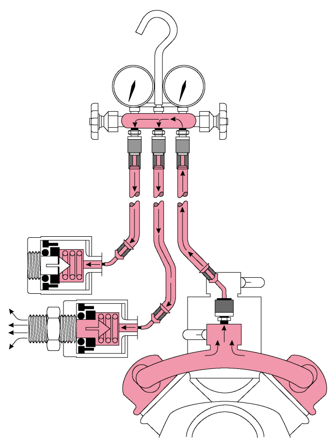
6. Open both manifold hand valves. System pressure should display on both gauges.
7. Slowly screw a 1/4 inch flare fitting into the center service line low loss fitting, 1-2 seconds, to purge the service line. Remove the flare fitting after purging. Secure line to manifold hose anchor.
8. Slowly screw a 1/4 inch flare fitting into the manifolds low pressure line low loss fitting to purge the line. Remove the flare fitting after purging.
9. Install the manifolds low pressure line on the suction service valve service port. Mid seat the suction service valve stem.
10. Close both gauge manifold hand valves.

Note: *These gauges may be removed and re-installed on the same unit without additional purging if a slight positive pressure remains in the manifold and lines.*

Service Valve



1. Service Port Cap
2. Stem Cap

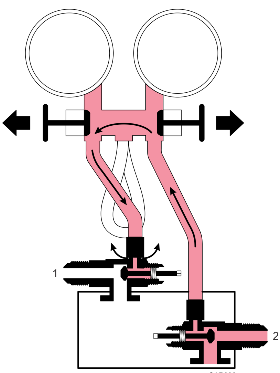


Installation without Low Loss Fittings

Purpose: To properly install gauges without low loss fittings.

1. Remove both the discharge and suction service valve stem caps. Save and re-use the caps and sealing washers or gaskets.
2. Verify both service valves are back seated.
3. Remove the service port caps for both the suction and discharge service valve. Save and re-use the caps and sealing washers or gaskets.

4. Attach the **high** pressure line to the discharge service port and secure the line fitting finger tight.
5. Attach the **low** pressure gauge line to the suction service port. Leave the fitting loose.
6. Turn the discharge service valve stem 1/4 turn (CW) to open the service port.
7. Open both manifold hand valves and purge the gauge manifold toward the suction service valve. Secure the low pressure line to the suction service port finger tight.
8. Purge the center manifold service line, then tighten the line fitting to the manifold hose anchor.
9. Close the manifold hand valves.
10. Mid seat the Suction Service Valve (SSV) stem.



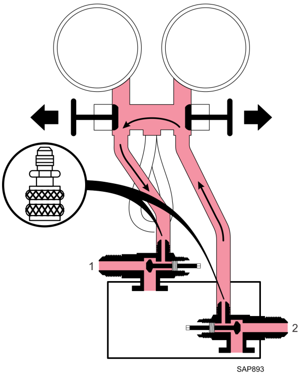
1.	Suction Service Valve (SSV)
2.	Discharge Service Valve (DSV)

Use the Gauge Manifold to:

- Verify unit operating condition.
- Test for internal high to low side leaks.
- Service the refrigeration system.

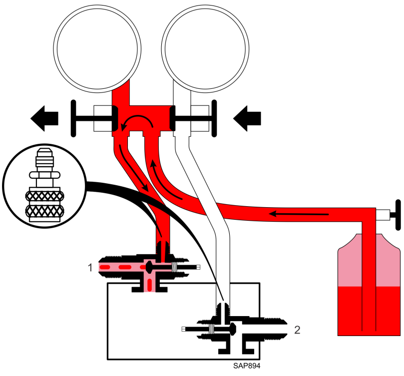
The gauges indicate high and low system pressure.

Figure 1. Balance System Pressures



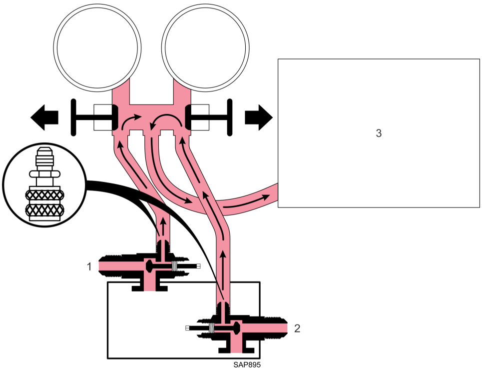
1.	Suction Service Valve (SSV)
2.	Discharge Service Valve (DSV)

Figure 2. Adding Refrigerant to an Operating, Partially Charged Unit



1.	Suction Service Valve (SSV)
2.	Discharge Service Valve (DSV)

Figure 3. Recover Refrigerant and Evacuate System



1.	Suction Service Valve (SSV)
2.	Discharge Service Valve (DSV)
3.	Recovery Machine

Removing the Gauge Manifold

Purpose: To properly remove gauges and minimize the loss of refrigerant.

Note: *For units with scroll compressors, refer to (**"Gauge Removal," p. 72**).*

1. Operate the unit in the cool mode.
2. Back seat the discharge service valve stem.
3. Open both manifold hand valves.
4. Front seat the suction service valve and pump down the compressor to a 20 inch (0.6 bar) vacuum.
5. Turn the unit off.
6. Establish compressor crankcase pressure between 1 to 3 psig (.06 to 0.2 bar) by momentarily cracking open either the Suction Service Valve (SSV) or the Discharge Service Valve (DSV).
7. Remove the gauge line from the suction service valve and cap the service port.
8. Remove the gauge line from the discharge service valve and cap the service port.
9. Back seat the suction service valve and cap the valve stem.

10. Cap the discharge service valve stem.
11. Secure all manifold lines to manifold hose anchors when the manifold is not in use.

Service Procedures

Quick Refrigerant Level Check

Purpose: To identify units that have recently developed a leak and have lost refrigerant.

1. Operate the unit on high speed cool 5 to 10 minutes.
2. Refrigerant should be present in the sight glass.
3. If the sight glass is empty, cover the condenser and operate the unit in high speed cool for 1 to 3 minutes.
4. Check the receiver tank sight glass:
    a. If refrigerant is visible in sight glass - charge is sufficient for present box temperature.
    b. If no refrigerant is visible in the sight glass - unit may have a leak and lost charge. Refer to “Controlled Refrigerant Level Check,” p. 37.

Controlled Refrigerant Level Check

Purpose: To check a unit for the recommended charge.

1. Install a calibrated gauge manifold.
2. Operate the unit in high speed cool.
3. Maintain a 0°F (-18°C)-18°C box temperature.
4. Cover the condenser as required to maintain discharge pressure equivalent for 100°F (38°C)38°C ambient. To confirm refrigerant type and recommended pressures, refer to (Table 1, p. 25Table 2, p. 25 and Table 3, p. 26).
5. Suction pressure should be near the approximate pressure shown in the table for a 0°F (-18°C)-18°C box.
6. Liquid refrigerant should be visible in the receiver tank sight glass when the unit is sufficiently charged.
7. If refrigerant needs to be added, refer to “Adding Refrigerant To a Partially Charged, Operating Unit,” p. 38.

    Note: *If the ball drops and cooling is reduced before a 0°F (-18°C)-18°C box temperature can be reached, the unit probably has a low charge. A low charge is probably caused by a refrigerant leak that must be repaired.*

Important: *Operating a unit will less than a full charge or with an overcharge can cause major compressor damage. Always leak check , repair, and properly check the refrigerant charge before returning a unit to service.*

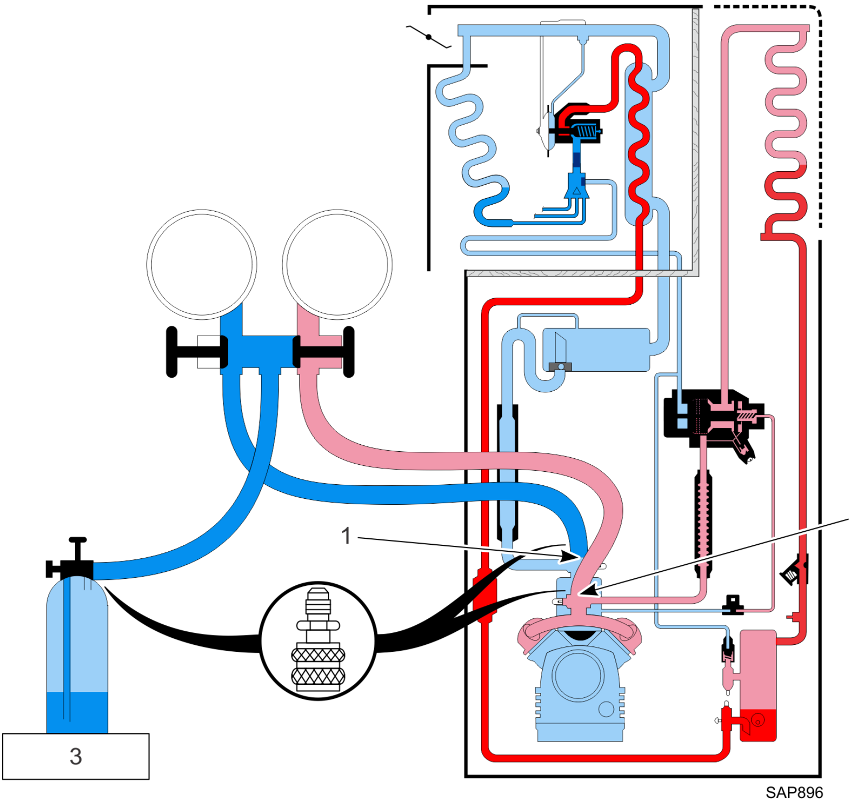
Adding Refrigerant To a Partially Charged, Operating Unit

PURPOSE: To add refrigerant to a unit low on charge.

1. Install a calibrated gauge manifold.
2. Verify SSV is mid-seated and gauge manifold hand valves are closed.
3. Attach the manifold service line to the refrigerant bottle and purge the line from the bottle to the manifold.
4. Set the refrigerant bottle to withdraw liquid refrigerant .
5. Operate the unit in high speed cool:
   - Maintain discharge pressure for 100°F (38°C)38°C ambient.

     R-404A/R-452A = 325 psig (22.1 bar)

     R-134a = 190 psig (12.9 bar)
   - Observe suction pressure. Refer to (Table 1, p. 25Table 2, p. 25 and Table 3, p. 26).
6. Open the gauge manifold low pressure hand valve only enough to permit suction pressure to increase approximately 25 psig (1.7 bar) above noted suction pressure. This will meter liquid refrigerant slowly into the low side.
7. Maintain the discharge pressure and add liquid refrigerant until it appears in the receiver tank sight glass.
8. When liquid refrigerant appears in the receiver tank sight glass enough that the ball starts to move, the unit has enough refrigerant to operate at the present box temperature.
9. Close valve on refrigerant tank.
10. Remove gauges and reinstall valve caps.



1.	Suction Service Valve (SSV)
2.	Discharge Service Valve (DSV)
3.	Scale

Overcharge Test

NOTICE

System Damage!

Do not overcharge the unit or damage to the system will result. If an overcharge is suspected, perform the Overcharge Test.

Purpose: To check a unit suspected to be overcharged.

1. Install a calibrated gauge manifold.
2. Operate the unit in high speed cool for five minutes or more to reduce box temperature to 60°F (16°C)16°C or cooler. **If the sight glass is full and the ball is at the top of the sight glass, the unit may be overcharged.**
3. Observe the discharge pressure. Cover the condenser and increase discharge pressure 75 to 100 psig (5.1 to 6.8 bar).
4. If the ball drops, the unit is not overcharged. Test need not be continued.
5. Remove the condenser cover to rapidly reduce the discharge pressure.
6. Observe the sight glass and discharge pressure.
7. The ball should move and the liquid level begin to drop by the time the discharge pressure drops to 50 psig (3.4 bar).

   Note: *The ball and liquid level will rise when discharge pressure stabilizes.*
8. If the ball will not move or liquid level will not drop, the unit likely has an overcharge. Recover refrigerant, evacuate, dehydrate, and weigh in a new charge. Refer to “Adding Refrigerant By Weight to an Evacuated, Non-Operating Unit,” p. 40.

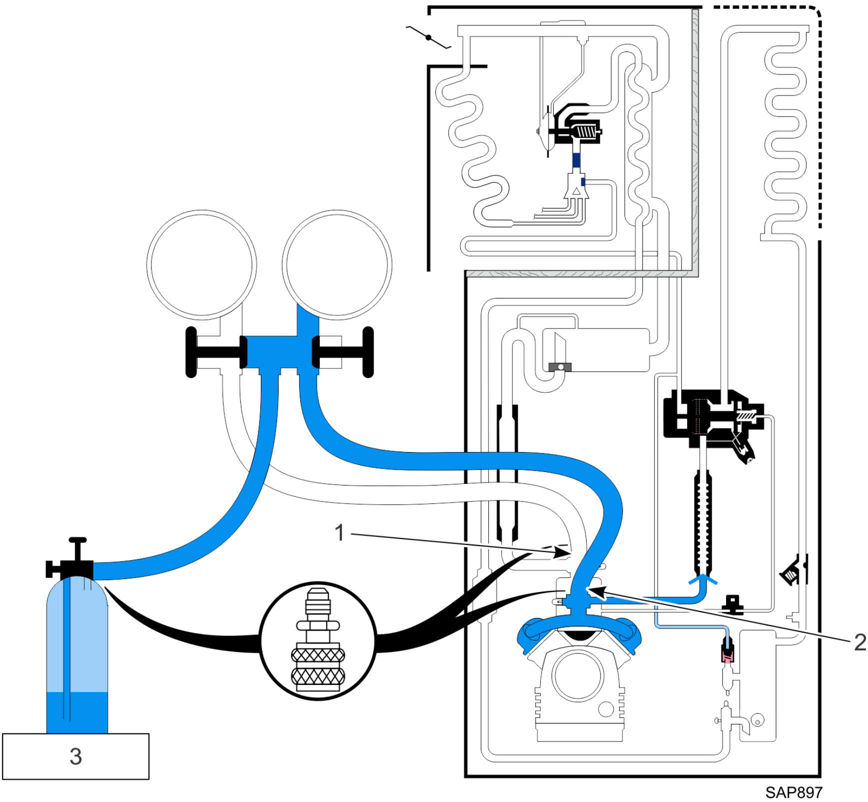
Adding Refrigerant By Weight to an Evacuated, Non-Operating Unit

Note: *The unit should be kept off when performing these procedures.*

1. Install a calibrated gauge manifold.
2. Recover the refrigerant and evacuate the system.
3. Place the refrigerant bottle on a scale and attach the manifold service line.
4. Purge air from the service line from the tank toward manifold. Open the bottle to withdraw liquid.
5. Record the total refrigerant and container weight.
6. Check the unit serial plate or unit Maintenance Manual for refrigerant weight required.
7. Mid seat the compressor discharge service valve.
8. Open the discharge hand valve all the way on the gauge manifold and begin charging the unit. Refrigerant flow can be felt as small pulsations on the manifold service line.

9. Watch the scale and close the hand valve at the refrigerant bottle when the correct charge weight has been added.

   Note: *If refrigerant flow stops before charging is complete, refer to* *"Adding Refrigerant To a Partially Charged, Operating Unit," p. 38.*



1.	Suction Service Valve (SSV)
2.	Discharge Service Valve (DSV)
3.	Scale

Unit Performance Field Test

Purpose: This field test determines whether a unit is performing up to standards. To complete the test, prepare the unit, measure the temperature difference of air passing through the evaporator and calculate the unit capacity.

1. Clean evaporator and condenser coils.
2. Check and/or adjust compressor RPM.
3. Check refrigerant charge. It must be full.
4. Check the compressor. It must pass the compressor capacity test.
5. Locate calibrated thermometer sensors in the evaporator inlet and outlet air stream or use return and discharge air sensors.
6. Locate unit CFM. Use TK 2671, TK marketing literature, or the Temperature Control System Reference Guide.
7. Stabilize box temperature near 35°F (2°C) or 0°F (-18°C) and measure the temperature change.
8. To determine capacity, use formula: **TD x CFM x K = Btu’s**

   TD = Evaporator Temperature Difference

   CFM = Evaporator Cubic Feet of Air Per Minute

   K = Constant based on box temperature

   K = 1.24 at 0°F (-18°C)

   K = 1.15 at 35°F (2°C)
9. Compare calculated capacity with published capacity. It should be within approximately 5 to 10 percent of specifications.

   A unit that can achieve 10 to 15 Evaporator Temperature Difference (TD) has sufficient cooling capacity for most conditions.

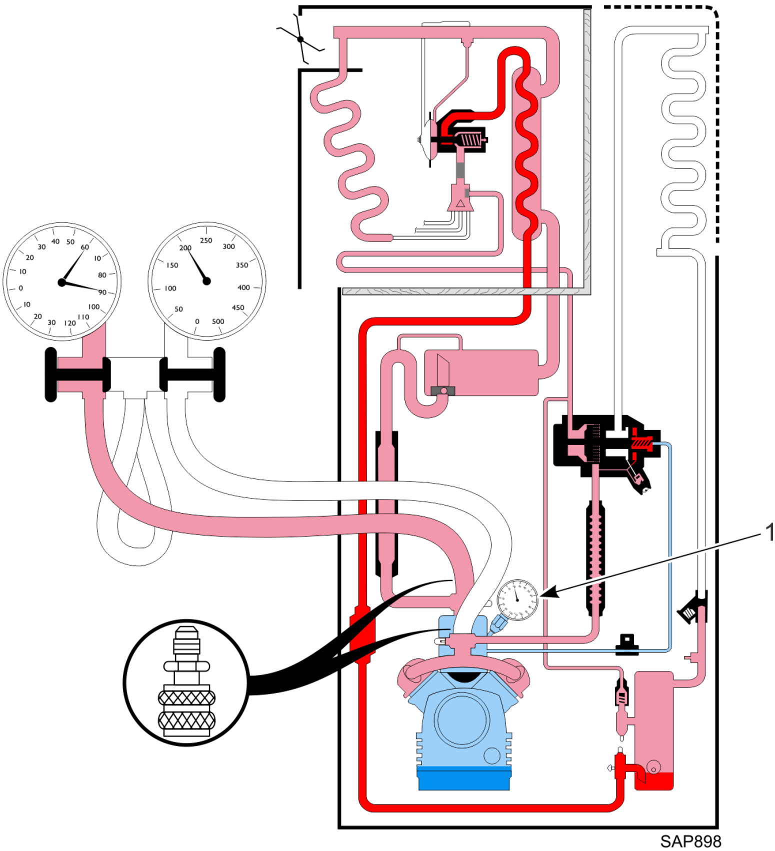
Throttling Valve Pressure Setting Check

Purpose: To accurately check the pressure setting of mechanical throttling valves.

1. Obtain the recommended setting from current Service Bulletins or the unit Maintenance Manual.
2. Install a calibrated gauge manifold.
3. Install a calibrated compound gauge on the base of the throttling valve.
4. Operate the unit in cool for five minutes or more.
5. Shift the unit to heat or defrost.
6. Observe the compound gauge and the gauge manifold’s low pressure

gauge.

7. When the gauge manifold's low pressure gauge reads approximately 40 psig (2.7 bar) or above, the compound gauge installed on the valve base should read within 10% of the recommended setting.



1.	Compound Gauge

Throttling Valve Adjustment

Purpose: To properly adjust throttling valves.

1. Pump down the compressor or the low side and adjust compressor

crankcase pressures to approximately one pound positive.

2. Remove the square end of the throttling valve to change the spring or to add or remove shims. Adding shims increases pressure and removing shims decreases pressure approximately 1/2 pound per shim.

   Note: *While shims may be used to make minor pressure adjustments, always install a new spring if more than a one pound change is required.*

3. Always recheck the setting after making changes.

Suction Pressure Regulator Test/Adjustment

Purpose: To check or adjust the suction pressure regulator setting.

1. Obtain the recommended setting from current Service Bulletins or the unit Maintenance Manual.
2. Install a calibrated gauge manifold.
3. Operate the unit in cool for five minutes or more.
4. For units running on R-134a, shift into heat or defrost and operate for three to five minutes.
5. For units running on R-404A/R-452A, operate the unit in cool with a box temperature between 59°F and 68°F (15°C and 20°C)15°C and 20°C.
6. Read the valve's setting on the gauge manifold's low pressure gauge.
7. Remove the protective cap and use a hex key to turn the adjustment screw in (CW) to increase or out (CCW) to decrease the setting. **Make all settings with the unit operating in heat or defrost.**

Low Side Pump Down for Diagnosis

Purpose: To test for internal high to low side leaks and to perform service on the low side without refrigerant loss.

1. Install a calibrated gauge manifold.
2. Operate the unit in high speed cool for 10 minutes or more.
3. Front seat the receiver tank outlet valve.
4. Pump down the low side to a 25 inch (0.8 bar) vacuum.
5. Stop the unit. Low side pressure should remain below a 15 inch (0.5 bar) vacuum for two minutes or more.
   a. If pressure rises **to zero and stops** - indicates low side refrigerant leak to the atmosphere.

   b. If pressure rises **above zero** - indicates refrigerant boiling out of the oil or internal high pressure to low pressure area leaks.

6. Repeat pump down up to three times. If after the third attempt, pressure still rises, check the following components:
   a. Evaporator side of the three-way valve.
   b. Bypass check valve.
   c. Compressor discharge valve plates.
   d. Pilot solenoid.
   e. Hot gas bypass valve on units with modulation or ETV.

   Note: *Refer to Internal Seal Points (“Seal Point Elimination Procedure,” p. 46) for component locations.*

Low Side Pump Down for Service

After performing Low Side Pump Down for Diagnosis, the following service can be performed with the low side pumped down and a slight positive pressure established.

1. Add or remove refrigerant oil.
2. Clean expansion valve screen.
3. Change expansion valve.
4. Service the throttle valve.
5. Replace drier.
6. Replace compressor oil filter.
7. Replace ETV.
8. Replace suction pressure transducer.
9. Replace suction vibrasorber.

Seal Point Elimination Procedure

Note: *This procedure can only be performed on units with reciprocating compressors. For units with scroll compressors, refer to (“Low Side Pump Down,” p. 70).*

Purpose: To use a process of elimination to identify an internal leak.

⚠ WARNING

Hazard of Explosion!

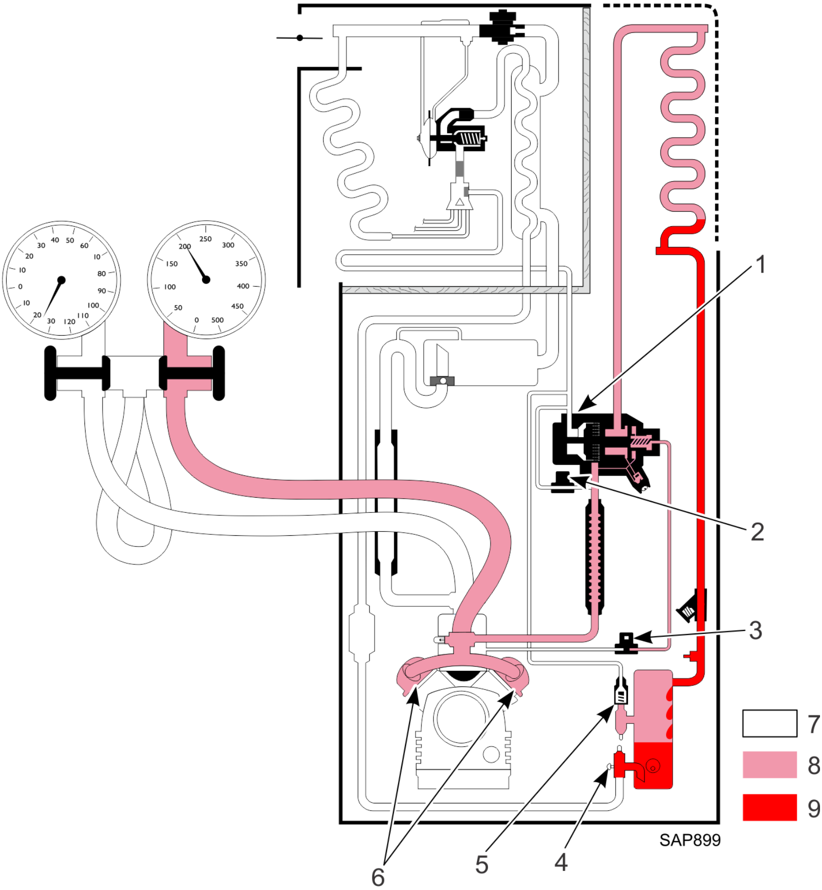
Never close the compressor discharge service valve when the unit is operating. Never operate the unit with the discharge valve closed (front seated). This condition increases internal pressure, which can cause an explosion.

1. Eliminate the bypass check valve. Perform a low side pump down with the bypass hand valve front seated.
2. Perform a compressor pump down to check the valve plates and pilot solenoid.

Prepare to remove the compressor or compressor heads.

1. Pump down the low side to a 15 inch (0.5 bar) vacuum or more.
2. Stop the unit.
3. Immediately front seat the discharge service valve.
4. Balance pressures through the manifold. Add additional pressure from the Discharge Service Valve (DSV) or Receiver Tank Outlet Valve (RTOV) if necessary to establish 1 to 2 psig (0.1 bar).
5. Front seat the suction service valve.

Figure 4. Internal Seal Points



1.	Evap Side of Three-Way Valve	6.	Comp Discharge Valve Plates
2.	Hot Gas Bypass Valve	7.	Vacuum
3.	Pilot Solenoid	8.	High Pressure Vapor
4.	Receiver Tank Outlet Valve	9.	High Pressure Liquid
5.	Bypass Check Valve		

Compressor Pump Down for Diagnosis

Purpose: To check for internal leaks through the discharge valve plates and the pilot solenoid and to perform service work on the compressor.

1. Install a calibrated gauge manifold.
2. Operate the unit in high speed cool five minutes or more.
3. Front seat the suction service valve and pump down the compressor to 20 to 25 inches (0.7 to 0.8 bar) of vacuum.
4. Stop the unit. Crankcase pressure should remain below zero psig for 15 seconds or more. If pressure rises above 0 psig (0 bar), repeat pump down up to three times.
   a. If pressure still rises **to zero and stops**: indicates low pressure area leak to the atmosphere.
   b. If pressure still rises **above zero**: indicates internal high pressure to low pressure area leaks through valve plates or pilot solenoid.

Compressor Pump Down for Service

⚠ 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.

Pump down the compressor and adjust pressures slightly positive 1 to 2 psig (0.1 bar) to perform the following service:

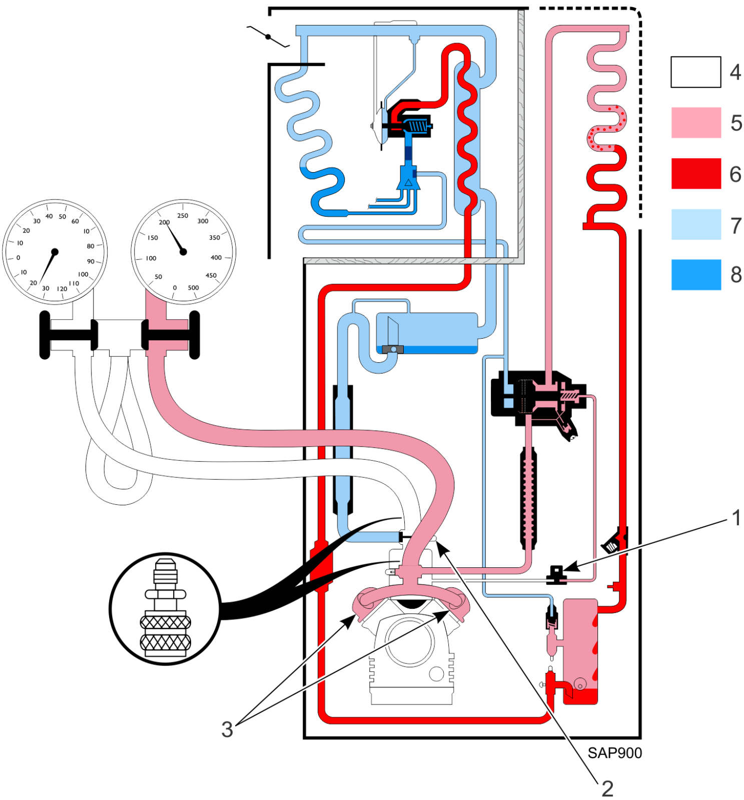
1. Add or remove compressor oil.
2. Repair or replace the throttling valve.
3. Repair or replace the compound gauge or gauge line.
4. Replace the line to the pilot solenoid.

Prepare to remove the compressor or compressor heads as follows:

1. Pump down the compressor to a 15 inch (380 mm) vacuum.
2. Stop the unit.
3. Immediately front seat the discharge service valve.
4. Balance pressures through the gauge manifold to 1 or 2 psig (0.1 bar).

5. If 1 to 2 psig (0.1 bar) cannot be established, the refrigerant must be recovered or a low side pump down must be performed.

Figure 5. Compressor Pump Down



1.	Pilot Solenoid	5.	High Pressure Vapor
2.	Suction Service Valve (SSV)	6.	High Pressure Liquid
3.	Comp Discharge Valve Plates	7.	Low Pressure Vapor
4.	Vacuum	8.	Low pressure Liquid

Compressor Capacity Test

Purpose: To test compressor piston reed condition, piston to cylinder clearance, piston and cylinder condition, and compressor performance capability.

Preparations Before the Test

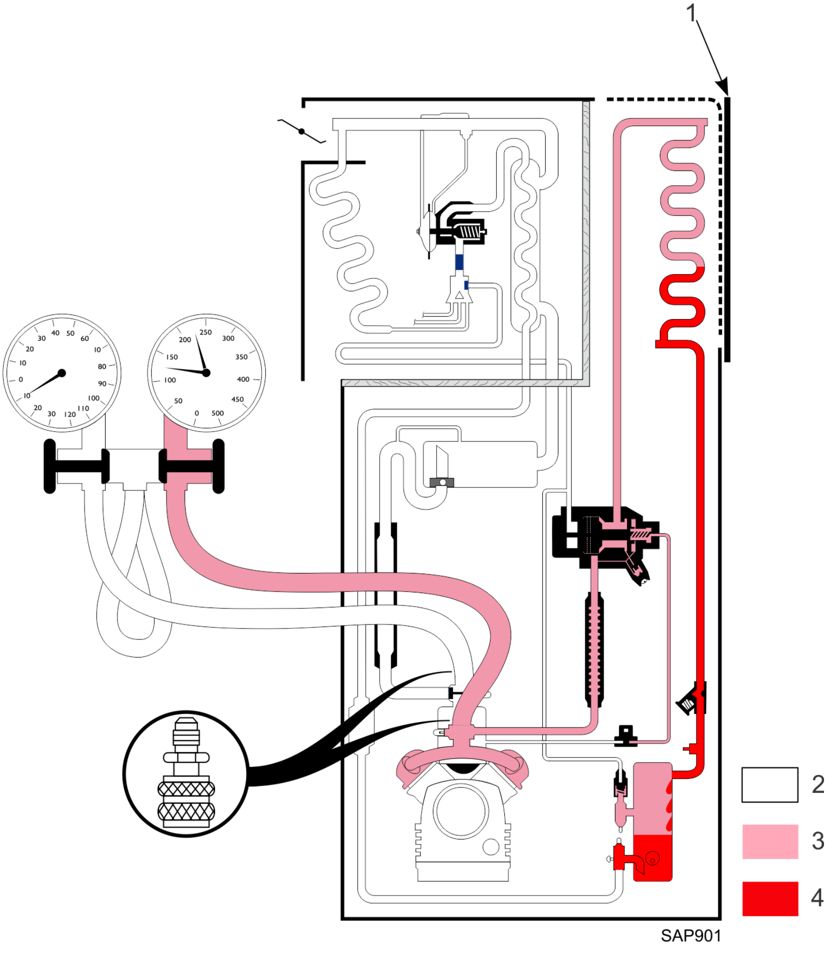
1. Ambient temperature must be above 60°F (15°C)15°C.
2. Install a calibrated gauge manifold.
3. Check the refrigerant charge (correct amount if needed).
4. Check/adjust compressor RPM.
5. Check for low side restrictions - pressures must be normal or high on the suction side.
6. Perform low side pump down and throttling valve check. Repair before continuing.
7. Warm the evaporator (operate in heat/defrost if needed).

Test Procedure

1. Operate the unit in cool and cover the condenser coil to build discharge pressure.
    - R-401B and R-134a = 250 psig (17 bar)
    - R-22, R-402A, R-403B, R-404A, and R-452A = 300 to 350 psig (20.4 to 23.8 bar)
2. Pump down the low side, while keeping the condenser coil covered.
3. When low side pumps down to a 10 inch (0.3 bar) vacuum, read discharge pressure. It should read as indicated or higher.
    - R-401B and R-134a = 125 psig (8.6 bar) or more
    - R-22, R-402A, R-403B, R-404A, and R-452A = 200 to 250 psig (13.7 to 17.2 bar) or more

    Note: *Compressors not meeting these specifications may function satisfactorily for higher box temperature applications but most compressors need repair.*

Figure 6. Checking Compressor Capacity



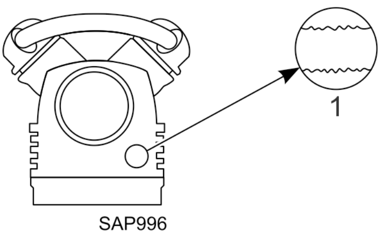
1.	Condenser Coil Covered	3.	High Pressure Vapor
2.	Vacuum	4.	High Pressure Liquid

Compressor Oil Checks

Purpose: To check compressor oil level, oil condition and oil pressure.

Oil Level Check Procedure

1. Warm the unit evaporator by operating the unit with 60°F to 70°F (16°C to 21°C)16°C to 21°C air over the evaporator for 10 to 15 minutes or operate the unit in heat or defrost for 10 to 15 minutes.
2. If the unit has been operated in heat or defrost, operate it in cool for five minutes.
3. Compressor sight glass should be 1/4 to 3/4 full.

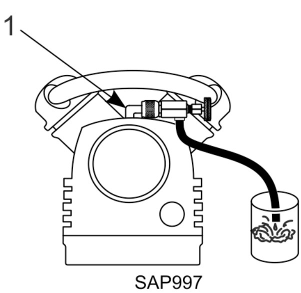


1.	Normal Oil Level 1/4 to 3/4 Full

Removing Excess Oil or Oil Sample Procedure

1. To remove compressor oil, install an access valve actuator (204 - 625) on the compressor oil pump or oil filter fitting and operate the unit. Catch oil in appropriate container.

Figure 7. Oil Fill Plug



1.	Oil Fill Plug

Adding Oil Procedure

1. To add compressor oil, perform a compressor pump down.
2. Adjust crankcase pressure slightly positive and remove the oil fill plug above the oil pump. Add oil as needed. Evacuate compressor to remove air.

   Note: *Units do not consume oil. Check and add oil as required if there has been a refrigerant leak or major component replacement.*

Compressor Oil Condition

Check compressor oil condition by observing its color during each major service or system repair. Test a sample of compressor oil for acid contamination. If acid is present, the system must be serviced according to TK 40229 “Clean-up of Refrigeration Systems With Thermo King Compressors”.

Note: *Two Thermo King acid test kits are available - one for alkylbenzene (synthetic) compressor oil and one for polyolester compressor oil. Be sure to use the correct test kit.*

Clear Oil: Appearance of good oil. (Suitable to perform acid test)

Black Oil: Carbonization from operating a unit with air and moisture in the system.

Brown Oil: Results from moisture in the system causing an acid condition and subsequent copper plating.

Gray/Metallic Oil: Caused by metal wear from pistons, bearings, cylinders, etc.

Green Oil: High moisture content POE oil.

Compressor Oil Pressure Check

1. Install a compound gauge to read compressor crankcase pressure (this can be on the base of the throttling valve or after the ETV or suction pressure regulator).
2. Install a compound gauge on the oil pump fitting to read oil pump pressure.
3. Operate the unit in high speed cool.
4. Read both the compressor crankcase pressure and oil pump pressure with the unit operating.
5. Subtract the compressor crankcase pressure from the oil pump pressure.

The difference is compressor oil pressure and should be between 20 and 35 psig (1.4 and 2.4 bar) or higher.

Oil Pump Pressure - Crankcase Pressure = Compressor Oil Pressure

Combined Heating Test

Purpose: To test the Condenser Check Valve, Condenser side of the Three-Way Valve, and Condenser Pressure Bypass Check Valve on units with heat and defrost complaints.

Preparing the Unit

1. Warm the engine to normal operating temperature.
2. Verify the unit has a full refrigerant charge.
3. Install a calibrated gauge manifold on the compressor.
4. Verify the unit has the proper throttling valve setting.
5. Be absolutely sure the receiver tank outlet valve (RTOV) is back seated. **Failure to back seat the RTOV may result in severe personal injury!**
6. Install a high pressure gauge on the receiver tank outlet valve.

(A) Testing the Condenser Check Valve

Note: *This procedure can only be performed on trailer units with reciprocating compressors. This is to prevent irreparable damage of the scroll compressor and because certain components do not exist on truck units.*

NOTICE

Equipment Damage!

Do not front seat the valve hard enough to damage the seal.

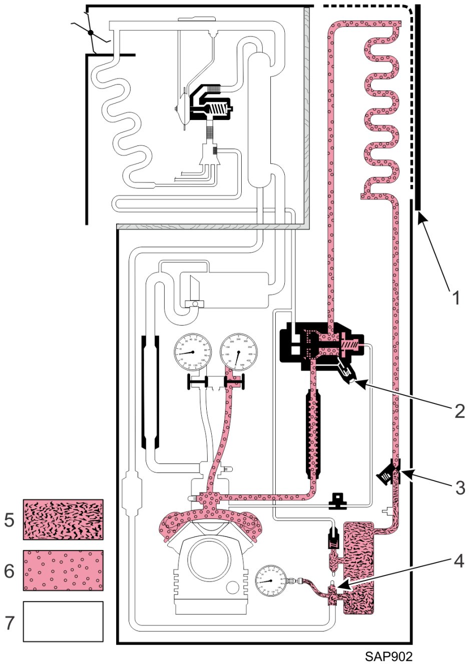
1. Front seat the condenser pressure bypass check valve.
2. Operate the unit in high speed cool and cover the condenser coil to build discharge pressure:
   - R-401B and R-134a = 200 to 250 psig (13.6 to 17 bar)
   - R-22, R-402A, R-403B, R-404A, and R-452A = 300 to 350 psig (20.4 to 23.8 bar)
3. Pump down the low side, while keeping the condenser coil covered.
4. When discharge pressure begins to decrease and the low pressure gauge reaches a 10 inch (0.3 bar) vacuum, remove the condenser cover to

reduce discharge pressure. When discharge pressure drops approximately 100 psig (6.8 bar), **STOP THE UNIT**.

5. Observe the manifold high pressure gauge:
   - **a pressure increase** - indicates the condenser check valve leaks.
   - **receiver tank pressure must remain above condenser pressure** - indicating a good condenser check valve.

   Note: *Receiver tank pressure may decrease slowly but must remain higher than discharge pressure on the gauge manifold.*

Figure 8. Testing the Condenser Check Valve



1.	Condenser Cover	5.	Receiver Tank pressure observed in step 5.
2.	Condenser Press Bypass Check Valve Hand Valve	6.	Pressure observed at the manifold high pressure gauge in step 5.

3.	Condenser Check Valve	7.	Area of system in a vacuum as seen on the manifold's low pressure gauge at the end of step 4. A vacuum that holds for two minutes or more at the end of step 4, indicates internal high-to-low pressure seals checked with the low side pumped down are satisfactory.
4.	Receiver Tank Outlet Valve Front Seated		

(B) Testing the Condenser Side of the Three-Way Valve

1. With the unit off, enter Service Test Mode - Heat.
   a. This energizes the pilot solenoid to shift the three-way valve against the condenser side seat. The valve must stay open for the remainder of this test. Failure to keep the pilot solenoid energized will prevent a positive test of the condenser pressure bypass check valve in the next section.
   b. On 1988 and older units, it is sufficient to momentarily energize the pilot solenoid.
2. Immediately observe the gauge manifold gauges. Manifold gauge pressures should equalize.
3. After the manifold gauge pressures equalize, a rise in gauge pressures indicates the three-way valve is leaking to the condenser side. The three-way valve spool, piston seal, or condenser pressure bypass check valve need service.

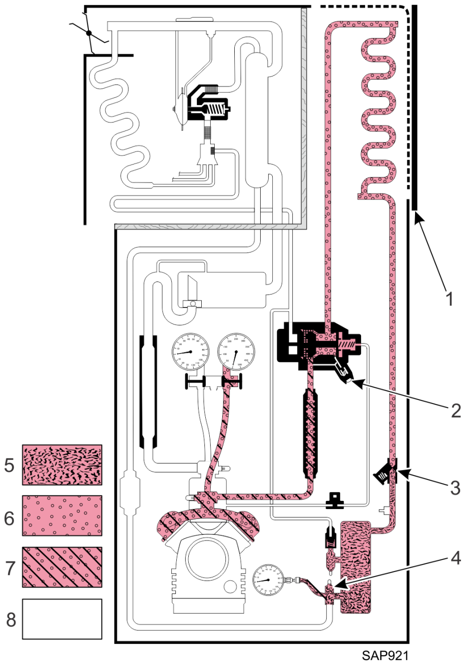
(C) Testing the Condenser Pressure Bypass Check Valve

NOTICE

Equipment Damage!

Do not back seat the valve too far, or the snap ring will disengage. Only back seat the valve until you feel a slight resistance against the snap ring.

1. With the pilot solenoid still energized, back seat the condenser pressure bypass check valve.
2. Manifold gauge pressures should rise if the condenser pressure bypass check valve is working properly.
3. Before returning the unit to service, remove gauges following the correct procedures and verify that all service valves are back seated.



1.	Condenser Cover	5.	Receiver Tank pressure observed in step 5.
2.	Condenser Press Bypass Check Valve Hand Valve	6.	Pressure observed at the manifold high pressure gauge in step 5. Pressure remains after completing step 6.
3.	Condenser Check Valve	7.	Pressure observed at the manifold high pressure gauge in step 5. This pressure balances with the area that was under a vacuum before completing step 6.
4.	Receiver Tank Outlet Valve Front Seated	8.	Area under a vacuum after step 5. This area is partially pressurized in step 6 and equalizes with condenser pressure after completing step 8.

Expansion Valve Check / Adjustment

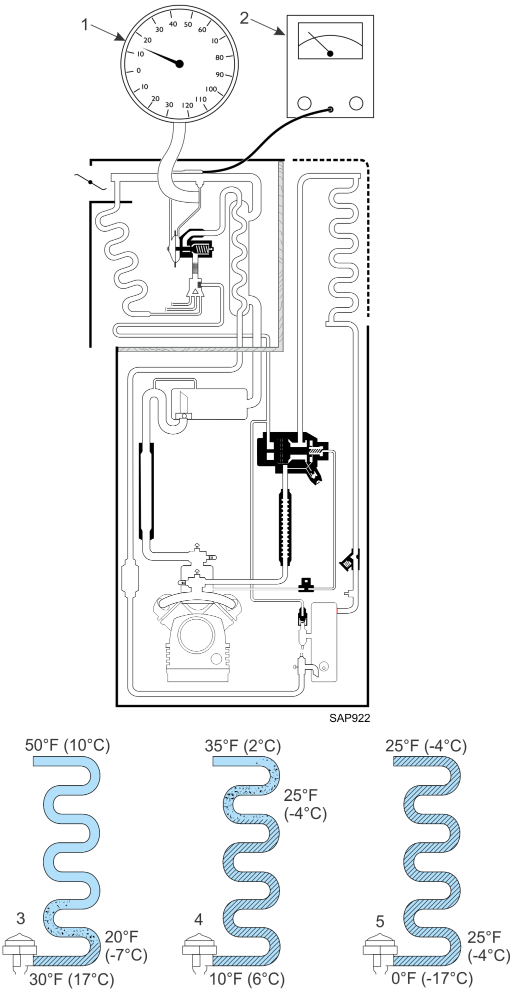
Purpose: This check confirms the expansion valve setting and operation and enables the technician to make adjustments if required.

Note: *Perform low side pump down, compressor capacity test, controlled refrigerant level check, engine RPM, etc. Repair as needed before continuing.*

1. Examine and/or clean evaporator and condenser coils.
2. Install an accurate compound gauge in the equalizer line.
3. Install an accurate thermometer sensor beside the expansion valve feeler bulb and secure and insulate it.
4. Defrost the evaporator and stabilize the box temperature near 40°F (4°C) 4°C.
5. Cover the condenser as needed to maintain discharge pressure as is normal for 100°F (38°C)38°C ambient temperature.
6. Check the type of refrigerant in the unit and determine the recommended discharge pressure. Refer to (Table 1, p. 25Table 2, p. 25 and Table 3, p. 26).
7. Read the equalizer pressure and suction line temperature simultaneously. Make several readings approximately every two minutes.
8. Superheat should be between 6°F (-3°C) and 12°F (-7°C) at 0°F (-18°C)-3°C and -7°C at -18°C box temperature.

Converting Pressure to Saturated Temperature from a Temperature Pressure Chart/Slide Rule:

Example:	At pressure of 14.7 psig, R-404A =	-22°F (-30°C)
Therefore:	If suction line temperature is -13°F (-25°C) and suction line pressure is 14.7 psig =	-22°F (-30°C)
	Superheat =	
	Suction line temperature	-13°F (-25°C)
	Minus suction line press/temp	-22°F (-30°C)
	Superheat =	41°F (5°C)
Example:	At pressure of 1 bar, R-404A =	-30°C
Therefore:	If suction line temperature is -25°C and suction line pressure is 1 bar =	-30°C
	Superheat =	
	Suction line temperature	-25°C
	Minus suction line press/temp	-30°C
	Superheat =	5°C



1.	Compound Gauge (15 psig)	4.	Superheat Normal
2.	Thermometer - 22°F (-6°C)	5.	Superheat Low
3.	Superheat High		

Heat Exchanger Test for Internal Leaks

Purpose: To test the heat exchanger for an internal high side to low side leak.

Note: *To prevent refrigerant loss to the atmosphere, recovery equipment must be available to perform this test.*

Test Procedure

Note: *Recover all refrigerant before opening system for service.*

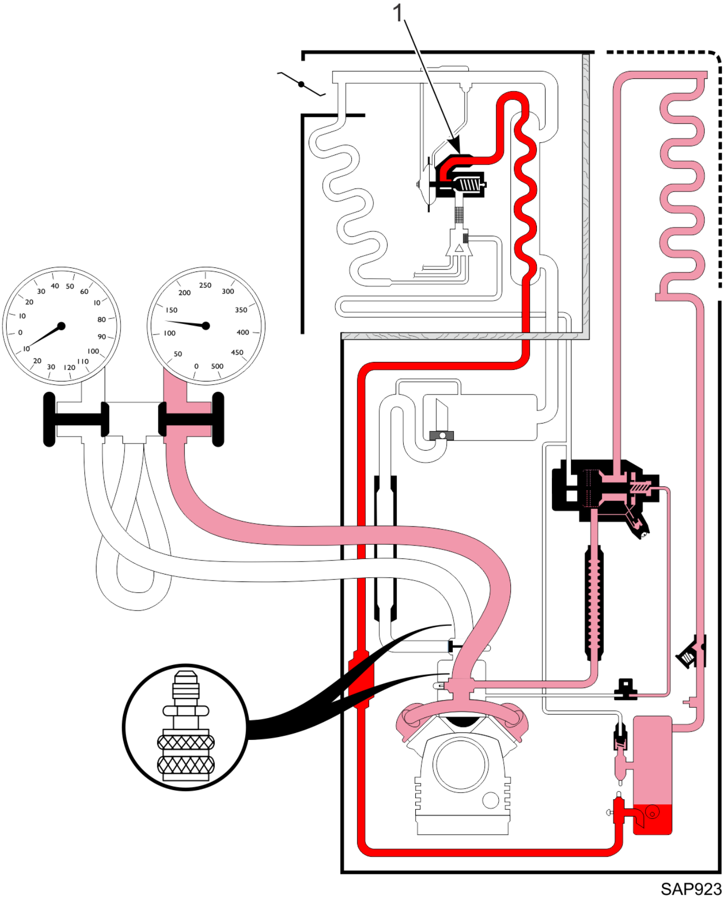
1. Install a calibrated gauge manifold on the compressor.
2. Pump down the low side and adjust pressure slightly positive so the low side can be opened.
3. Remove the liquid line at the expansion valve inlet and plug or cap the line and expansion valve inlet.
4. Open the receiver tank outlet valve to pressurize the liquid line.

A rise in the service manifold low pressure gauge pressure indicates the heat exchanger is leaking internally. A heat exchanger with an internal leak must be replaced.

Returning the Unit to Service

1. Units with an internal leak in the heat exchanger may have the low side pumped down and the unit repaired.
2. Units with a good heat exchanger must have the refrigerant recovered from the receiver tank outlet valve using approved recovery equipment. Keep a slight positive pressure in the system.
3. Remove the plug or caps from the liquid line and expansion valve inlet.
4. Replace the liquid line drier.
5. Properly position all service valves, replace all service caps, leak check all fittings that were disturbed, and check the refrigerant level.

Figure 9. Heat Exchanger Test for Internal Leaks



1.	Capped or Plugged

Truck Units with Thermax

Introduction to the TherMax™ System

The TherMax system allows the complete unit charge to be available during heat. Truck units with TherMax have had some components of the standard three-way valve system removed and other components added.

Components Removed

- Bypass check valve
- Bypass line
- Condenser check valve

Components Added

- **TherMax (Heat) Solenoid:** A normally closed solenoid that opens during the condenser evacuation mode to allow refrigerant flow to bypass the evaporator and flow directly into the accumulator. Located in a line between the suction and liquid lines.
- **Receiver Outlet Check Valve:** Stops refrigerant flow into the receiver tank during the heat/defrost mode.
- **The Heat Initiation Timer (HIT):** Prevents the pilot solenoid from energizing during the condenser evacuation mode (approximately two to four minutes). May be an individual device or built into the microprocessor controller.
- **Ambient Switch:** This switch is normally used on units with R-502 and other high pressure refrigerants. The switch will prevent the TherMax solenoid from opening, eliminating the condenser evacuation mode, when the ambient temperature is above approximately 0°F (-18°C)-18°C. The switch is not present in microprocessor controlled units.

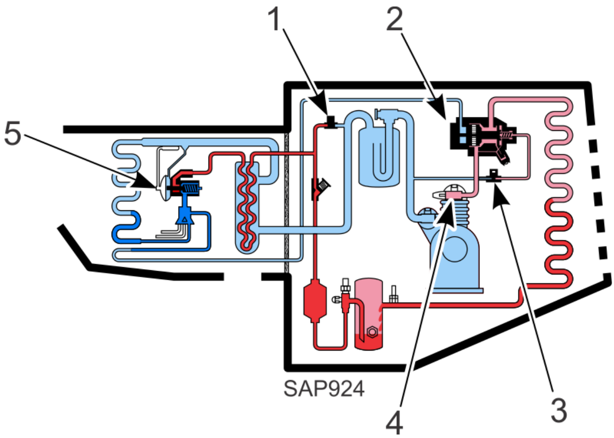
Modes Of Operation

- **Cool:** Unit operates as normal.
- **Condenser Evacuation:** Discharge pressure forces liquid refrigerant from the condenser and receiver tank into the accumulator for use during the heat/defrost cycle. The three-way valve remains in the cool position with the TherMax (heat) solenoid open for approximately two to four minutes.
- **Heat/Defrost:** The three-way valve shifts to heat and the condenser, receiver tank and liquid line between the receiver tank and receiver outlet check valve are isolated.

TherMax Modes of Operation

Cool Mode

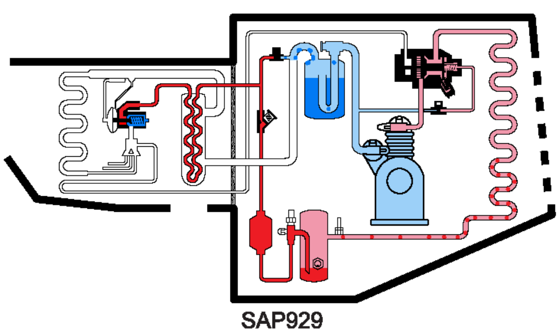
Truck unit with TherMax heating showing pressure separation points during the cool mode.



1.	TherMax (Heat) Solenoid	4.	Comp Valve Plates and Piston Reeds
2.	Evap Side of Three-Way Valve	5.	Expansion Valve
3.	Pilot Solenoid		

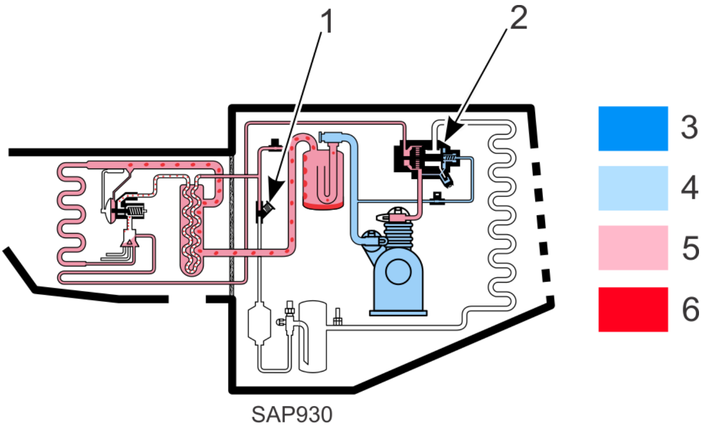
Condenser Evacuation Mode

Truck unit with TherMax heating showing pressure separation points during the condenser evacuation mode.



Heat/Defrost Mode

Truck unit with TherMax heating showing pressure separation points during the Heat/Defrost mode.



1.	Receiver Outlet Check Valve	4.	Low Pressure Vapor
2.	Condenser Side of Three-Way Valve	5.	High Pressure Vapor
3.	Low Pressure Liquid	6.	High Pressure Liquid

Low Side Pump Down - TherMax Units

Purpose: To test for internal high to low side leaks and to perform low side service without refrigerant loss.

Low Side Pump Down Procedure

1. Install a calibrated gauge manifold.
2. Run the unit in cool 10 minutes or more.
3. Front seat the receiver tank outlet valve.
4. When the compound gauge reaches 20 to 25 inches (0.7 to 0.8 bar) of vacuum, stop the unit.
5. Observe the low pressure gauge. It should remain below a 15 inch (0.5 bar) vacuum two minutes or more.

   If pressure rises:

   a. To zero and stops: Low side refrigerant leak to the atmosphere.

b. Above zero: Refrigerant boiling out of the oil or internal high pressure to low pressure area leaks. Check the following:
   - Evaporator side of the three-way valve
   - TherMax solenoid
   - Discharge valve plates
   - Pilot solenoid
6. Use a process of elimination to identify an internal leak. Perform a compressor pump down to determine valve plate and pilot solenoid condition.
7. The following services can be performed with the low side pumped down and a slight positive pressure established:
   - Add or remove refrigerant oil
   - Clean expansion valve screen
   - Change expansion valve
   - Service the throttle valve
   - Replace the suction pressure regulator
   - Replace drier

Removing the Compressor or Compressor Heads Procedure

1. Pump down the low side to a 15 to 20 inch (0.5 to 0.7 bar) vacuum.
2. Stop the unit.

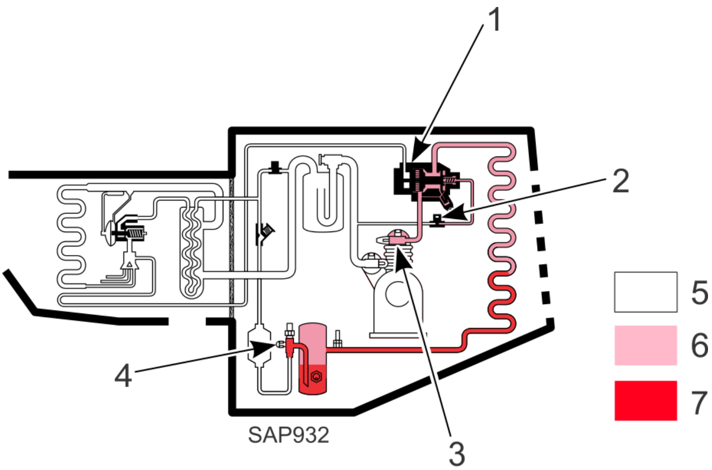
⚠ WARNING

Hazard of Explosion!

Front seat the suction service valve. Do not operate the compressor with the discharge service valve front seated. This condition increases internal pressure, which can cause an explosion.

3. Immediately front seat the discharge service valve.
4. Balance pressures through the manifold. Add additional pressure from the discharge service valve or RTOV if necessary to establish 1 to 2 psig.

Figure 10. Low Side Pump Down - TherMax Units



1.	Evap Side of Three-Way Valve	5.	Vacuum
2.	Pilot Solenoid Valve	6.	High Pressure Vapor
3.	Discharge Valve Plates	7.	High Pressure Liquid
4.	Receiver Tank Outlet Valve		

Receiver Outlet Check Valve Test

Purpose: To check for a leak through the receiver outlet check valve.

1. Install a calibrated gauge manifold.
2. Install an additional compound gauge on the receiver tank outlet service port.
3. Confirm the three-way valve shifts properly.
4. Verify the unit has a full refrigerant charge.
5. Operate the unit in high speed cool five minutes or more.
6. Adjust the thermostat to cycle the unit to the heat mode.
7. The unit should run two to four minutes in the condenser evacuation mode. Pressures will stabilize. **

*Note: ** Some units have variations of or a modified TherMax cycle. An ambient switch may be in the TherMax solenoid circuit and the heat initiation timer may be disconnected or missing. These modifications will require manual control of the pilot solenoid and TherMax solenoid during system checkout.*

8. Observe the additional compound gauge on the receiver tank and the receiver tank sight glass as the three-way valve shifts to heat. Run in heat five minutes or more.
    - The sight glass should remain empty.
    - Receiver tank pressure should remain stable.

    Note: *A leaking receiver outlet check valve will cause a loss in heating capacity by allowing the refrigerant to flow into the receiver tank during the heat cycle. This will allow the sight glass to fill with refrigerant and the receiver tank pressure to increase.*

TherMax (Heat) Solenoid Opening Test

Purpose: To test the TherMax solenoid for opening.

1. Install a calibrated gauge manifold.
2. Remove the #26 wire from the TherMax solenoid coil.
3. Operate the unit in cool mode.
4. Observe the gauge manifold low pressure gauge and attach a test lead between battery positive and the #26 terminal on the TherMax solenoid.
5. Suction pressure should increase when the valve opens.

    Note: *A solenoid that fails to open will result in reduced unit heating capacity.*

TherMax (Heat) Solenoid Leak Test

Purpose: To check for a leak through the TherMax solenoid in the cool mode.

1. Install a calibrated gauge manifold.
2. Confirm the compressor, three-way valve, and refrigerant level are serviceable.
3. Run the unit in cool mode.
4. Check the unit suction pressure during the cool mode. It should be normal.

5. If suction pressure is higher than normal, check the TherMax solenoid and solenoid outlet. A cold or frosted solenoid outlet indicates a leak through the solenoid.

   Note: *A TherMax (Heat) solenoid that leaks will reduce the units cooling capacity.*

Truck Units with Scroll Compressor

Scroll System Service

The scroll compressor system requires some specific diagnostic and service procedures.

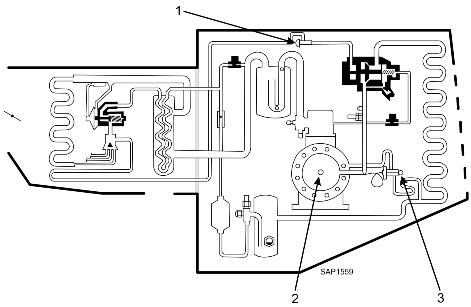
- Low Side Pump Down
- High Side Pump Down
- Compressor Capacity Test
- Gauge Removal

Remember, open drive scroll compressors used on truck units differ from reciprocating compressors as follows:

- Scroll compressors are not equipped with discharge valve plates.
- The flow of refrigerant is essential to cool and lubricate the internal components of the compressor.

Added Components

- Discharge Pressure Regulator (DPR): Is installed in the hot gas line between the three-way valve and the evaporator coil distributor. Its purpose is to increase discharge pressure when the unit shifts into heat or defrost. These higher pressures create higher discharge temperatures resulting in enhanced heating capabilities.
- Liquid Injection Valve (LIV): Measures the temperature through a feeler bulb of the discharge line. When temperature is too high it injects liquid refrigerant in the core of the Scroll to cool it down.
- High Temperature Cutout Switch (HTCO): Is located in the centre of the compressor discharge muffler. It measures the core temperature of the Scroll. When the temperature is too high it will shut down the unit.



1.	Discharge Pressure Regulator (DPR)
2.	High Temperature Cutout Switch (HTCO)
3.	Liquid Injection Valve (LIV)

Low Side Pump Down

Purpose: A low side pump down will allow you to change the drier and service other low side components.

NOTICE

Equipment Damage!

Different pump-down service techniques are required when working on scroll compressors than on reciprocating compressors.

- When pumping down scroll compressors always operate the unit in low speed.
- Only pump the unit to a 5 to 10 inch (0.2 to 0.3 bar) vacuum. Running the unit into a deep vacuum will damage the compressor.
- Never run the unit with the low side in a vacuum for more than one minute.

Diagnosis

If a unit has lost cooling capacity and has high suction pressure, an internal high to low side leak may be the problem. A low side pump down will check the following internal seal points:

- Evaporator side of Three-way Valve
- Pilot Solenoid
- Compressor Discharge Check Valve
- Low Side External Leak
- Thermax Solenoid
- Liquid Injection Valve

Procedure

1. Install a calibrated gauge manifold in accordance with “Installing and Purging a Gauge Manifold with Low Loss Fittings” (“Gauge Manifold,” p. 31).
2. Start the unit and enter Service Test Mode in accordance with TK Diagnostic Manual. Using Service Test Mode, place the unit in low speed cool [tESt-LSC].
3. Front seat the receiver tank outlet valve.
4. Run until a suction pressure of 5 to 10 inches (0.2 to 0.3 bar) vacuum is reached. Do not run the unit in a vacuum for more than one minute.
5. Turn the unit off.
6. Suction pressure should raise somewhat but stop. If it continues to rise, this indicates an internal leak.

High Side Pump Down

Purpose: A high side pump-down will allow service to the following:

- High pressure cutout switch
- High pressure relief valve
- Drier and other low side components.

Diagnosis

This procedure combines the functions of the Three-Way Valve Heat Check and the Low Side Pump down. A high side pump down procedure will check the following internal seal points:

- Three-Way Valve Evaporator Seat
- Pilot Solenoid
- Compressor Discharge Check Valve
- Liquid Injection Valve
- Condenser side of the Three-way Valve

Procedure

1. Install a calibrated gauge manifold in accordance with “Installing and Purging a Gauge Manifold with Low Loss Fittings” (“Gauge Manifold,” p. 31).
2. Front seat the condenser pressure by-pass check valve on the three-way valve.

3. Start the unit and enter Service Test Mode in accordance with TK Diagnostic Manual. Using Service Test Mode, place the unit in low speed cool [tESt-LSC].
4. Front seat the receiver tank outlet valve.
5. Run until a suction pressure of 5 to 10 inches (0.2 to 0.3 bar) vacuum is reached. Do not run the unit in a vacuum for more than one minute.
6. Stop unit.
7. Without starting the unit, shift the three-way valve using Service Test Defrost Mode (tESt-dEF).
8. The three-way valve should shift and gauge pressures should equalize near 0 psig and not rise.

   Note: *If the system was opened for service, it should be leak tested and evacuated before opening the receiver tank outlet valve.*

Scroll Compressor Capacity Test

The scroll compressor **CANNOT** be pumped down to check the efficiency of the compressor. Use the following procedure.

Diagnosis

This procedure checks loss of cooling capacity at low box temperatures.

Service Procedure

1. Install a calibrated gauge manifold in accordance with “Installing and Purging a Gauge Manifold with Low Loss Fittings” (“Gauge Manifold,” p. 31).
2. Run the unit in high speed cool for five minutes or more until pressures stabilize.
3. Note the discharge pressure on the high pressure gauge.
4. Cover the condenser to build discharge pressure.
5. Allow discharge pressure to rise to at least 100 psig (6.8 bar) above the previously noted pressure.
6. The compressor is probably faulty if it does not raise discharge pressure at least 100 psig (6.8 bar). Check all other possible causes of capacity loss before replacing a compressor.

Gauge Removal

Preparation

1. Remove the high side gauge line from the discharge Schrader port.

   Note: *Use of low loss fittings is mandatory.*
2. Backseat the suction service valve and then crack open one half turn.

Procedure

1. Start the unit and enter Service Test Mode in accordance with TK Diagnostic Manual. Using Service Test Mode, place the unit in low speed cool [tESt-LSC].
2. Open both service manifold hand valves.
3. Front seat the receiver tank outlet valve.
4. Monitor suction pressure. When it falls to 3 psi (0.2 bar), fully back seat the suction service valve.
5. Stop the unit.
6. Back seat the receiver tank outlet valve.
7. Remove the low side manifold gauge line.
8. Replace all valve and stem caps.

Discharge Pressure Regulator (DPR) Test

Diagnosis

Unit lacks heat/defrost capacity.

Service Procedure

1. Test the pilot solenoid and three-way valve for proper operation.
2. Check refrigerant charge.
3. Perform compressor capacity test in cool mode.
4. Check the suction pressure regulator or throttling valve for proper operation.
5. Check the discharge pressure during heat or defrost. The discharge pressure should rise to 300 to 350 psig (20.4 to 23.8 bar) when suction pressure is 30 psig (2.0 bar) or higher for R-404A/R-452A.
6. If the unit passes the pilot solenoid, three-way valve, and compressor tests, and the discharge pressure does not rise in the heat/defrost mode, replace the discharge pressure regulator.

Diagnosis

Unit shuts down because of high discharge pressure.

Service Procedure

1. Check unit pressures during cool mode operation and repair as required.
2. Run the unit in low speed heat and monitor discharge pressure. If discharge pressure rises quickly to an excessive level (in several seconds), there may be a restriction in the three-way valve, discharge pressure regulator valve, or the hot gas line at the evaporator inlet.
3. If discharge pressure rises slowly to an excessive level, check the suction pressure regulator or throttling valve for proper operation.

Trailer Units with Screw Compressor

Diagnosis and Service of Trailer Units with Screw Compressors

To diagnose and service trailer units with screw compressors, refer to the SB-400 Refrigeration System Manual (TK 51696).

Leak Check/Soldering/Clean-Up

Refrigerant Leak Check Tools and Recommended Testing Procedures

Units low on refrigerant must be tested for leaks and the leaks must be repaired before adding refrigerant. The following are recommended tools and testing procedures:

Electronic Leak Detector Recommendations

- Calibrate frequently with a leak standard to be sure of reliability.
- Calibrate in fresh air to increase sensitivity.
- Keep sensor free of dirt and refrigerant oil.
- Move sensor slowly.
- Start leak testing at the top and work down.

AC & DC Powered Electronic Leak Detectors

1. **AC Powered Electronic Detectors:** Normally react faster and are the most reliable. A built-in pump pulls air across the sensor.
   - **Travel Rate:** 1/2 to 1 inch (12.7 to 25.4 mm) per second
   - **Sensitivity:** .1 ounce (2.9 ml) refrigerant loss per year or less
2. **DC Detectors:** Normally use a heated tip and convectional currents to pull air samples across the sensor. Pumps used are usually low capacity.
   - **Travel Rate:** 1/2 inch (12.7 mm) per second
   - **Sensitivity:** As little as .1 ounce (2.9 ml) refrigerant loss per year

Liquid Leak Check Solutions

Leak check solutions are generally acceptable in areas that are easily reached or where the air is saturated with refrigerant. However, several factors determine how well a solution will work.

A good solution should:

- be bubble free
- have a high surface tension
- adhere to and not break away from the joint
- work for several minutes without evaporating
- be commercially made for leak detection

Leak Characteristics

- **Multiple leaks** may exist. Leak check beyond the first leak.
- **Component or line temperature** may determine leak or leak size. Leak test before and after running the unit.
- **Circulating refrigerant oil** may temporarily plug leaks on a unit that is operated. When possible, leak check before running the unit.

Leak Testing Recommendations

- **Observe lines and components** for an oil and dirt accumulation indicating leak location.
- **Apply liquid bubble solution** with soft brush or low pressure applicator to prevent bubbles from forming. Allow several minutes to work.
- **Blow out confined areas** with compressed air to remove refrigerant accumulations.
- **In windy conditions,** shield the leak area for leak testing.

Leak Check Procedures

Purpose: To determine source of refrigerant leaks.

1. Visually check entire system for possible component damage and refrigerant oil loss.
2. Install a gauge manifold set.
3. Check low side pressure gauge reading. The manifold gauge will have a reading that falls into one of three ranges:
   - 0 psi.
   - 1 to 50 psi.
   - Over 50 psi.

<u>0 psi reading</u>

There is no pressure in the system with no obvious signs of a major leak.

1. Pressurize the system to 25 psi with refrigerant.
2. Monitor the system pressure for one minute.
   - If pressure reading does not change or falls slowly, the leak is small. Proceed to the 1 to 50 psi procedure.
   - If pressure drops rapidly, the leak is large. Further inspection is required. Do NOT add more refrigerant to the system because it will vent to the atmosphere.

1 to 50 psi reading

The system contains some pressure.

1. Add refrigerant to the system to increase pressure. Use the same refrigerant that would normally be used in the unit.
2. Add enough refrigerant to raise system up to bottle pressure. Keep track of added refrigerant. This may require as much as 6 pounds of refrigerant.

   Note: *This refrigerant will be recovered when the leak check is complete.*
3. Perform a complete and thorough leak check.
4. Recover refrigerant from the system.
5. Repair unit as required.
6. Recharge and leak check unit.

Over 50 psi reading

1. Use existing system pressure, perform a complete and thorough leak check of the refrigeration system.
2. Use a properly maintained electronic leak detector.
3. Inspect all joints and connections.
4. If no leaks are found, but the system has lost some of its refrigerant charge, refer to the 1 to 50 psi procedure.

Recommended Solders and Soldering Procedures

The following solders are recommended when servicing Thermo King refrigeration systems:

SOFT SOLDER 95/5: (95% tin, 5% antimony) **TK 204-167**

- **Flux Required:** Non-corrosive Paste **TK 204-417**
- **Identification:** Smooth, dull silver finish.
- **Usage:** Low pressure, copper to copper lines between the evaporator and the compressor.

SILVER SOLDER 15%: (Phoson +) **TK 203-364**

- **Flux Required:** None, may work better with white flux **TK 203-365**
- **Identification:** Dark, almost black appearance.
- **Usage:** High pressure, copper to copper connections. CANNOT be used with dissimilar metals.

SILVER SOLDER 35%: TK 203-366

- **Flux Required: TK 203-365**
- **Identification:** Bright, smooth, gold finish.
- **Usage:** High strength, high pressure connections made of dissimilar metals (brass to copper, copper to steel, etc.)

Good soldering connections are frequently the result of extensive practice. However, several factors and techniques if properly observed will help ensure success for even the inexperienced. See the following pages for details.

Tubing Fit

- Too tight a fit between two pieces of swedged tubing may not permit the solder to flow throughout the joint. Too loose a fit will also weaken the connection.
- A five thousandths of an inch space is recommended between two pieces of a swedge joint. This is about equal to two pieces of notebook or typing paper.

Cleanliness

- **Male end of the tube:** Remove all grease or oil with solvent or clean rags. Remove oxides from the tubing with scotch brite pads only. Sandpaper and steel wool are not recommended as they may contaminate the connection or remove excess metal. Wipe away loose oxide and abrasive particles to prevent contamination.
- **Female end of the tube:** Use appropriate size stainless steel brush. Turn brush one full turn clockwise out to remove any debris or excess shavings. (Repeat several times)

Proper Flux

- Flux male tube only .0625 inch (1.5875 mm) from end. Use recommended fluxes to reduce oxide formation, to aid in cleaning the connection and to help the solder flow. <u>AVOID</u> getting flux inside the tubing.

Heat Control

- Speed is important. Use a neutral flame large enough to finish the job quickly and prevent oxide formation. On swage connections, heat the male tubing first, then heat the entire connection evenly. Cool slowly. Never cool with water or wet rags.

Clean Up

- Clean the external solder joint with a flux neutralizing agent such as baking soda and water solution to reduce formation of oxides and neutralize the flux.
  – 6 ounce (170 gram) baking soda to one gallon (3.785 liter/litre) water, or 2 ounce (57 gram) to .5 gallon (1.9 liter/litre) water.

System Evacuation and Clean-up

Refrigeration systems that have had service performed with the system open to the atmosphere must be evacuated and dehydrated to remove air and moisture that may have entered during service. In addition, systems that have been open to the atmosphere for an extended period may require multiple evacuations to verify all air and moisture are removed.

Refrigeration systems that have had major service or repairs, and systems suspected of having air, moisture, or foreign particle contamination, must follow procedures outlined in TK 40229 “Clean-up of Refrigeration Systems with Thermo King Compressors”, and TK 40612 “Evacuation Station Operation and Field Application”.

Evacuation Equipment Checkout

Evacuation equipment must be in good condition to properly evacuate the unit. Always check it's condition before starting the evacuation process. We recommend the use of TK evacuation station.

1. Secure all evacuation hoses to the manifold hose anchors.
2. Properly attach the evacuation manifold to the vacuum pump and start the pump.
3. Open all hand valves on the pump and manifold.
4. Operate the vacuum pump to evacuate the gauge manifold, lines and test equipment to 100 microns for approximately five minutes.
5. Close the shut-off hand valve to isolate the vacuum pump from the test equipment. Turn the evacuation pump off.
6. Pressures must remain below 1000 microns for five minutes or more.

Note: *Before continuing, change pump oil or repair equipment that will not evacuate to or remain at the recommended level.*

System Evacuation And Dehydration

1. Check the condition of the evacuation equipment in accordance with

"Evacuation Equipment Checkout," p. 80.

2. If the evacuation equipment is acceptable, open the shut-off hand valve and place the unit service valves in the mid seat position.
3. Operate the vacuum pump to evacuate the refrigeration system to less than 1000 microns.
4. When lowest vacuum level is achieved (500 to 1000 microns), close hand valve on pump, turn off pump, wait five minutes and observe micron gauge. A leak to atmosphere exists if pressure rise exceeds 2000 microns and continues to rise to 0 psig (0 bar). If pressure rise stops below 0 psig (0 bar) there may be moisture in the system. Repeat evacuation and dehydration.

Multiple Evacuation

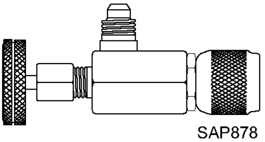
Perform a multiple evacuation if a system has been open to the atmosphere for an extended period or as recommended in TK 40229 "Clean-up of Refrigeration Systems with Thermo King Compressors".

1. Check the evacuation equipment and repair as required.
2. Open the shut-off valve and place the unit service valves in the mid seat position.
3. Evacuate the system to 2000 microns for 30 minutes.
4. Break the vacuum with nitrogen until a 2 to 5 psig (0.1 to 0.3 bar) positive pressure is established.
5. Allow the nitrogen to remain in the system for 10 minutes or more and then release.
6. Evacuate the refrigeration system to 1500 microns for 30 minutes.
7. Break the vacuum with nitrogen until a 2 to 5 psig (0.1 to 0.3 bar) positive pressure is established and then release.
8. Change the liquid line drier.
9. Evacuate the system to 500 microns then continue to evacuate for 30 minutes.
10. Close the hand valves on the gauge manifold.
11. Remove the vacuum pump and charge the unit with refrigerant.
12. Prepare the unit for service.

Compressor Oil Acid Test (TK 203-346)

An acid test of the compressor oil must be done whenever an acid condition is suspected. Perform an acid test whenever a unit has a substantial refrigerant loss, a noisy compressor, or as noted in TK 40229 “Clean-up of Refrigeration Systems with Thermo King Compressors”. To complete an oil acid test:

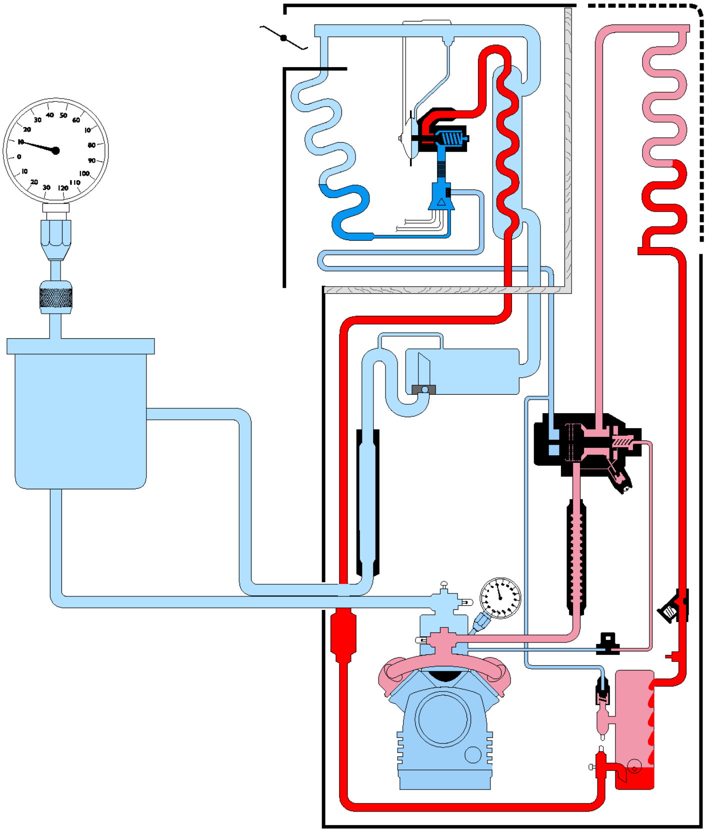
1. Use an access valve (TK 204-625) on the compressor oil pump service port or filter port and draw an oil sample into a clear container for inspection.


SAP878

2. Add oil to the test bottle up to the line on the neck. Replace the cover and shake. Bottle must be 3/4 full to use or oil can dilute solution.
3. Compare the oil kit color with the color test strip.

Suction Line Filter

The suction line filter is designed for use when major system contamination has occurred as defined in TK 40229 “Clean-up of Refrigeration Systems with Thermo King Compressors”. As indicated in the recommended clean-up procedure, the compressor oil filter is also recommended for permanent installation on systems requiring the use of a suction filter.



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Refrigerant Recovery and Methods of Recovery

Whenever refrigerant is removed from a refrigeration unit for service or after leak testing the unit, it must be recovered to limit the potential harm it could cause to the environment if it were allowed to escape to the atmosphere.

The following terms are used to refer to the process of removing, storing and cleaning or purifying refrigerant:

- **RECOVERY:** The process of removing refrigerant from a unit and storing it in an external container for later use.
- **RECYCLING:** The process of removing moisture and/or oil from refrigerant to prepare it for reuse in the system it came from.

- **RECLAIMING:** The process of cleaning refrigerant to meet the standards of new refrigerant. This cannot be performed at the shop level. Must be sent to a Refrigerant Reclamation Center.

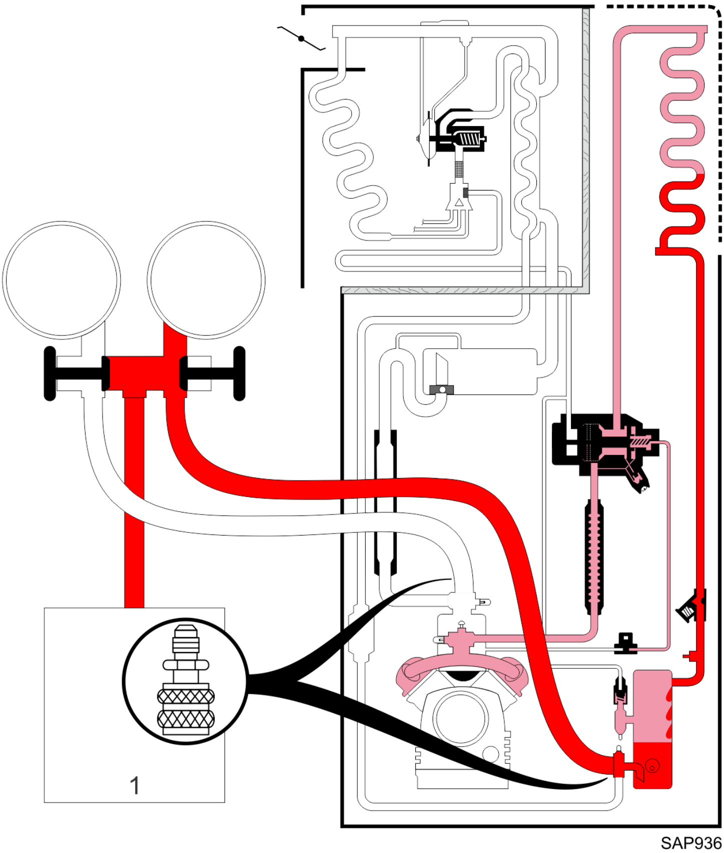
Important: *Recovered refrigerant must be properly reclaimed before it can be used in another unit. Failure to properly clean the refrigerant can introduce contaminants from one unit into another causing damage to additional units.*

Note: *Refrigerant must be recovered from both operable and non-operable units. In addition, refrigerant used to pressurize units for leak testing must also be recovered.*

Recovery from an Operating Unit

If a unit is operable and the compressor functions, the refrigerant should be removed as a liquid. This is the fastest and most efficient method. Proceed as follows to remove refrigerant as a liquid:

1. Install a calibrated gauge manifold.
2. Attach a service line between the receiver tank outlet service port and the recovery machine inlet.
3. Pump down the unit’s low side to force the refrigerant into the condenser and receiver tank.
4. Set the recovery machine for liquid recovery and remove the refrigerant through the receiver tank outlet service valve.



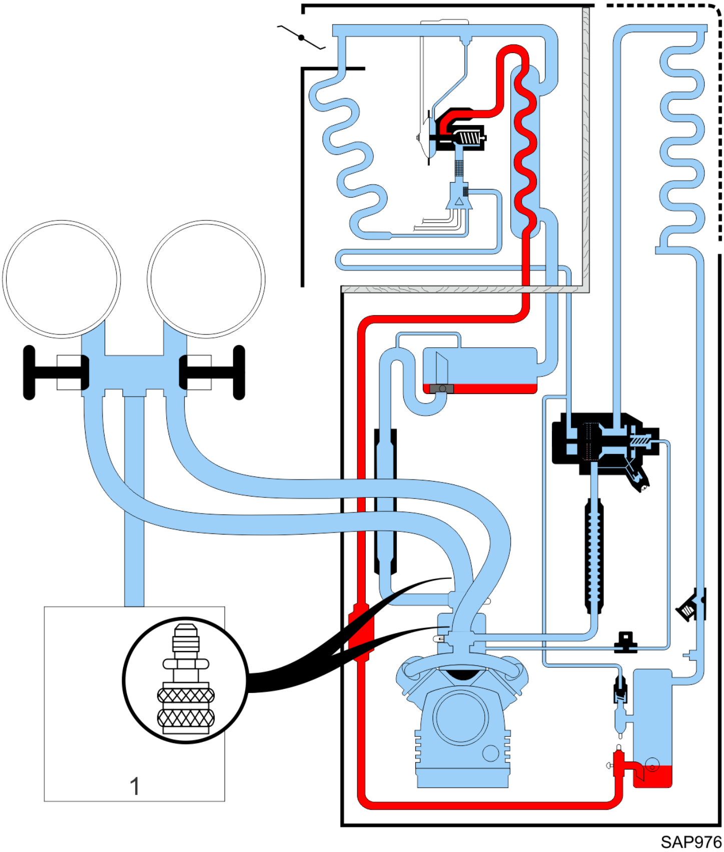
1.	Recovery Machine

Recovery from a Non-Operating Unit

When a unit is inoperable or the compressor will not function, the refrigerant must be removed as a vapor. It can be removed from almost any convenient service port on the compressor or receiver tank. Because refrigerant must evaporate in the unit before removal, it is less efficient and more time consuming than the liquid removal process.

1. Attach a service line between one of the units service ports and the recovery machine inlet.

2. See the recovery machine for refrigerant vapor removal and recover the refrigerant.



1.	Recovery Machine

Refrigerant Types and Properties

During unit cooling, refrigerant is the vehicle within the refrigeration system that picks up the heat inside the box. It then carries the heat outside where it can be given up to the outside air. Following are characteristics of refrigerants and oils presently used in Thermo King units.

NOTICE

Equipment Damage!

Some autos, trucks, and other air conditioning systems use PAG Polyalkylene Glycol compressor lubricant. DO NOT mix with Thermo King Ester Base Oils.

Note: *Polyolester oil has several viscosities specific to compressor type. Refer to Maintenance or Parts manuals for appropriate part number.*

R-22	**Refrigerant Type:** HCFC **Container Color:** Green **Oil Type:** Alkylbenzene/Synthetic
R-134a	**Refrigerant Type:** HFC **Container Color:** Light Blue **Oil Type:** Polyolester (TriPac only - Polyalkylene glycol)
R-401B (MP 66)	**Refrigerant Type:** HCFC **Container Color:** Yellow Brown **Oil Type:** Alkylbenzene/Synthetic
R-402A (HP 80)	**Refrigerant Type:** HCFC **Container Color:** Light Brown **Oil Type:** Alkylbenzene/Synthetic
R-403B (69L)	**Refrigerant Type:** HCFC **Container Color:** Gray **Oil Type:** Alkylbenzene/Synthetic 67–404
R-404A (HP 62) (FX 70)	**Refrigerant Type:** HFC **Container Color:** Orange **Oil Type:** Polyolester
R-452A (XP44)	**Refrigerant Type:** HFO / HFC **Container Color:** White **Oil Type:** Polyolester

Temperature Pressure Chart

Note: *Red numerals - inches HG below 1 ATM.*

TEMP	Green R-22	Lt. Blue R-134a	Yellow Brown R-401B (MP 66)	Lt. Brown R-402A (HP 80)	Gray R-403B (69 L)	Orange R-404A (HP 62) (FX 70)	White R-452A
°F/°C	PSIG	PSIG	PSIG	PSIG	PSIG	PSIG	PSIG
-50/-45.6	6.1	18.5	17.0	1.0	0.5	0	1.1
-48/-44.4	4.8	17.4	16.2	1.3	1.3	0.9	2.3
-46/-43.3	3.4	16.9	15.4	2.8	2.1	2.0	2.9
-44/-42.2	2.7	16.2	14.5	3.7	3.0	2.7	3.8
-42/-41.1	2.0	15.4	13.6	4.6	3.9	3.6	4.8
-40/-40.0	0.5	14.7	12.6	5.6	4.8	4.5	5.8
-38/-38.9	1.3	13.7	11.6	6.7	5.8	5.5	6.8
-36/-37.8	2.2	12.7	10.6	7.8	6.8	6.5	7.9
-34/-36.7	3.0	11.7	9.5	8.9	7.9	7.6	9.0
-32/-35.6	3.9	10.7	8.4	10.0	9.0	8.7	10.2
-30/-34.4	4.8	9.8	7.1	11.3	10.1	9.9	11.5
-28/-33.3	5.8	8.6	5.9	12.5	11.3	11.1	13.1
-26/-32.2	6.9	7.4	4.6	13.8	12.5	12.3	14.1
-24/-31.1	7.9	6.2	3.2	15.2	13.8	13.6	15.4
-22/-30.0	9.0	5.0	1.8	16.6	15.1	14.9	15.8
-20/-28.9	10.1	3.8	0.3	18.0	16.5	16.3	18.3
-18/-27.8	11.3	2.2	0.6	19.5	17.9	17.7	19.8
-16/-26.7	12.6	0.7	1.4	21.1	19.3	19.2	21.3
-14/-25.6	13.8	0.3	2.2	22.7	20.8	20.7	22.9
-12/-24.4	15.1	1.0	3.0	24.3	22.4	22.3	24.8
-10/-23.3	16.4	1.8	3.9	26.1	24.0	23.9	26.5
-8/-22.2	17.9	2.7	4.8	27.8	25.6	25.6	28.3
-6/-26.7	19.4	3.6	5.8	29.7	27.3	27.3	30.1
-4/-25.6	20.9	4.5	6.8	31.5	29.1	29.1	30.3
-2/-24.4	22.4	5.4	7.8	33.5	30.9	30.9	34.0
0/-17.8	23.9	6.3	8.8	26.1	32.8	32.8	36.0
2/-16.7	25.6	7.3	9.9	27.8	34.7	34.8	38.1
4/-15.6	27.4	8.4	11.1	29.7	36.7	36.8	40.2
6/-14.4	29.1	9.4	12.3	31.5	38.8	38.9	42.6
8/-13.3	30.9	10.5	13.5	33.5	40.9	41.1	44.9
10/-12.2	32.7	11.6	14.7	46.6	43.0	43.3	47.3
12/-11.1	34.7	12.8	16.0	49.0	45.3	45.6	49.7
14/-10.0	36.8	14.1	17.4	51.4	47.6	48.0	52.2
16/-8.9	38.8	15.4	18.8	54.0	49.9	50.4	54.7
18/-7.8	40.9	16.7	20.2	56.6	52.4	52.9	57.4

TEMP	Green R-22	Lt. Blue R-134a	Yellow Brown R-401B (MP 66)	Lt. Brown R-402A (HP 80)	Gray R-403B (69 L)	Orange R-404A (HP 62) (FX 70)	White R-452A
°F/°C	PSIG	PSIG	PSIG	PSIG	PSIG	PSIG	PSIG
20/-6.7	43.0	18.0	21.7	59.3	54.9	55.5	60.1
22/-5.6	45.3	19.5	23.2	62.1	57.4	58.1	62.9
24/-4.4	47.7	21.0	24.8	65.0	60.1	60.9	66.0
26/-3.3	50.0	22.5	26.5	67.9	62.8	63.7	69.0
28/-2.2	52.4	24.0	28.2	70.9	65.6	66.5	72.0
30/-1.1	54.8	25.6	29.9	74.0	68.4	69.5	75.1
32/0	57.5	27.3	31.7	77.2	71.3	72.5	81.3
34/1.1	60.2	29.1	33.5	80.5	74.3	75.6	81.6
36/2.2	63.0	30.9	35.5	83.8	77.4	78.8	85.0
38/3.3	65.7	32.7	37.4	87.3	80.6	82.1	88.4
40/4.4	68.5	34.5	39.4	90.8	83.8	85.5	92.0
42/5.6	71.6	36.5	41.5	94.5	87.1	89.0	95.9
44/6.7	74.7	38.6	43.7	98.2	90.6	92.5	99.7
46/7.8	77.8	40.7	45.8	102.0	94.0	96.2	103.5
48/8.9	80.9	42.8	48.1	105.9	97.6	99.9	107.4
50/10.0	84.0	44.9	50.4	109.9	101.3	103.7	111.4
52/11.1	87.5	47.3	52.8	114.0	105.0	107.7	115.5
54/12.2	91.0	49.7	55.3	118.2	108.9	111.7	119.8
56/13.3	94.5	52.1	57.8	122.6	112.8	115.8	124.1
58/14.4	98.0	54.5	60.4	127.0	116.8	120.0	128.5
60/15.6	101.6	56.9	63.1	131.5	120.9	124.3	133.4
62/16.7	105.5	59.6	65.8	136.1	125.1	128.8	138.0
64/17.8	109.5	62.4	68.6	140.9	129.4	133.3	142.8
66/18.9	113.4	65.1	71.5	145.7	133.8	137.9	147.6
68/20.0	117.4	67.9	74.4	150.7	133.8	142.7	152.5
70/21.1	121.4	70.7	77.8	155.8	142.9	147.5	157.6
72/22.2	125.8	73.8	80.6	161.0	147.6	152.5	162.8
74/23.3	130.2	76.9	83.8	166.3	152.4	157.6	168.1
76/24.4	134.7	80.1	87.1	171.7	157.3	162.8	173.5
78/25.6	139.1	83.2	90.4	177.3	162.3	168.1	179.5
80/26.7	143.6	86.4	93.8	183.0	167.4	173.5	185.1
82/27.8	148.5	89.9	97.4	188.8	172.6	179.1	190.9
84/28.9	153.5	93.5	101.0	194.7	177.9	184.7	196.8
86/30.0	158.4	97.0	104.7	200.8	183.3	190.5	202.8
88/31.1	163.4	100.6	108.4	207.0	188.9	196.5	208.9
90/32.2	168.4	104.2	112.3	213.3	194.5	202.5	215.2
92/33.3	173.9	108.2	116.3	219.7	200.3	208.7	221.6
94/34.4	179.4	112.2	120.3	226.3	206.2	215.0	228.1
96/35.6	184.9	116.2	124.5	233.0	212.2	221.4	235.3
98/36.7	190.4	120.2	128.7	239.9	218.3	228.0	242.1

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Temperature Pressure Chart

TEMP	Green R-22	Lt. Blue R-134a	Yellow Brown R-401B (MP 66)	Lt. Brown R-402A (HP 80)	Gray R-403B (69 L)	Orange R-404A (HP 62) (FX 70)	White R-452A
°F/°C	PSIG	PSIG	PSIG	PSIG	PSIG	PSIG	PSIG
100/37.8	195.9	124.3	133.1	246.9	224.5	234.7	248.9
102/38.9	201.9	128.9	137.5	254.1	230.9	241.5	256.1
104/40.0	208.0	133.3	142.1	261.4	237.3	248.5	263.3
106/41.1	214.1	137.8	146.7	268.8	243.9	255.7	270.6
108/42.2	220.2	142.3	151.5	276.4	250.7	262.9	278.1
110/43.3	226.3	146.8	156.3	284.6	257.5	270.3	285.7
112/44.4	233.0	151.8	161.3	292.1	264.5	277.9	293.5
114/45.6	239.7	156.8	166.3	300.1	271.6	285.6	302.1
116/46.7	246.4	161.8	171.5	308.3	278.8	293.5	310.2
118/47.8	253.1	166.8	176.8	316.7	286.1	301.5	318.4
120/48.9	259.9	171.9	182.2	325.2	293.6	309.7	326.8
122/50.0	267.2	177.4	187.7	333.9	301.3	318.0	335.3
124/51.1	274.6	183.0	193.3	342.8	309.0	326.5	344.0
126/52.2	282.0	188.6	199.1	351.8	316.9	335.2	352.8
128/53.3	289.4	194.2	204.9	361.0	324.9	344.0	361.8
130/54.4	296.8	199.8	210.9	370.4	333.1	353.0	371.0
132/55.6	304.8	205.9	217.0	380.0	341.4	362.1	381.2
134/56.7	312.9	212.0	223.3	389.7	349.8	371.5	390.7
136/57.8	321.0	218.2	229.6	399.6	358.4	381.0	400.3
138/58.9	329.1	224.3	236.1	409.7	367.2	390.6	410.2
140/60.0	337.2	230.5	242.7	420.0	376.0	400.5	420.2
142/61.1	346.0	237.2	249.5	430.5	385.0	410.5	430.4
144/62.2	354.9	244.0	256.4	441.1	394.2	420.7	440.7
146/63.3	363.7	250.8	263.4	452.0	403.5	431.1	451.2
148/64.4	372.6	257.6	270.5	463.0	413.0	441.7	461.9
150/65.6	381.5	264.4	277.8	474.3	422.6	452.5	473.8

Modulation

Modulation Function

The modulation system functions to control the box temperature of fresh perishables without excess heating or cooling. It improves the humidity and temperature conditions desirable for fresh products.

A modulation valve, or ETV, and a hot gas bypass valve work together in the refrigeration system to provide precise control of box temperature. Modulation begins when the box temperature is near set point. Full modulation and opening of the hot gas bypass solenoid occur when box temperature comes to within one degree of setpoint.

Modulation functions under the following operating conditions:

1. The unit must be operating in continuous run.
2. The set point must be set above heat lockout 24°F (15°C)-4ºC or -9ºC.
3. The box temperature must be within approximately 10°F (6°C)6°C of setpoint.

Modulation Valve - This valve is located in the suction line between the evaporator and compressor. It closes to its maximum at a box temperature within one degree of setpoint. During modulation the flow of suction gas to the compressor is restricted. This results in a lower cooling effect and is seen as a lowering of the suction pressure at the compressor.

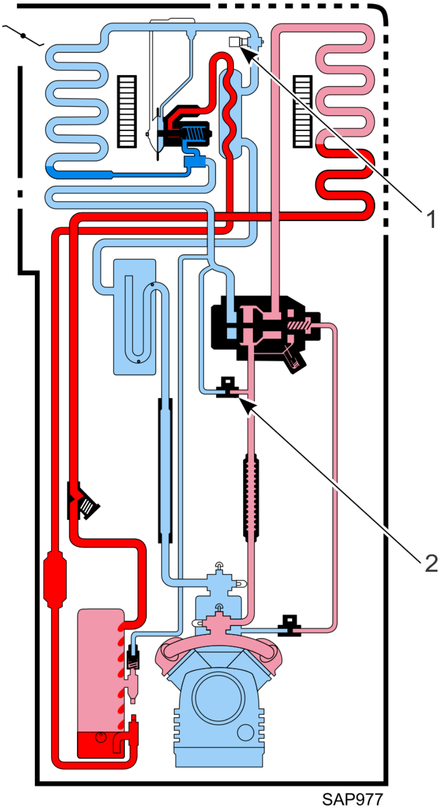
Electronic Throttling Valve (ETV) - This valve is located in the suction line between the evaporator and compressor. It performs the function of the modulation valve and replaces it. The ETV also acts as the throttling valve and replaces it.

Hot Gas Bypass Valve - When box temperature is within about one degree of setpoint, the hot gas bypass valve may be energized (opened). Its function is to minimize the cooling effect of the evaporator’s outlet air while allowing the ETV or modulation valve to remain partially open.

Modulation systems reduce suction pressure returning to the compressor during the modulation mode. The modulation valve is normally in the open position and may be disabled for refrigeration system troubleshooting.

The ETV does not automatically open when de-energized. Refer to the appropriate Maintenance and Diagnostic manuals for proper service procedures.

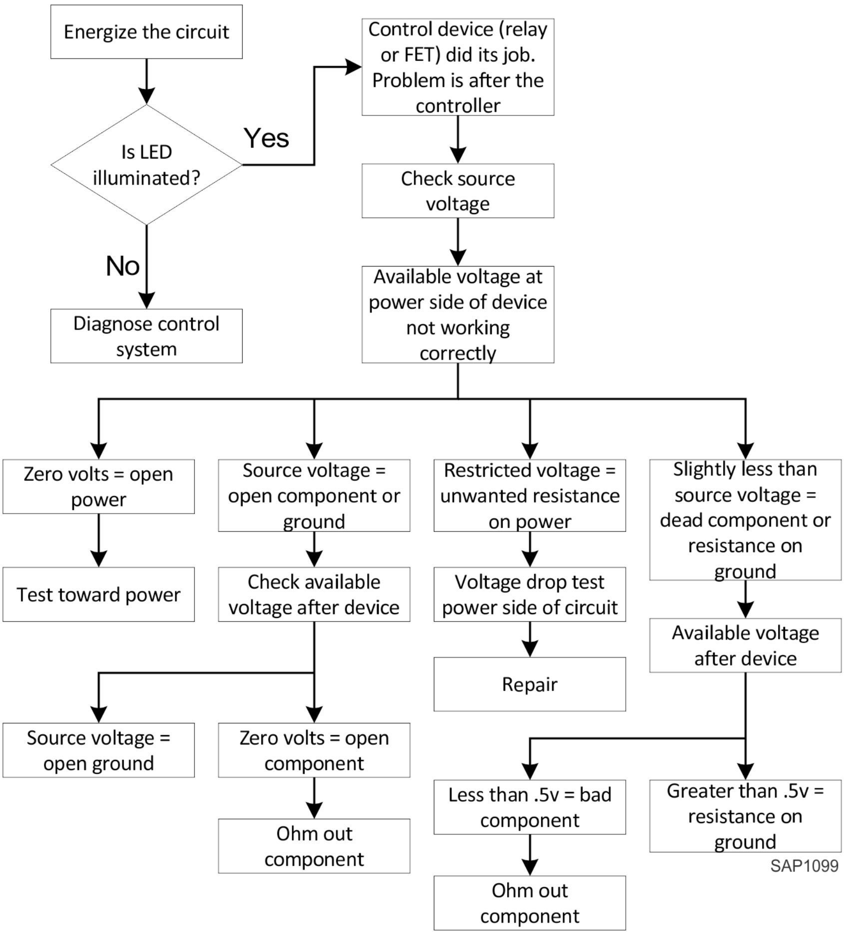
Figure 11. Refrigeration Cycle



1.	Modulation Valve/ETV
2.	Hot Gas Bypass Valve

Initial Electrical Diagnosis

Divide and Conquer



Glossary of Refrigeration Terms

Ambient Air: The air surrounding an object.

Ambient Temperature: Temperature of the air surrounding an object.

Back Seated: The valve stem is backed all the way out (counterclockwise). In this position, the valve outlet to the system is open and the service port is closed.

Bar: Pressure in bar as read by a gauge calibrated to zero when open to the atmosphere. 1 bar = 1 atmosphere pressure.

Boiling Point: The temperature at which a liquid will change to a vapor state when heat is added.

British Thermal Unit (BTU): Heat required to increase the temperature of a pound of water one degree Fahrenheit.

Bypass Check Valve: Located on the receiver tank and is closed during the cool cycle. While in heat or defrost the valve permits hot gas line pressure to pressurize the receiver tank. This pushes refrigerant from the receiver tank out through the expansion valve for increased heating capacity.

Capacity: Refrigerating effect produced by a unit and generally measured in tons or BTU's per hour.

Change of State: The process of changing from a liquid to a gas, a gas to a liquid, a solid to a liquid or a liquid to a solid.

Charge: Amount of refrigerant in a system. The process of adding refrigerant to a system.

Check Valve: A valve that allows refrigerant to flow in only one direction.

Compound Gauge: A gauge that reads inches of vacuum and pounds of pressure per square inch.

Compressor: The refrigeration component that compresses refrigerant vapor and creates refrigerant flow.

Condenser: An arrangement of tubing in which the vaporized and compressed refrigerant is liquefied as heat is removed.

Condenser Pressure Bypass Check Valve: A valve located in the three-way valve end cap. It permits condenser pressure to flow to the discharge line when the 3-way valve first shifts to heat. It improves the three-way valve response time when the pilot solenoid closes.

Condenser Check Valve: A check valve that keeps receiver tank refrigerant from entering the condenser during heat and defrost.

Conduction: Heat transfer between two substances in physical contact.

Convection: Heat transfer between substances through the movement of a fluid (gas or liquid).

Damper Door: An evaporator door that closes during defrost, stopping the flow of heat into the cargo compartment while the unit is in defrost.

Defrost Timer: A solid state module that initiates defrost at selected intervals. Also establishes a maximum defrost time if normal circuits malfunction. This function is built into microprocessor controllers.

Defrost Termination Switch: A temperature sensitive device that closes a circuit at a preset temperature to permit defrost to occur. It opens the circuit to terminate defrost. Found in non-microprocessor controlled systems.

Defrost Relay: A relay with multiple sets of contacts that energize or de-energize circuits required for defrost. Found in non-microprocessor controlled systems.

Dehydration: Removal of moisture with a deep vacuum.

Drier (Dehydrator): A device used to remove moisture from refrigerant.

Discharge Pressure: Operating Pressure measured in the discharge line at the compressor outlet.

Distributor: A device for dividing flow of liquid between parallel paths in an evaporator.

DPR: Discharge Pressure Regulator.

DSV: Discharge Service Valve.

ETV: Electronic throttling valve performs the functions of both modulation valve and throttling valve.

Evacuation: The removal of air or other non-condensable gases from the refrigeration system.

Evaporator: The part of the system in the cargo area where heat is absorbed during cooling.

Expansion Valve: A device that meters liquid refrigerant into the distributor and evaporator coil in direct response to the heat load on the evaporator. When replacing expansion valves, only Thermo King replacement valves must be used due to special machining. Using valves without this machining will result in reduced heating and defrost capacity.

Front Seated: A service valve with the stem turned in (clockwise) all the way. The valve outlet to the system is closed and the service port is open.

Frost Back: The accumulation of frost on the suction line indicating that liquid refrigerant is evaporating in the line on its way to the compressor.

Gauge Pressure: The pressure reading measured on a gauge calibrated to read zero psi (zero kPa) at atmospheric pressure. Referred to as PSIG.

Gas: Common terminology for refrigerant in the gaseous state.

Head Pressure: A term commonly used to mean discharge pressure.

Heat Exchanger: The component in which heat is transferred from one fluid to another.

Heat Initiation Timer: A solid state module used to time the evacuation cycle on truck units with Thermax. This function is built into microprocessor controllers.

High Pressure Relief Valve: A safety valve on the refrigeration system that will allow refrigerant to escape from the system if the operating pressures exceed a predetermined specification.

High Side: The portion of the refrigerating system operating under condensing pressure.

HIT: See Heat Initiation Timer.

Hot Gas Defrost: Coil defrosting using high pressure and temperature refrigerant vapor.

Hot Gas Bypass Valve: On units Equipped With Modulation. The valve is located between the discharge line and the hot gas line. This valve is energized (open) when the modulation valve or ETV is near 100% modulation (fully closed).

TherMax: Refers to a truck unit that uses a condenser evacuation cycle for added heating capacity.

Inches of Vacuum: Pressure below atmospheric pressure. Measured in inches of mercury. Written as 29″Hg.

Latent Heat: Heat absorbed or released during the change of state of a substance without changing its temperature.

Liquid Line: The tube carrying liquid refrigerant from the receiver tank to the expansion valve.

Load: The amount of heat to be removed in a given amount time.

Low Side: The part of a refrigeration system normally under low pressure during the cool mode.

Modulation Valve: A valve placed in the suction line of the refrigeration system. Its purpose is to control refrigerant flow back to the compressor when the box temperature is close to setpoint. Enables the unit to maintain a more precise box temperature.

Pilot Solenoid: An electromagnetic valve for controlling the three-way valve. When energized the unit will operate in the heat mode.

Piston Reeds: Valve reeds located on the top of the compressor piston. They lift to allow refrigerant to enter the cylinder and close to compress the refrigerant vapor. These reeds are tested by using the compressor capacity test.

Pressure: The push exerted against container walls by a liquid or gas, usually given in pounds per square inch.

Pressure Drop: Loss in line pressure from one point to another due to friction, etc.

Pretrip: A term commonly used for the procedure followed to check the operating condition of a refrigeration system before loading.

Product: The cargo being temperature controlled.

Psig: Pressure in pounds per square inch as read by a gauge calibrated to zero when open to the atmosphere.

Pump Down: The operation by which the refrigerant in a charged unit is pumped and stored in one part of the system while servicing another part.

Radiation: Heat transfer through a substance without changing the substance temperature.

Receiver Tank: A refrigerant storage tank.

Receiver Outlet Check Valve: A check valve used in the liquid line to prevent refrigerant flow from the liquid line to the receiver during heat and defrost modes in Thermax units.

Reclaim: The process of cleaning refrigerant to like-new condition. Cannot be done in the field.

Recover: To remove refrigerant from a system and store it in an external container without testing or processing it.

Recycle: To clean refrigerant for reuse by removing oil through single or multiple passes through moisture absorption devices such as replaceable core filter driers. Considered an in-field process.

Refrigerant: The chemical used to carry the heat from one point to another in the refrigeration system. It absorbs heat as it evaporates and releases heat as it condenses.

RPM: An abbreviation for revolutions per minute.

Sensible Heat: Heat that can be measured. Causes a change of temperature in a substance.

Sight Glass: A system component that permits a visual inspection of oil and/or refrigerant level and condition.

Short Cycling: The circulation of air out of the evaporator outlet and back to the evaporator inlet without properly circulating through the load of product.

Slugging: The return of either refrigerant or oil to the compressor in a liquid state. Slugging can cause knocking and damage to the compressor.

Solenoid Valve: An electro-magnetic valve that can be opened or closed electrically.

Specific Heat: The ratio of heat required to change the temperature of a given unit of a substance compared to the amount of heat required to change the temperature of an identical amount of water.

SSV: Suction Service Valve.

Suction Pressure Regulator: A device that controls the flow of refrigerant vapor to the compressor. It limits the load on the engine or electric motor. Similar to a throttling valve.

Suction Reeds: See Piston Reeds.

Superheated Gas or Vapor: Vapor that is at a temperature which is higher than the saturation temperature, or boiling point, for a given pressure.

TD: An abbreviation for Temperature Difference.

TherMax (Heat) Solenoid: An electromagnetic valve used on truck units with improved heating. This valve is open during the condenser evacuation cycle allowing refrigerant to flow from the liquid line to the accumulator.

Thermostat (Box Temperature Thermostat): A device that controls the unit modes of operation to maintain a desired box temperature. This function is built into microprocessor controllers.

Three-Way Valve: A valve used on Thermo King refrigeration units that controls refrigerant flow. It's position determines whether the unit cools or heats.

Throttling Valve: A device that controls the flow of refrigerant vapor to the compressor. It limits the load on the engine or electric motor.

Ton of Refrigeration: Refrigerating capacity equivalent of 12,000 BTU/ Hour.

Transducer: A mechanical device that converts internal refrigerant system pressures to an electrical output (analog) which is sent to the microprocessor.

Valve Plate: An internal part of the compressor located above the piston, Its purpose is to prevent refrigerant flow back into the cylinder from the compressor head and manifold area.

Vapor/Vapour: Common terminology for refrigerant in a gaseous state.

Conversion Chart

English To Metric Conversions

1 Bar	=	14.7 psig
1 Btu	=	252 Gram-calories
1 Btu/Hr	=	.252 K cal/Hr
1 Btu/Hr-°F	=	.453 K cal/Hr.°C
1 Btu/Hr-Ft^2-°F	=	4.88 K cal/Hr-M^2-°C
1 Cfm	=	28.32 Liters/Minute
1 Cfm	=	1.7 Cubic Meters/Hr
5/9 (°F-32)	=	°C
1 Foot	=	.3048 Meter
1 Square Foot	=	.0929 Square Meter
1 Cubic Foot	=	.0283 Cubic Meter
1 Gallon	=	3.785 Liter
1 Inch	=	2.54 Centimeters
1 Square Inch	=	6.452 Square Centimeters
1 Cubic Inch	=	16.39 Cubic Centimeters
1 Inch H^{2}O	=	2.54 Grams/CM^2
1 Pound	=	453.6 Grams
1 PSI	=	.07031 Kg/CM^2
1 Watt	=	3.413 Btu/Hr
Micron	=	.000 0001 Meters

1 Bar	=	14.7 psig
1 Btu	=	252 Gram-calories
1 Btu/Hr	=	0,252 K cal/Hr
1 Btu/Hr-°F	=	0,453 K cal/Hr.°C
1 Btu/Hr-Ft^2-°F	=	4,88 K cal/Hr-M^2-°C

1 Cfm	=	28.32 Liters/Minute
1 Cfm	=	1.7 Cubic Meters/Hr
5/9 (°F-32)	=	°C
1 Foot	=	0,3048 Meter
1 Square Foot	=	0,0929 Square Meter
1 Cubic Foot	=	0,0283 Cubic Meter
1 Gallon	=	3,785 Liter
1 Inch	=	2,54 Centimeters
1 Square Inch	=	6,452 Square Centimeters
1 Cubic Inch	=	16.39 Cubic Centimeters
1 Inch H^2O	=	2,54 Grams/CM^2
1 Pound	=	453,6 Grams
1 PSI	=	0,07031 Kg/CM^2
1 Watt	=	3,413 Btu/Hr
Micron	=	0,000 0001 Meters

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.

TK 5984-7-RP-EN 01 Mar 2018
Supersedes TK 5984-7-RP-EN (April 2015)