TRANSPORT REFRIGERATON EXAMINATION

PART C – TRANSPORT SPECIFIC QUESTIONS

General Engine Preventive Maintenance

This section is devoted to discussing general preventive maintenance that will cover belt tension, oil, fuel, air filters, and the battery charging system.

Battery Maintenance. If a battery is not maintained properly, its service life will be reduced. Battery maintenance should be done periodically—during tune-ups, grease jobs, or anytime symptoms indicate battery problems. Battery maintenance typically includes: (1) Checking the electrolyte level. (2) Cleaning the battery terminal connections. (3) Cleaning the battery top. (4) Checking the battery hold-down and tray. (5) Inspecting for physical damage to the case and terminals.

The battery has several important functions. It operates the starting motor, ignition system, electronic fuel injection system, and other electrical devices during the cranking and starting. It helps the charging system. It acts as a capacitor (voltage stabilizer) that smooths current flow through the electrical system and stores energy for extended periods.

A fully charged 12 volt battery has six cells, which produces an "open circuit" (no load) voltage of 12.6 volts.

Battery cables are large wires that connect the battery terminals to the unit's electrical system. The positive cable is usually red and fastens to the starter solenoid. The negative cable is usually black and connects to ground on the engine block. The ground cable may not always be insulated. Sometimes the negative battery cable will have a body ground wire, which ensures that the unit body is grounded. If this wire does not make a good connection, components grounded to the body may not operate properly.

The term microprocessor means small (mirco) computer (processor). A microprocessor is a small computer chip or an integrated circuit capable of analyzing data and calculating appropriate outputs.

Before performing repairs on units equipped with microprocessor controllers be sure to turn OFF the microprocessor before removing the battery cables. On negative ground DC electrical systems always disconnect the negative battery cable before removing removing the positive battery cable.

While performing a PM inspection, start the unit and observe the charging system charge rate. It should be fairly high between 20 and 25 amperes at first and then fall fairly quickly if the battery is in good condition and fully charged.

The Battery Cold Cranking rating (600 CCA) determines how much current (600 amperes) the battery can delivery for 30 seconds at 0 degrees F while maintaining terminal voltage of 7.2 volts. This rating indicates the battery's ability to crank a specific engine (based on started current draw) at a specified temperature.

In emergency situations, it may be necessary to jump start the engine by connecting another battery to the discharged battery. Connect the red jumper cable to the positive terminal of both batteries. Then, connect one end of the black jumper cable to the negative terminal of the good battery. Finally, connect the other end of the black jumper cable to a good ground on the unit with the bad battery.

If it becomes necessary to jump start a unit, do not jump start a frozen battery, do not connect the negative jumper cable directly to the negative battery post on the unit or use a booster device of a 24Vdc source.

A loose alternator belt, loose or broken wire connections in the alternator circuit, or corroded battery cables may cause the battery to be undercharged or discharged. Under-charging or over-charging, removing battery cables by twisting, ending, prying, and "hammering" cables onto the battery posts can cause early battery failure.

Most manufacturers recommend the use of a belt tension gauge to measure belt tightness. Use of the gauge ensures that the belt is not too tight or too loose. An over tightened belt will fail quickly and may damage other parts. A loose belt will slip and squeal, or it could fly off its pulleys.

After adjusting the belt tension on a truck unit, the belt tension should be rechecked cold after 10 hours of operation.

A battery voltage test is done by measuring total battery voltage with a voltmeter or special test. It will determine the general state of charge and battery condition quickly. A fully charged battery under a 5 amp load should have 12.5 volts.

When tests show that a battery is discharged, a battery charger may be used to re-energize it. The battery charger will force current back into the battery to restore the charge on the plates and in the electrolyte.

To use a battery charger, be sure that the battery charger is OFF when connecting or disconnecting it to or from the battery. This will reduce the possibility of a dangerous battery explosion.

The charging system is needed to replace electrical energy drawn from the battery during starting system operation. To re-energize the battery, the charging system forces electric current back into the battery. The fundamental part of the charging system is the alternator.

When the engine is running, a drive belt spins the alternator pulley. The alternator can then produce electricity to recharge the battery. A voltage regulator, usually built into the alternator, controls the voltage and current output of the alternator by controlling the voltage in the rotor field.

When diagnosing an alternator that does not charge, check for voltage on the output, sense, and excite terminals at the alternator.

Diesel Fuel System. The fuel system must provide the correct mixture of air and fuel for efficient combustion (burning). The system must add the right amount of fuel to the air entering the cylinders. This ensures that a very volatile (burnable) mixture enters the combustion chambers.

Fuel Filter and Diesel Injection Pump. The fuel system must also alter the air-fuel-ratio (percentage of air and fuel) with changes in operating conditions (engine temperature, speed, load, and other variables).

A diesel injection pump has several important functions: (1) Meters the correct amount of fuel lines to each injector. (2) Circulates fuel through fuel lines and nozzles. (3) produces extremely high fuel pressure. (4) Provides a means of the driver to control engine power output. (5) Controls engine idle speed and maximum engine speed. (6) Helps close injector nozzles after injection and (7) Provides a means of shutting off the engine.

After replacing the fuel filter and cleaning the fuel pump inlet screen, if the engine will not start, you should open the bleed screw and use the hand-pump to purge air from the fuel system.

The air filter should be changed when the Filter Minder indicates 22-25 inches of mercury.

Fuel Tank Service. Typical fuel tank problems include fuel leakage, physical damage (dents, holes, etc.), and contamination (rust, dirt, and water). Vibration or rusting can cause a fuel tank to develop pinhole leaks. Rocks can puncture the tank. Internal deterioration of the tank or foreign matter in the fuel can cause contamination problems.

Before servicing a fuel tank, make sure you empty the tank. A full tank is very heavy and can rupture if dropped.

To remove fuel from the tank, unscrew the small drain plug and drain the fuel into an approved safety can.

Other PM Items. When performing a 12-month PM service, it is not necessary to install a gauge manifold set on the refrigeration unit to check the compressor oil level. Check the oil level at the compressor crankcase sight glass.

When refilling the crankcase of a self-powered truck unit's engine always add oil slowly and remove the dipstick. Do not add oil too quickly because this may cause oil to flow into the intake manifold cylinders. Never over-fill the crankcase.

Check for worn or loose compressor and engine mounts. Worn or loose mounts may case refrigerant leaks, additional strain on vibration eliminators, broken doors or hardware.

Synthetic grease should be applied to damper door stops and bushings to displace moisture and to prevent frozen damper doors on the refrigeration unit.

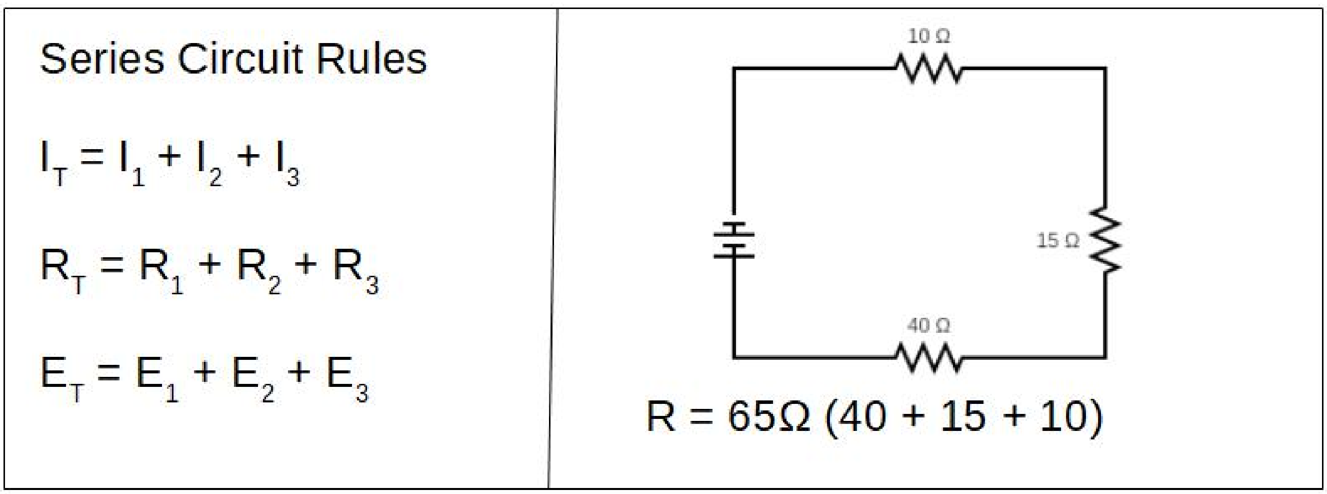
Trailer Unit High Speed Adjustment. Correct engine speed (RPMs) is critical. Engine speed affects airflow in the trailer, unit capacity, and fuel consumption. Incorrect engine speed can even lead to refrigerant line leaks due to abnormal and excessive vibration. Check unit engine speed specifications.

The high-speed adjustment on the trailer unit should always be done at the throttle solenoid linkage.

Basic Electrical

In this section we will discuss what is required to have an electrical circuit. An electrical circuit must have a power source, a conductor (electrical wire) to carry the current, and a load or device to use the current. An example would be a 12 volt DC or 120 volt AC electric fan motor that requires a power source and conductor (wire) to carry the current.

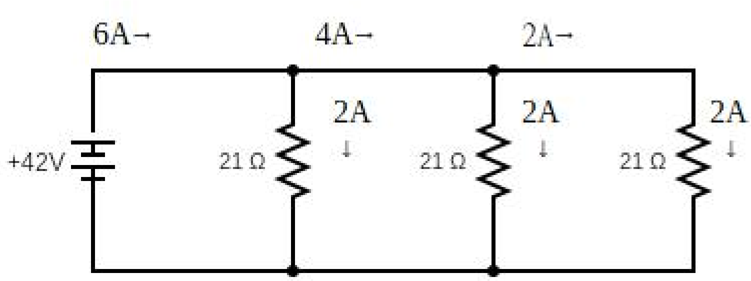
Series Circuit. In a series circuit the voltage is divided across the different resistances. The total current flows through each resistance or load and the resistances are added together to obtain total resistance. A series circuit provides only one possible path for the current flow. All of the power must flow through all of the loads. When multiple loads are connected in series, each load is part of the complete circuit. If one load opens (burns out), there is no conducting path. The effect is the same as opening a switch.



Remember, the circuit uses up all the voltage is starts with. Each load in a series circuit will use some of the available voltage. This leaves less voltage for the loads that follow. In a series circuit, the loads in the circuit uses up all of the voltage. For example, if we have a 24Vdc series circuit, after passing the voltage through all of the loads, it ends with 0 volts.

Parallel Circuits. Parallel Circuits have two or more paths for current flow. In a parallel circuit the total voltage is applied across each resistance.

The current is divided between the different loads according to their individual resistances, and the total current is equal to the sum of the currents in each branch.



In order to determine the voltage, amperage, or resistance (ohms) in an electrical circuit, there are four different types of meters that are used: a voltage meter, amperage meter, ohmmeter, or a digital voltmeter (multi-meter). The digital voltage meter (multi-meter) can be used to determine voltage, amperage, or resistance (ohms). Multi-meters are best for quickly testing the condition of a DC circuit. It is also used for AC circuits.

It is important to note that a 12-volt test light is not recommended for diagnosing electrical systems. Test lights may overload and damage delicate microprocessor circuits and components.

Voltage Drop in a Circuit. Voltage drop is the amount of voltage lost in a circuit. Increased resistance in a circuit causes increased voltage drop.

In a Volt Drop test we would use a voltmeter to look for high resistance in a circuit. The best part of this test is that it allows you to check for resistance without physically taking things apart. The volt drop test is very flexible. It can be used to test complete circuits or individual components. High resistance in the circuit causes high voltage drop. It allows you to locate where voltage is lost. The voltage drop test is an excellent way to locate unwanted resistance in any part of a circuit.

While performing a voltage drop test on the circuit before a solenoid the voltmeter reads a 4 volt drop. This would indicate that the circuit has abnormally high resistance.

A solenoid that has a loose and corroded chassis ground may not operate normally, even though it receives full battery voltage.

When voltage drops between the source and device exceeds 10% of source voltage or a circuit segment rises above 0.5 Vdc, it starts to become a problem. Voltage that is lost, or dropped, in a circuit is not available for components to operate. They may become slow, dim, or weak.

When a throttle solenoid will not pull in and the relay board LED is on and available voltage at the power terminal is 12.6 Vdc, you need to test the available voltage at the ground side terminal . If the ground side terminal voltage is 12.6 Vdc, this indicates that the ground side of the circuit is open. If the ground side terminal voltage is 0 Vdc, this indicates that the throttle solenoid coil is open.

Refrigeration Components

The Four Basic Components of a Refrigeration System. The basic refrigeration system has four components: (1) Compressor, (2) Condenser, (3) Expansion Valve, (4) Evaporator.

Compressor. The compressor is the heat of the refrigeration system. It pumps heat through the system in the form of heat-laden refrigerant. A compressor can be considered a vapor pump. It reduces the pressure on the low-side of the system, which includes the evaporator, and increases the pressure on the high-side of the system. This pressure difference is what causes the refrigerant to flow through the system. The compressor increases the pressure, temperature, and boiling point of the refriger**ant.**

Condenser. Refrigerant systems are divided into a high-side and a low-side. The condenser oil is located in the high-side. It rejects both sensible and latent heat from the refrigeration system to the ambient air while changing the refrigerant vapor to a liquid state. This heat can come from what the evaporator has absorbed, any heat in the compression or mechanical friction generated in the compression stroke, motor-winding heat, and any heat that may have been picked up in the suction line before the refrigerant entered the compressor.

Thermostatic Expansion Valve. After the hot liquid refrigerant leaves the condenser coil, the high pressure, high temperature liquid travels down the liquid line to the expansion valve. The expansion valve restricts and controls the flow of refrigerant pressure entering the evaporator coil.

Expansion valves used on three-way valve refrigeration systems include a bleed notch machined into the expansion valve. The bleed notch is part of the bypass circuit that flushes refrigerant from the receiver tank and liquid line into the evaporator for improved heating and defrost.

Evaporator. The evaporator coil absorbs heat from the refrigeration system. As the refrigerant liquid boils off in the evaporator coil the refrigerant liquid absorbs latent heat from the refrigeration load. The refrigerant liquid changes state to a vapor. Then the refrigerant vapor exits the evaporator coil and travels back down the suction line to return to the compressor.

Three-Way Valve and Pilot Solenoid Valve. The three-way valve directs hot refrigerant gas to either the condenser coil (in the cooling mode) or directly to the evaporator (in the heating mode). The three-way valve uses a combination of spring pressure and internal system pressures to control the spool movement (sliding back and forward). The spool position determines whether the unit will cool or heat.

The pilot solenoid valve is an electrically operated valve that controls the position of the three-way valve spool. When electrically de-energized, the pilot solenoid is closed. A combination of spring pressure and discharge gas pressure maintain the three-way valve in the cool position. The three-way valve directs the hot gas to the condenser. The three-way valve is shifted to the evaporator side seat.

When energized, the pilot solenoid valve is open. Discharge gas pressure is removed and the three-way valve shifts to the heat position. The three-way valve directs hot gas to the evaporator.

When performing the Combined Heating Test the condenser pressure bypass check valve, condenser check valve, and the condenser seat of the three-way valve are tested.

Throttling Valve. The throttling valve limits refrigerant pressure entering the compressor. Too much refrigerant pressure results in compressor overloading. If left uncontrolled, this excessive load reduces fuel economy and can overload the electric motor of units equipped with the optional electric standby system.

When checking the throttling valve setting, the gauge pressure should be approximately 40 psig. Install a gauge manifold and attach a low pressure gauge to the Schrader port on the throttling valve. When the manifold compound gauge reads above 40 psig the low pressure gauge should read within 10% of specifications.

After performing a throttling valve pressure setting check, a change of more than 2 pounds of pressure drop would require a new spring.

System Charging

Charging the Refrigeration System. Charging a system refers to adding refrigerant to a refrigeration system. The correct charge must be added for a refrigeration system to operate as it was designed to, and this is not always easy to do. Each component in the system must have the correct amount of refrigerant. The refrigerant may be added to the system in the vapor or liquid state by weighing, measuring, or using operating pressure charts. When using the system operating charts and tables to determine the correct system charge, a number of factors should be taken into account. These factors include, but are not limited to, high-and-low-side saturation pressures, ambient temperatures, evaporator superheat, condenser sub-cooling, compressor amperage draw, and temperature differentials across heat exchange surfaces.

Normal Discharge Pressure. To estimate normal discharge pressure, you need to know the type of refrigerant, the ambient air temperature entering the condenser, and the actual discharge pressure.

As a standard rule, condenser coil temperature is about 25 degrees F higher than the ambient temperature for fresh product range. For frozen product range, add 15 degrees F to the ambient temperature to determine the condenser coil temperature.

Normal Suction Pressure. To estimate normal suction pressure, you need to know the system's refrigerant type, the return air temperature inside the refrigerated space, and the actual suction pressure.

As a general rule, evaporator coil temperature is about 30 degrees F lower than return air temperature in the fresh product temperature range. This difference in temperature is required to cause heat to transfer from the air to the evaporator coil. To estimate normal suction pressure, subtract 30 degrees F from the return air temperature and then convert to pressure using a temperature-pressure chart.

Refrigerant Level Checks. On start up of your refrigeration unit in high speed cooling mode and after running for several minutes, you notice that your unit's liquid light sight glass is empty. Your next step would be to keep the unit running and gradually cover the condenser and observe the sight glass for two to three minutes.

If you are going to perform the Refrigerant Level Quick Check you will need to run the unit for five to ten minutes in high speed cooling mode. Cover the condenser for 1 to 3 minutes as you check for liquid in the sight glass.

If you determine that the unit has a partial charge and you need to add refrigerant you would continue to run the unit and meter liquid to the suction service valve port at 25 psig above normal suction pressure.

If you want to perform the Controlled Refrigerant Level Check on a unit you must install a gauge manifold, operate the unit in high speed cooling mode at 0 degrees box temperature with discharge and normal suction pressure.

System Breakdown Process. In the refrigeration system, oxygen and moisture quickly join in a common attack on the refrigerant and refrigeration oil. Oxygen and moisture can cause corrosion, copper plating, acid formation, sludge formation, and other harmful reactions. Tests have shown that, in the presence of heat, the combination of air and moisture is far more likely to cause a breakdown of the refrigerant and oil mixture than increased amounts of moisture alone.

To remove a sample of refrigerant oil from the compressor for acid testing, it is best to use the access valve actuator to draw a sample from the compressor oil filter while the unit is running.

Compressor Oil Pressure. Most compressors need at least 30 psig of actual oil pressure for proper lubrication. This means that whatever the suction pressure is, the oil pump discharge pressure has to be at least 30 pounds above the oil pump inlet pressure, because the oil pump inlet pressure is the same as the suction pressure.

When checking the oil pressure, note the pressure difference between the Schrader valve on the compressor oil pump and the Schrader valve on the front of the throttling valve.

Reciprocating and Scroll Compressors

In a refrigeration system, the compressor performs several important functions and is sometimes referred to as "the heart of the system". It is the pump that keeps refrigerant and oil moving through the system.

Type of Compressors

In truck and trailer units you may find several types of open drive compressors. This means there is a pulley, clutch, or drive coupling attached to a crankshaft that extends out of the compressor body. There are two types of open drive compressors: 1) Reciprocating and 2) Scroll.

Reciprocating Compressors

This type has pistons that move up and down in cylinders, similar to an internal combustion engine.

Some open drive compressors are drive coupling connected. A drive coupling is used to connect the compressor directly to the engine in the trailer unit. A pulley may be used to connect the compressor to an engine or electric motor by belt in truck units.

Compressor Drive Coupling. Drive couplings and pulleys should always be removed with an appropriate puller. Never hammer the coupler or the end of the crankshaft. Damage to the coupler, shaft, or main bearing may occur.

The compressor crankshaft keyway is cut with a tool that leaves a radius at the end of the keyway. If the key being installed is pushed too far into the keyway it will rise on this radius, preventing the taper from sealing properly and will cause the coupling to wobble. Abnormal stress is placed on the crankshaft and will shorten its life. The compressor drive coupler should be installed using the alignment tool.

Compressor Crankshaft Seals. The compressor crankcase is part of the refrigeration system and is pressurized with refrigerant. On an open drive compressor, the crankshaft must pass through the compressor body to connect to the external drive source. The compressor crankshaft seals prevent refrigerant loss while allowing the shaft to turn.

Steel Bellows Type Compressor Shaft Seal. When installing the steel bellows type compressor shaft seal, do not touch or damage the polished seal face surface. Apply absolutely clean compressor oil to the polished surfaces of the seal, the lip seal, and the seal plate gasket. Clean the mating ring (hard ring) and primary ring (bronze) with alcohol wipes follow by the use of lint-free dry wipes.

If just after installing a steel bellows type compressor shaft seal, you discover a small leak, operate the unit for a period of time and recheck.

Scroll Compressors

The concept of compressing a gas by turning one scroll against another around a common axis isn't new.

Scroll compressor operation is relatively simple. Two spiral-shaped scrolls fit inside one another. One of the spiral-shaped parts stays stationary while the other orbits around the stationary member. The orbiting motion is created from the center of the journal bearings and the motor being offset.

The scroll compressor always takes a fixed volume of gas at suction pressure and then decreases the same gas volume, which increases its pressure. In fact, during the discharge phase, the scroll compressor compresses the discharge gas to a zero volume. This eliminates any carryover of trapped discharge gas in a clearance volume that is characteristic of piston-type compressors. Because of this, the scroll compressor is often referred to as a "fixed-compression ratio" compressor.

Unlike the piston-type compressors, the scroll compressor has no re-expansion of discharge gas that can be trapped in a clearance volume.

To change the liquid line drier, replace the high pressure cutout, or to check the condenser side of a three-way valve, you would perform a high side pump down on a scroll compressor unit.

To perform the high pressure pump down on a scroll compressor you should operate the unit in low speed to no more than 10" Hg for less than one minute.

Since a scroll compressor does not have a discharge valve plate a low side pump down is not used to test the compressor discharge.

Heat and Defrost Modes

Heating Mode. Most transport refrigeration units are capable of heating when necessary to protect cargo in cold ambient conditions.

When the refrigeration unit is switched from the cooling mode to the heating mode the compressor receives low pressure refrigerant vapor from the suction line and compresses it at a ratio of approximately 50:1. High pressure, high temperature vapor travels up the discharge line, through the discharge vibration absorber, to the three-way valve.

Since the temperature control (microprocessor controller) is calling for the heat mode, the pilot solenoid is energized (open). The open pilot solenoid causes the three-way valve spool to shift to the condenser seat, blocking refrigerant flow to the condenser.

Refrigerant vapor travels up the hot gas line to the distributor. From the distributor, hot gas is routed directly to the evaporator coil to warm box air as it passe through the suction line into the accumulator. The accumulator is a very significant component in the heat mode. It protects the compressor by trapping liquid refrigerant and compressor oil before it returns to the compressor. Where does the liquid come from?

A large amount of compressor oil may accumulate in the evaporator coil when the unit is operating in cooling mode. When the unit shifts to the heat mode, a sudden rush of hot refrigerant vapor enters the cold evaporator and immediately condenses to liquid. This liquid refrigerant, along with the compressor oil, travels down the suction line to the accumulator. The accumulator is designed to trap liquid and meter it back to the compressor at a slow and harmless rate. A small hole in the accumulator "U-tube" safely meters liquid refrigerant and oil to the compressor.

After leaving the accumulator, refrigerant vapor travels through the suction line, suction vibration absorber, suction service valve, and the throttling valve. The throttling valve reduces high suction line pressures entering the compressor. This limits the load on both the compressor and the engine or electric motor on units equipped with the optional electric standby system. Current units may have an electronic throttling valve that replaces the mechanical valve.

Heat/Defrost Cycle Diagnosis. The heat/defrost cycle is based on a different system from the cool mode. The role of some components and the internal seal points change in the heat mode. As a result symptoms and diagnostics will be different.

Low Discharge Pressure during the heat cycle in the main symptoms of a problem.

Lack of heating capacity may be caused by:

1) Low refrigerant charge.
2) Reduced compressor capacity.
3) Leaking internal seals at the three-way valve condenser seat or the condenser check valve.

Note that long or frequent defrost cycles will reduce cooling capacity.

A discharge pressure regulator in a scroll compressor system helps to maintain a minimum discharge pressure during the heating mode.

Defrost Mode. The defrost mode of a single-temp unit is identical to the heat mode, except that, during defrost operation, the damper door is closed. Closing the damper door traps and re-circulates heat within the evaporator compartment. The heat melts ice from the evaporator coil and water drips into the defrost pan. The defrost pan channels water to a pair of drain tubes. The drain tubes carry melt-water to the outside of the refrigerated compartment and deposit it on the ground beneath the trailer.

During the cooling mode the evaporator will accumulate ice on the evaporator coil due to the moisture content in the air. The defrost timer function of the microprocessor controller will initiate a defrost operation on a timed interval if the evaporator coil is below about 45 degrees F.

Excessively long defrost operation or the unit repeatedly staying in defrost mode for over 45 minutes may be caused by:

1) The damper door did not seal properly or the refrigerant level is low.
2) A leak in the three-way valve on the condenser side.
3) A leak in the condenser check valve.
4) The throttling valve pressure is set to low.

Service Symptoms

By comparing normal conditions to current conditions, you may find some differences. There are three primary symptoms that will help you diagnose system problems:

1) Suction pressure (high or low)
2) Discharge pressure (high or low)
3) Suction line condition (dry or frosted)

Low Suction Pressure. Low suction pressure will be caused by:

1) Lack of heat exchange in the evaporator. Anything that prevents air touching the coil fins or moving through the evaporator coil restricts heat exchange.

Plastic pallet wrap and dirt accumulation on the evaporator coil may cause the unit to consume more fuel due to reduced efficiency, may cause the unit to go into defrost mode more often than necessary, and may cause the unit to not provide adequate air flow to the refrigerated load.

When the air flow through the evaporator coil is restricted, the suction pressures will be abnormally low and the suction line very cold or frosted.

Example: A unit with a throttling valve has lower than normal suction pressure with a heavily frosted suction line. Check for a heavily frosted evaporator coil, dirt or debris on the coil, or a damper door that may be stuck closed.
2) Lack of refrigerant reaching the evaporator due to a liquid line restriction or low refrigerant charge in the unit. A restricted component in the liquid line would cause a lower than normal suction pressure and an unfrosted suction line.

3) Restricted suction line. A malfunctioning Electronic Throttling Valve (ETV) may restrict flow to the compressor. The ETV may be electrically tested using an ohmmeter or AC voltmeter.

High Suction Pressure. High suction pressure can be caused by:

1) Internal high to low side leak. Discharge pressure leaking into the low side at one of the internal seal points. A leaking three-way valve evaporator seat or hot gas bypass valve will create a high suction pressure with a warm/dry suction line. To check for an internal high to low side leak, perform a low side pump down during the cool mode.

To perform the low side pump down, close the receiver outlet tank service valve and operate the compressor until the suction pressure pulls down into a vacuum. Shut off the unit and let it set. Watch for a rise in the suction pressure. If the suction pressure rises, this indicates an internal high side leak. On a single-temperature trailer unit, a low-side pump down test allows you to check the seal points of the pilot solenoid and discharge valve plates, the receiver tank bypass check valve, and the evaporator seat of the three-way valve.

2) High heat load. A hot trailer, warm load, or open door causing large amounts of heat to reach the evaporator coil will increase unit suction pressure.

3) High discharge pressure. The refrigeration system is a closed loop. Increased discharge pressure will affect the low side pressure.

High Discharge Pressure. High discharge pressure will be caused by:

1) Lack of heat exchange in the air-cooled condenser. A defective fan motor, bent fins, or a dirty coil surface will prevent the air flow from touching the coil find or moving through the condenser coil. Restricted air flow through the condenser will cause abnormally high discharge pressures during the cooling mode.

2) High levels of a non-condensable in the system, such as air or nitrogen. This reduces the condenser's ability to release heat and causes temperatures and pressures to increase, reduces system efficiency, and contributes to the formation of acid in the system.

3) A restricted discharge line. This may be a physical restriction before the condenser or the three-way valve screen.

4) High ambient temperature.

Low Discharge Pressure. Low discharge pressure will be caused by:

1) Lack of refrigerant reaching the compressor. This can be caused by a low refrigerant charge, a liquid line restriction, or suction line restriction.
2) Reduced compressor capacity caused by worn compressor parts or leaking piston reeds and low compressor RPM.

3) Low ambient temperature.

Frosted Suction Line. A frosted suction line will be caused by:

1) Too much liquid refrigerant leaving the evaporator. Refrigerant did not boil off in the evaporator due to too much liquid entering the coil or a lack of evaporator heat exchange. Too much liquid refrigerant leaving the evaporator on a unit with a reciprocating compressor generally will cause the suction line to frost.

Warm, Dry Suction Line. A warm, dry suction line is caused by:

1) High pressure in the suction line. As pressure increases, so does temperature.
2) Lack of refrigerant leaving the evaporator. Little or no refrigeration is occurring. This may be caused by a liquid line restriction or a low refrigerant charge.

Evaluate the information you have gathered. You are looking for common causes of the primary symptoms.

During refrigeration system diagnosis you may come to a point where primary symptoms are not enough to make an accurate diagnosis. Secondary symptoms and additional diagnostic procedures may be needed to gather enough information.

Receiver Sight Glass Level. Because the sight glass level is always changing during normal operation it is not a reliable indicator that the system may be low or full of refrigerant. However, in combination with other symptoms it may be helpful. Example: if the glass if empty with high discharge pressure, the unit is not overcharged.

Component Temperatures. If there is a temperature drop from one side of the inlet side of the liquid drier to the outlet side, it is restricted. Frost on the outlet side of the drier may occur on the liquid line in severe cases. Heat on both sides of the component may suggest the component is stuck in the open position.

Diagnostic Procedures. Locating an Internal Leak. A system has reduced cooling capacity with high suction pressure and a warm/dry suction line. These symptoms may indicate that the system has an internal high-to-low side leak during the cooling mode. This leak must be located so that it can be repaired.

Single-Temperature systems have four seal points:

1) Discharge Valve Plates
2) Receiver Tank Bypass Check Valve

3) Pilot Solenoid on the Three-Way Valve
4) Three-Way Valve Evaporator Seat

Perform the following procedures in combination to help pinpoint an internally leaking component:

1) Low Side Pump Down
2) Compressor Pump Down

Reciprocating Compressor Leaking Piston Reeds: To check for leaking piston reeds you would perform a low side pump down procedure.

Install the manifold gauge set so that you can get a low and high side pressure reading. Start the unit in the cooling mode. Then front-seat (clockwise) the receiver outlet tank service valve. This will stop all of the refrigerant from leaving the receiver outlet tank.

The suction side of the compressor will pull the refrigerant through the system and back down the suction line into the compressor. The discharge side of the compressor will compress all of the refrigerant gas out of the compressor. During this procedure the low side pressure decreases to 1 psig. (This will ensure that the crankcase is in a positive pressure so that you will not be drawing in air or moisture if you have an external leak in the suction or liquid line piping).

When the suction pressure is at 1 to 2 psig, you will stop the compressor. Observe the low side gauge pressure. If the pressure rises from 1 to 2 psig to approximately 6 to 10 psig, then you may have an external leak or a leak in internal seal points.

The low side pump down procedure is recommended to perform service on the low side of the system without refrigerant loss.

The low side pump down procedure allows you to replace liquid line driers and other component parts in the low side of the refrigeration unit. You may also remove compressor oil and repair the throttling valve. (Note that you should always adjust the crankcase pressure to 1 psig to ensure that air and moisture is not drawn into the system during the component replacement.)

The pilot solenoid valve and the compressor discharge valve plates can be tested with the low side compressor pump down.

The Compressor Capacity Test. Inefficient compressor operation can be one of the most difficult problems to find. When the compressor is pumping at slightly less than capacity, it is hard to determine the problem. It helps at this point to remember that a compressor is a vacuum pump. It should be able to create a pressure from the low side of the system to the high side under design conditions.

If the reciprocating compressor is inefficient because its valves are bad, the suction pressure will be high and the head pressure will be low (defective suction and discharge reeds). There is not other situation that will give a system both low head pressure and high suction pressure at the same time, other than worn piston rings causing blow-by of gases around the rings.

A compressor is pumped down to 20" Hg vacuum and you turn off the unit. If the low side pressure gauge rises above zero, this would indicate that liquid refrigerant may be evaporating from the refrigerant oil of the discharge valve plates are leaking.

However, if you pump the compressor down to 20" Hg vacuum and turn off the unit and the low side pressure gauge rises to 0 psig and stops, this will indicate that the crankshaft seal or throttling valve bellows is leaking.