

***DENSO***

Heating, Ventilation, and  
Air Conditioning System

**S e r v i c e M a n u a l**  
**for**  
**R e c r e a t i o n a l V e h i c l e s**



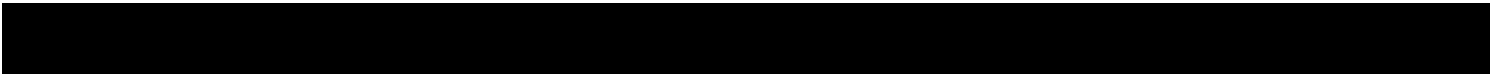
This manual applies to vehicles  
using HFC-134a refrigerant ONLY.

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This manual was developed to assist certified technicians in servicing the air conditioning system on class A motorhomes built on Ford, GM, Spartan, or Freightliner chassis, equipped with a DENSO air conditioning system.

Since the dash A/C system utilizes chassis components (compressor, condenser, receiver/drier and discharge hose), it is advised that the appropriate chassis repair manual for Ford, GM, or Freightliner be consulted when required or necessary.



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## 1. The Purpose of Air Conditioning

The purpose of an automotive air conditioner is to maintain a cool, comfortable environment for passengers.

Here are the four ways this is achieved:

- Temperature Control
- Air Circulation Control
- Humidity Control
- Air Purification

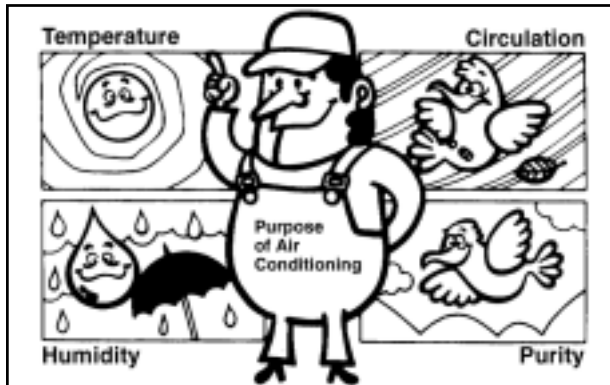


Fig. 1: The Four Factors of Air Conditioning

## 2. Technical Terms

### A. Heat

#### 1) Heat Quantity

Heat is a form of energy. There are two units to measure heat quantity, Kcal or BTU (British Thermal Unit).

- One Kcal heat quantity changes the temperature of one Kg of liquid water by one degree centigrade.
- One BTU of heat changes the temperature of one pound of liquid water by one degree Fahrenheit.

$$1 \text{ Kcal} = 0.252 \text{ BTU}$$

$$1 \text{ BTU} = 3.968 \text{ Kcal}$$

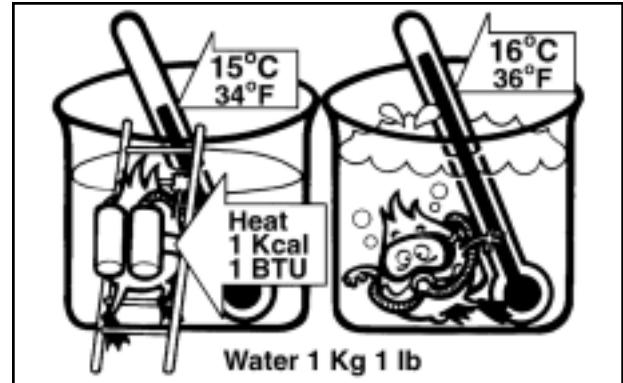


Fig. 2: Heat Quantity

#### 2) Specific Heat

Specific heat is the quantity of heat required to CHANGE THE TEMPERATURE of an object by one degree.

The unit of specific heat is Kcal/kg°C or BTU/lb°F.

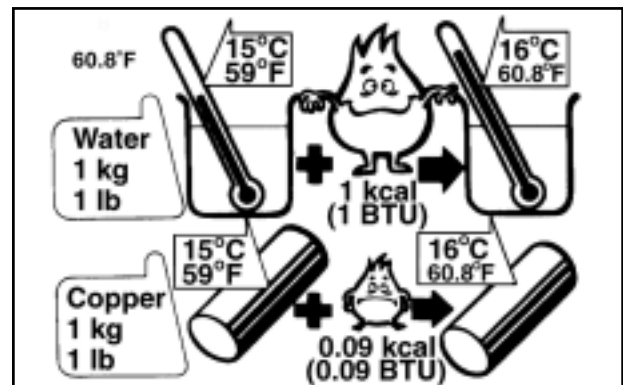


Fig. 3: Specific Heat

#### 3) Heat Transfer

As heat travels over a distance, it tends to lose energy. Heat can be transmitted through CONDUCTION, CONVECTION or RADIATION. It can also be transmitted by a combination of any or all of these methods.

- Conduction is the transfer of heat by direct contact. When you heat one side of a steel bar, the other side becomes warmer by conduction.
- Radiation is the transfer of heat by rays. Heat from the sun is transferred to the earth in rays. But the sun isn't the only object that radiates heat. Every object that contains heat can radiate it.

# GENERAL INFORMATION

- c) Convection is the transfer of heat by the movement of heated liquid or gas. When heat is applied to the bottom of a container of liquid or gas, the warmed particles at the bottom expand and rise. The colder particles at the top, which are denser than the heated particles, sink to the bottom.

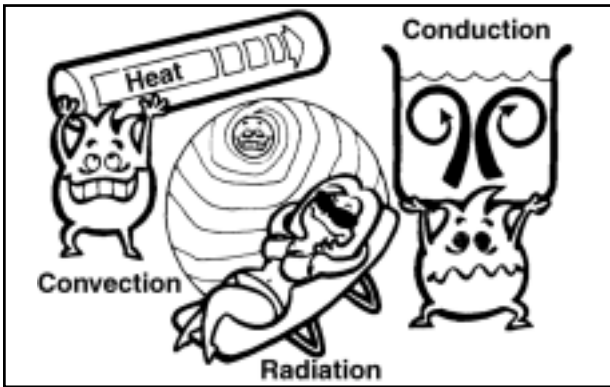


Fig. 4: Three Ways Heat is Transferred

## B. Temperature

### 1) Temperature Scales

Temperature is the degree to which an object is hot or cold. The unit generally used to express this is degrees Centigrade ( $^{\circ}\text{C}$ ) or degrees Fahrenheit ( $^{\circ}\text{F}$ ). In the Centigrade scale, the freezing point (solid point) of pure water is taken as  $0^{\circ}\text{C}$ , and the distance between the freezing point and the boiling point are divided into 100 parts and each part is designated as  $1^{\circ}\text{C}$ .

In the Fahrenheit scale, the freezing point of pure water is taken as  $32^{\circ}\text{F}$ , and the distance between the freezing point and the boiling point are divided into 180 parts with each part designated as  $1^{\circ}\text{F}$ .

$$[^{\circ}\text{C}] = 5/9([^{\circ}\text{F}] - 32)$$

$$[^{\circ}\text{F}] = 9/5([^{\circ}\text{C}] + 32)$$

	Celcius Scale ( $^{\circ}\text{C}$ )	Absolute Scale ( $^{\circ}\text{K}$ )	Fahrenheit Scale ( $^{\circ}\text{F}$ )
Water Boiling Point	100	373	212
Freezing Point	0	273	32
	-150	123	-238
	-200	73	-328
Absolute Zero	-273	0	-459.4

Fig. 5: Temperature Scales

### 2) Wet Bulb and Dry Bulb Thermometers

The bulb (heat sensitizing part) of a glass tube thermometer is wrapped with a gauze or other rough mesh cloth. One end of the cloth is immersed in a water container to allow the water to be drawn up by a capillary action and to moisten the heat sensitizing part. The water in the cloth surface near the heat sensitizing part evaporates and robs the latent heat of evaporation from the surrounding air, causing the air temperature around the heat sensitizing parts to drop. The temperature registered by the thermometer at this time is called the wet bulb temperature.

This is used to find out the humidity in combination with the dry bulb temperature.

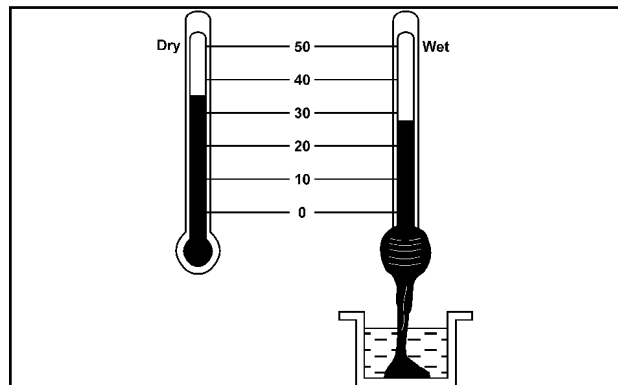


Fig. 6: Thermometer



**3) Dew Point Temperature**

When the air surrounding us is cooled, the air temperature drops, and when the humidity becomes 100%, that is, when the dry bulb and wet bulb temperatures become the same, the water vapor contained in the air will be in a saturated state.

On further cooling, the water vapor reaches a condition where it cannot remain in a vapor state so that a part condenses and becomes dew. The temperature at which the humidity becomes 100% and dew is formed is called the dew point temperature.

**C. Humidity**

**1) Humidity**

When you pour water and ice into a glass, you notice that drops of water are generated on the glass. Do you sometimes wonder where these drops of water come from?

Drops of water come from the surrounding air, so humidity is water vapor contained in the air.

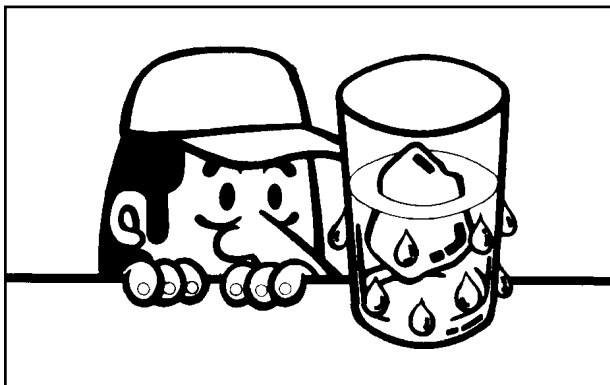


Fig. 7: Humidity

**2) Relative Humidity**

There are two ways to measure humidity: relative humidity and absolute humidity.

The most common way to measure humidity is using the relative method. Relative humidity is the amount of water the air contains, compared with the amount the air could hold at a given temperature.

In other words, if the relative humidity is 50 percent, the air could hold as much water again as it does at that temperature.

Water capacity means the amount of water vapor which the air could hold at a given temperature. The water capacity changes according to the temperature of the air. The water capacity of cooled air is lower. Therefore, the amount of vapor in the air at 50°C, 50 percent, is different from that in the air at 10°C, 50 percent.

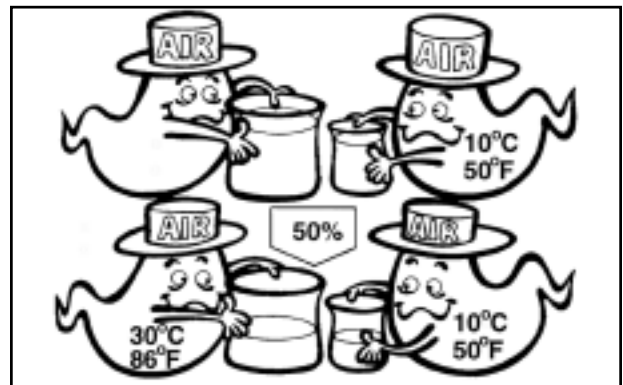


Fig. 8: Relative Humidity

**3) Absolute Humidity**

Absolute humidity is the amount of water the air contains, compared with the dry air.

**D. Pressure**

**1) What Is Pressure?**

Pressure is defined as the vertical force exerted on a unit area by a solid, liquid, or gas. The unit generally used to indicate the pressure is "kg/cm".

When indicating blower performance, mmAq (water column) is generally used, and when indicating pressure below atmospheric (vacuum), cmHg (mercury column) is commonly used.

When expressing boiler pressure, the atmospheric pressure is taken as the basis, and the pressure is expressed in number of atmospheres (atmos). The concept held toward pressure is entirely in accordance with Pascal's law.

# GENERAL INFORMATION

Pascal's Law: "Pressure exerted on a liquid confined in a container is transmitted undiminished in all directions. Regardless of container shape, if the interior area is equal, the pressure subject there will be equal."

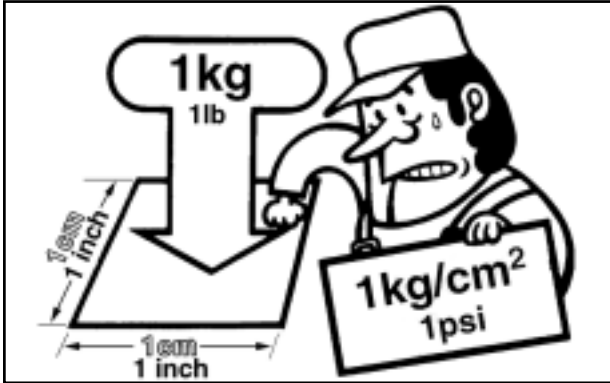


Fig. 9: Pressure

## 2) Atmospheric Pressure

This is the pressure that is subjected on all objects and matter on earth. This pressure is the weight of the air surrounding everyone and is equal to 1 atmosphere.

At this pressure the mercury column will be 760 mmHg (76 cmHg).

$$1 \text{ atm} = 1.03 \text{ kg/cm}^2 = 760 \text{ mmHg} = 14.7 \text{ psi}$$

Pressure gauges commonly indicate atmospheric pressure in units of  $\text{kg/cm}^2$  or  $\text{psi}$ .

## 3) Absolute Pressure

Absolute pressure is that in which a perfect vacuum is taken as  $0 \text{ kg/cm}^2$ . Thus, the atmospheric pressure, when expressed in terms of absolute pressure, will be  $1.03 \text{ kg/cm}^2$ .

To differentiate, pressure measured with a gauge is called gauge pressure.

For identification, absolute pressure is indicated by  $[\text{kg/cm}^2 \text{ abs.}]$  and gauge pressure by  $[\text{kg/cm}^2 \text{G}]$ . Absolute pressure to gauge pressure relationship is as follows:

$$\begin{aligned} \text{Absolute press. } [\text{kg/cm}^2 \text{ abs.}] &+ \text{Gauge} \\ \text{press. } [\text{kg/cm}^2 \text{G}] &+ 1.03 \text{ kg/cm}^2 \end{aligned}$$

## 4) Vacuum

Vacuum is the pressure below atmospheric pressure and is expressed in terms of a mercury column (cmHg, mmHg).

When the vacuum is measured with a mercury column, the difference between this measurement and that for atmospheric pressure becomes the amount of vacuum.

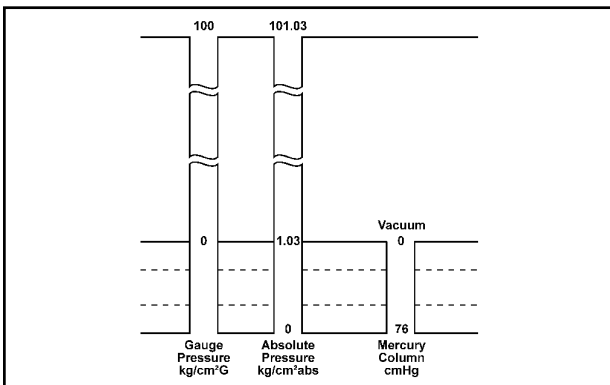


Fig. 10: Pressure Scales

### 3. Change of State

#### A. State Change of Water

Now, we will consider how ice changes its state when we add heat to it, because water is the most common example to understand heat and states of object.

If we add heat to ice until the temperature of ice reaches 0°C (32°F), ice melts into water, and while the ice is melting, the temperature of ice and water remains at 0°C. After the ice has melted, the temperature of water begins to rise.

When the temperature of water reaches 100°C (212°F), water begins to become steam. Until all the water becomes steam, the temperature of water remains 100°C (212°F).

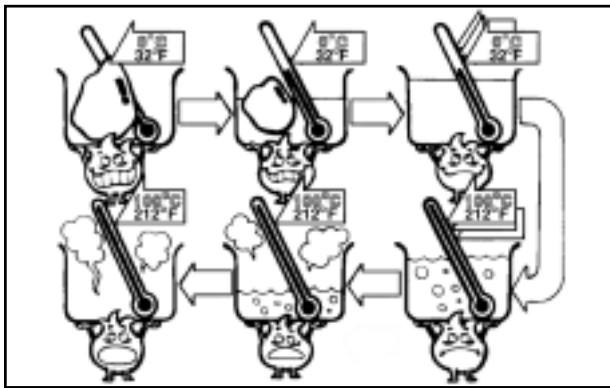


Fig. 11: State Change Of Water

#### B. Sensible Heat and Latent Heat

The chart below shows the relation between heat and temperature. There are two kinds of heat called sensible heat and latent heat.

Sensible Heat can change the temperature of water but cannot change the state of water. Therefore, the sensible heat raises or lowers the temperature of water. In the case of water, 1 kg of water at 0°C must absorb 100 Kcal of sensible heat to change to 1 kg of water at 100°C.

Latent Heat can change the state of water, but cannot change the temperature of water. Ice melts into water by adding latent heat and water evaporates into steam by adding latent heat. In the case of water, 1 kg of ice at 0°C must absorb 80

Kcal of latent heat to change to 1 kg of water at 0°, and 1 kg of water at 100°C must absorb 539 Kcal of latent heat to change to 1 kg of steam.

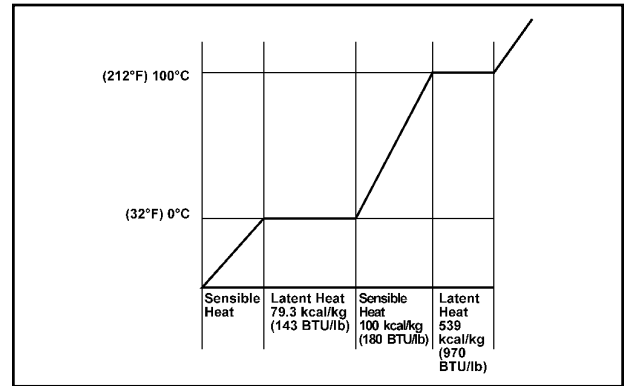


Fig. 12: Sensible Heat and Latent Heat

#### C. The Three States of Matter

As you know, matter exists in three states: solid, liquid and gas. In the case of water, the solid state is ice, the liquid state is water, and the gas state is steam.

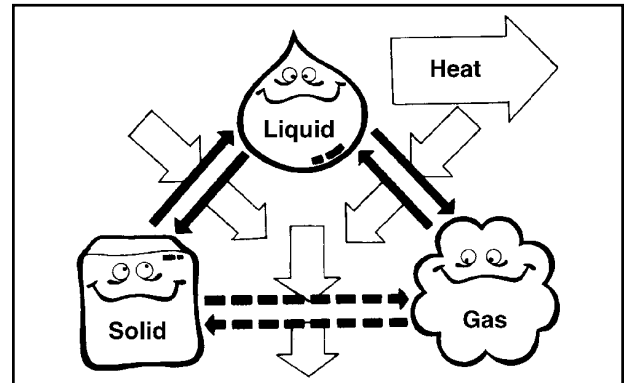


Fig. 13: Three states of Matter

##### 1) Fusion

When a solid melts into a liquid, heat is absorbed from its surroundings.

##### 2) Solidification

In the opposite situation, when liquid changes into a solid, heat is released to its surroundings.

##### 3) Evaporation

When liquid evaporates into gas, heat is absorbed from its surroundings.

## GENERAL INFORMATION

### 4) Condensation

In the opposite situation, heat is released to the surrounding matter.

In the case of water, when 1 kg of water evaporated into 1 kg of steam, 539 Kcal of heat is absorbed from its surroundings.

In the opposite situation, 539 Kcal of heat is released to the surrounding matter.

### 5) Sublimation

In a rare case such as dry ice (solid carbon dioxide) and naphthalene, heating causes the solid to directly turn into gas.

### 6) Adhesion

The reverse of the sublimation process is called adhesion.

## 4. The Relationship Between Pressure and Temperature

So far we have been discussing the state of change that occurs in water under atmospheric pressure. The boiling point of water or any liquid changes depending on the pressure working on the liquid.

Rule 1. When the pressure is high, the boiling point of liquid also becomes high.

Rule 2. Conversely, under a low pressure, liquid begins to boil at a lower temperature.

The illustration below shows how the boiling point is influenced by pressure change.

- A. Under normal atmospheric pressure (0 kg/cm<sup>2</sup>G) water boils at 100°C.
- B. If the pressure exerted on water increases by 0.09 kg/cm<sup>2</sup> from atmospheric pressure, the water does not boil until water temperature reaches 118°C.
- C. The water under pressure which is lower than normal atmosphere by 0.4 kg/cm<sup>2</sup> begins to boil as soon as the water temperature passes 84°C.

The above rules between pressure and boiling point can be applied to all liquids. HFC-134a, the refrigerant used in automobile air conditioner is no exception.

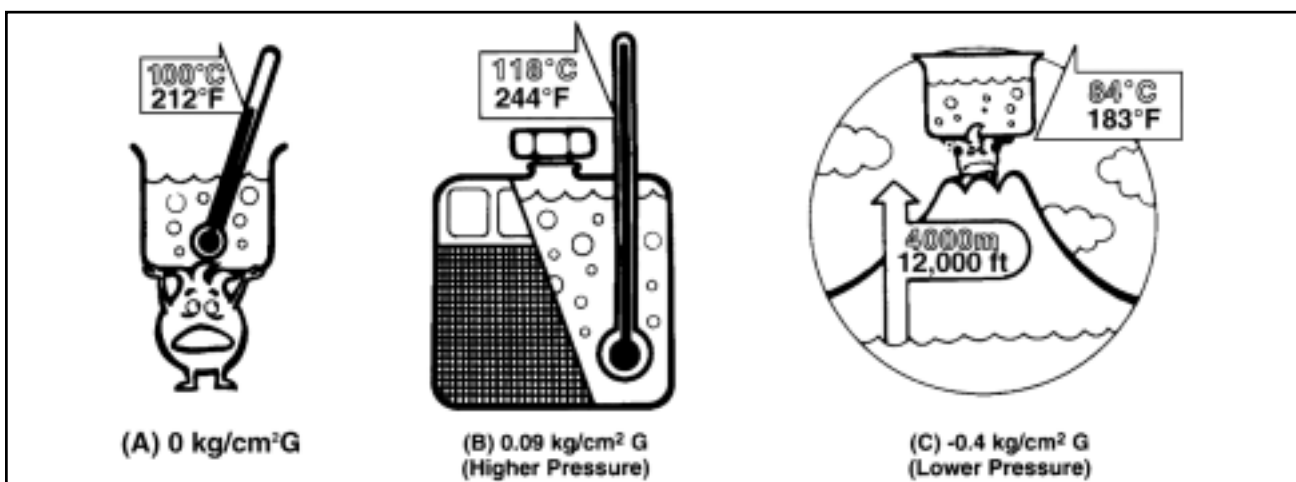


Fig. 14: Pressure and Boiling Point Relation

## 5. Basic Theory of Cooling

We feel a little cold even on a hot day after swimming. This is because water on your body takes away the heat through evaporation. The same principle is at work when we apply alcohol to our arms. Evaporation of the alcohol removes the heat.

This natural phenomenon can be used to create coolness. That is, liquid takes the heat from substances when it evaporates.



Fig. 15: Evaporating Heat

Next, we conduct an experiment in latent heat. As the liquid placed in a heat insulating box begins to evaporate, it takes heat out of the air from around the receptacle in the box and becomes gas when the valve is turned. The temperature of the air goes down before opening the valve.

This is the way we will create coolness. However, since we are forced to constantly add liquid to this receptacle, this is an inefficient method. The best way to achieve this coolness is to change the gas to liquid and then evaporate it again.

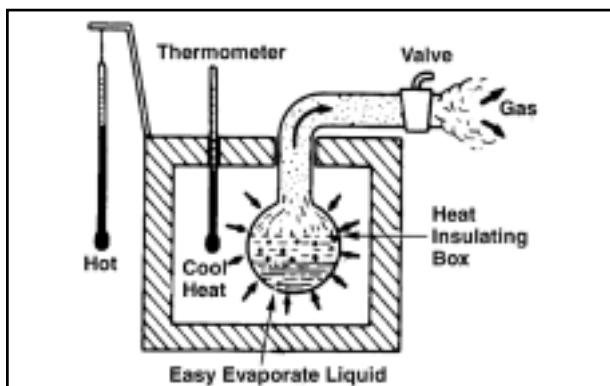


Fig. 16: Cooling Experiment

## 6. Refrigerant

Any substance used to create refrigeration is called a refrigerant. It may be in the form of a liquid, gas or solid. In general, a refrigerant is a substance that serves as a moving fluid in the refrigerator and circulates through the functional parts to attain the refrigerating effect by absorbing heat through expansion and evaporation. The resulting low temperature matters such as cold water and ice are called secondary refrigerants.

### A. Properties of Refrigerants

Among the refrigerants there are toxic gases, inflammable gases, those that have strong properties of oxidizing or corroding metals, as well as those that are expensive. The important properties demanded in the refrigerant are as follows:

- 1) Since refrigeration is attained by evaporation of liquid, the refrigerant must evaporate or vaporize easily.
- 2) The larger the latent heat at vaporization, the smaller the amount of the refrigerant will be required for circulation, and the smaller will be the refrigerator.
- 3) The equipment must be safe to operate so that refrigerant will not be flammable or explosive.
- 4) The refrigerant must not be hazardous and preferably a substance in which leakage can be detected easily.
- 5) The stability must be high to allow repeated use without decomposing or changing in property.
- 6) There should be no injurious effect on parts or packings used in the compressor and other units.
- 7) The critical temperature should be far higher than the condensation temperature.
- 8) If the evaporation pressure is lower than atmospheric, there will be a chance of air entering in the refrigeration cycle so that evaporation pressure should be higher than atmospheric pressure.

- 9) The higher the condensation pressure, the greater will be the requirement to make functional parts such as the compressor, condenser, and pipe of higher resistant construction. As a result, a refrigerant with a too high condensation pressure will be unsuitable.

## B. Types of Refrigerants

Refrigerants can be classified into inorganic compounds, carbide halogenated hydrocarbons, and azeotropic mixtures.

### 1) Inorganic Compounds

In inorganic compound refrigerants, there are ammonia, sulfurous acid gas, and water.

#### a) Ammonia

Although highly toxic, the other properties are excellent for use as refrigerant. Ammonia is used in large size refrigerators.

#### b) Sulfurous Acid Gas

This refrigerant is not commonly used because of its strong odor and high toxicity.

#### c) Carbon Dioxide

Carbon dioxide is a safe gas that allows refrigerators to be made smaller. However, the critical temperature is a very low 31°C (89°F). At present, dry ice (solid carbon dioxide) has found wide use as secondary refrigerant.

#### d) Water

Water is used as a refrigerant for refrigerators such as the injection type and absorption type.

#### e) Hydrocarbons

These refrigerants include methane, ethane, and propane. They are used mainly in the petrochemical industry. In addition, hydrocarbons are considered inferior in safety.

#### f) Halogenated Carbide

This is the general term for hydrocarbons containing one or more halogens (Cl, F, Br). Out of these, types containing chlorofluorocarbons are made in numerous varieties. Its greatest advantage is the fact that it is very safe and chemically stable.

#### g) Azeotropic Mixture

This is a mixture of two different refrigerants although it acts as if it were a single refrigerant.

## C. Properties of Refrigerant HFC-134a

Refrigerant is a substance that serves as a moving fluid in a refrigerator and circulates through functional parts to produce the cooling effect by absorbing heat through the expansion valve and vaporizing. The refrigerant used in new vehicle today is now HFC-134a, which has no ozone destroying properties (does not contain chlorine).

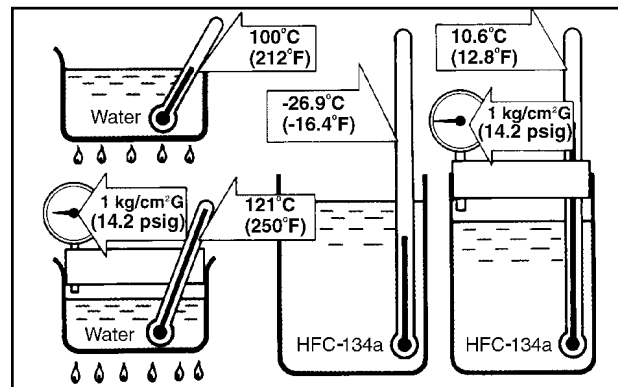


Fig. 17: Boiling Point of HFC-134a

### Characteristics of HFC-134a

Water boils at 100°C (212°F) under atmospheric pressure, but HFC-134a boils at -26.9°C (-16.4°F) under atmospheric pressure.

Water boils at 121°C (250°F) under 1 kg/cm<sup>2</sup>G (98 kPa) of pressure, but HFC-134a boils at -10.6°C (12.8°F) under 1 kg/cm<sup>2</sup>G (98 kPa) of pressure.

If HFC-134a were released to the air under normal room temperature and atmospheric pressure, it will absorb the heat from the surrounding air and boil immediately, changing into a gas. HFC-134a is also easily condensed back into liquid under pressurized conditions by removing the heat.

The graph shows the characteristic relationship between the temperature and pressure of HFC-134a.

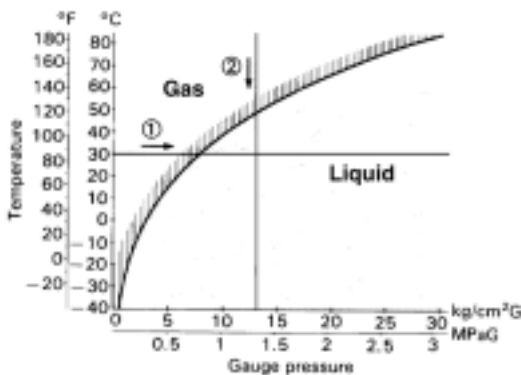
The curve in the graph indicates the boiling point of HFC-134a under different temperatures and pressures. The upper portion above the curve is gaseous HFC-134a and the lower portion is liquid HFC-134a.

**Example-1**

The gaseous refrigerant can be converted into the liquid refrigerant by increasing the pressure without changing the temperature.

**Example-2**

The gaseous refrigerant can also be converted into a liquid by decreasing the temperature without changing the pressure.



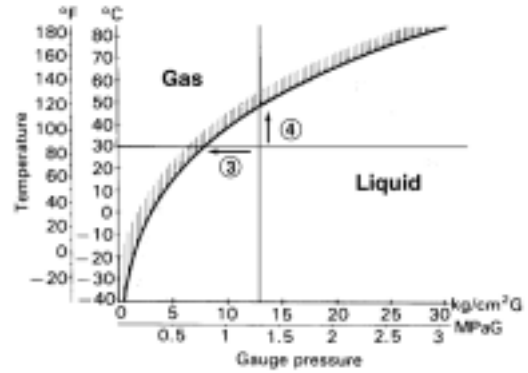
**Conversely**

**Example-3**

The liquid refrigerant can be converted into gas by decreasing the pressure without changing the temperature.

**Example-4**

The liquid refrigerant can be converted into a gas by increasing the temperature without changing the pressure.



**D. Precautions on Handling HFC-134a**

The following precautions should be fully exercised when handling HFC-134a.

**1) Avoid Heat**

Do not allow the refrigerant to stand, be stored in direct sunlight or near a heat source. HFC-134a should never be exposed to temperatures above 52°C (126°F). If heat must be applied to the container (service can), it should be heated with warm water under 40°C (104°F). Never heat the container or the bath filled with warm water directly over a flame.

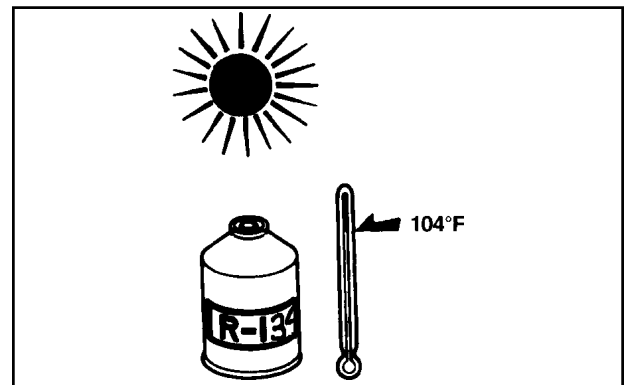


Fig. 18: Heat Precautions

## GENERAL INFORMATION

### 2) Avoid Contact With Skin

At atmospheric pressure, HFC-134a vaporizes so rapidly that if it touches the skin, there is a real danger of that area becoming frostbitten. It is especially dangerous if HFC-134a gets in the eye. There is a great risk that the moisture in the eye will be frozen, which can lead to blindness.

Always wear safety goggles when handling HFC-134a and take extra care that it does not touch exposed skin.

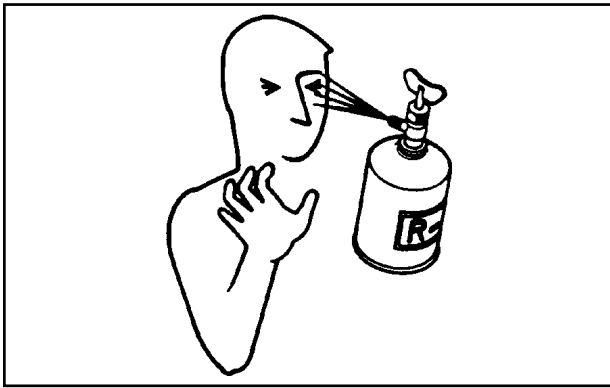


Fig. 19: Contact Precautions

## 7. Principles of Air Conditioning

### A. Expansion and Evaporation

In the mechanical refrigeration system, cooled air is created by the following method:

- 1) The high temperature and high pressure liquid refrigerant is stored in the container called a receiver.
- 2) Next, the liquid refrigerant is released to the evaporator through a small hole called the expansion valve. At this time, the temperature and pressure of the liquid refrigerant are both lowered, and some of the liquid refrigerant is now changed to vapor.
- 3) The low temperature and low pressure refrigerant flows into the container called the evaporator. In the evaporator, the liquid refrigerant evaporates and removes heat from the surrounding air.

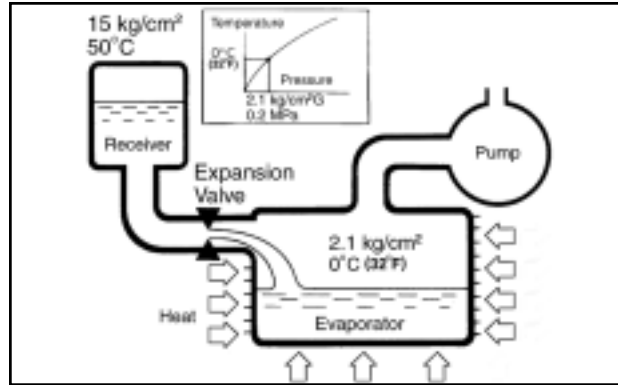


Fig. 20: Expansion and Evaporation

### B. How to Condense Gaseous HFC-134a Into Liquid

The air conditioning system cannot cool the air when the liquid refrigerant is used up (i.e. changed to the gaseous refrigerant.)

To change the gaseous refrigerant into a liquid refrigerant, a compressor is used in the car air conditioning.

As you know, when the gas is compressed in the compressor, both the temperature and pressure increase.

For example, when the gaseous refrigerant is compressed from 2.1 kg/cm² (0.21 MPa) to 15 kg/cm² (1.47 MPa), the temperature also increases from 0°C to 80°C. (32°F to 176°F)

The boiling point of refrigerant at 15 kg/cm² (1.47 MPa) is 57°C (135°F). The temperature 80°C (176°F) of compressed gaseous refrigerant is higher than its boiling point (57°C) and also higher than the surrounding air. The refrigerant stays in gaseous state.

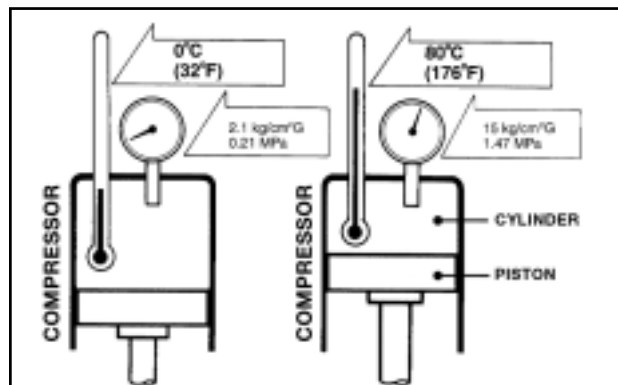


Fig. 21: How to Condense HFC-134a



### C. Condensing the Gaseous HFC-134a

In the car air conditioning, the high pressure, high temperature gaseous refrigerant is transformed into a liquid by cooling it down at the condenser.

By flowing through the condenser, the compressed gaseous refrigerant releases heat to the surrounding air and is condensed back into a liquid. At this time, the refrigerant temperature becomes lower than the boiling point (around 57°C). The liquid refrigerant then returns to the receiver.

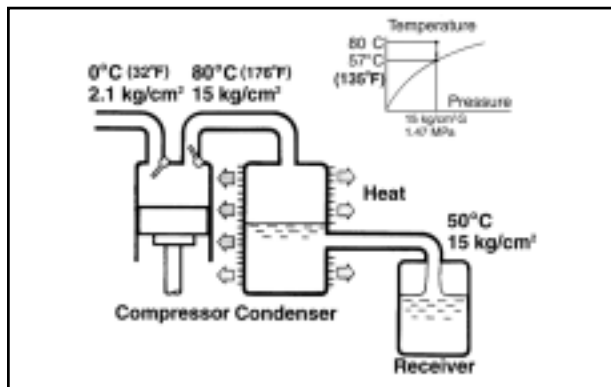


Fig. 22: Condensation of HFC-134a

### D. Refrigeration Cycle

- 1) The compressor discharges high temperature and high pressure refrigerant that contains the heat absorbed from the evaporator plus the heat created by the compressor in a discharge stroke.
- 2) This gaseous refrigerant flows into the condenser. In the condenser, the gaseous refrigerant condenses into liquid refrigerant.
- 3) This liquid refrigerant flows into the receiver which stores and filters the liquid refrigerant until the evaporator requires the refrigerant.
- 4) After going through the expansion valve, the liquid refrigerant changes into low temperature, low pressure liquid and gaseous mixture.

- 5) This cold and foggy refrigerant flows into the evaporator. Vaporizing the liquid in the evaporator, the heat from the warm air stream passing through the evaporator core is transferred to the refrigerant.

All the liquid will change into the gaseous refrigerant in the evaporator and only the heat-laden gaseous refrigerant is in the compressor. Then, the cycle begins once again.

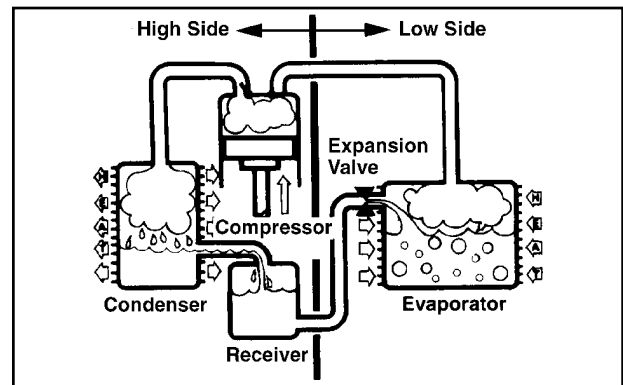


Fig. 23: Refrigeration Cycle

## 8. Automotive Refrigeration System

### A. Basic Components

**Compressor:** It is critical that only gas be drawn into the compressor. If liquid enters, it will cause a hydrostatic lock in the compressor and stall. The gas drawn in is compressed to over 14.1 kg/cm<sup>2</sup> (201 psi, 1.383 kPa), which becomes extremely hot.

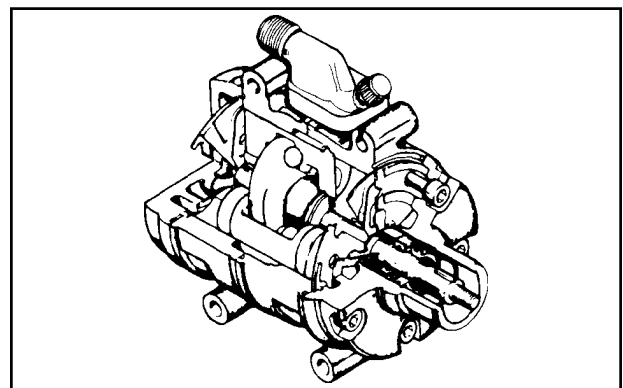


Fig. 24: Compressor

## GENERAL INFORMATION

**Condenser:** The condenser mounted at the front of the coach acts as a radiator, drawing off some of the heat of compression, and changes the high temperature gas into a liquid under high pressure. When operating normally, the inlet of the condenser is full of hot gas and the outlet is full of hot liquid. There are some models which are equipped with a fan exclusively for the condenser

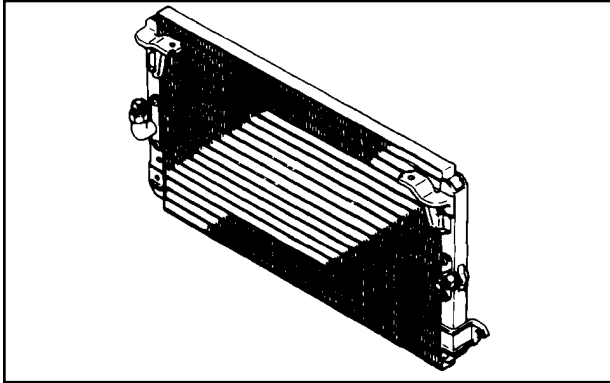


Fig. 25: Condenser

**Receiver/Drier:** The receiver is a part of the system that is used to store the liquid refrigerant.

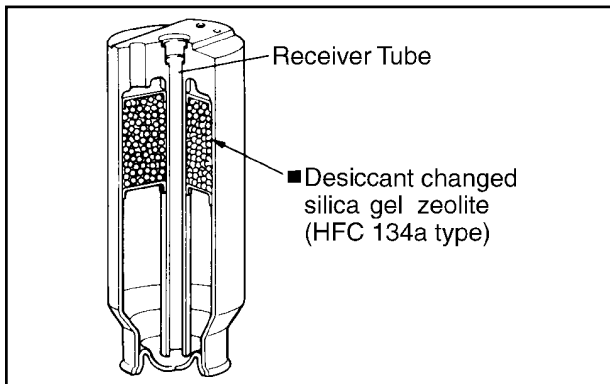


Fig. 26 Receiver/Drier

Also, the drier and filter in the receiver remove the moisture and the dirt contained in the refrigerant.

- 1) The receiver separates the gaseous refrigerant from the liquid refrigerant by the weight difference and ensures a steady flow of liquid refrigerant be supplied to the expansion valve.
- 2) The drier is simply a bag of desiccant, such as zeolite, that is capable of absorbing and holding moisture.

- 3) The sight glass is installed on the top of the receiver. The refrigerant charge amount is very important for the efficiency of the air conditioner. The sight glass is used to check the amount of refrigerant. Also the sight glass is installed on the high pressure pipe between the receiver and the expansion valve.

**Expansion Valve:** This small valve controls the flow of refrigerant into the evaporator. It is controlled by a temperature sensor at the evaporator outlet. If the outlet temperature is too high, it means not enough refrigerant is flowing into the evaporator and the result will be poor cooling.

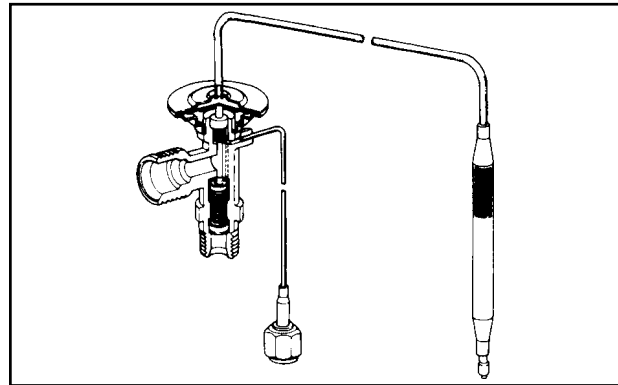


Fig. 27: Expansion Valve

If the outlet temperature is too cool, it means too much refrigerant is flowing and the evaporator fins will probably load up with ice. In either case, the feedback temperature sensor opens and closes the expansion valve opening to achieve the correct flow rate and evaporator outlet temperature.

Evaporator: This is the last component in the cycle, and where the air is finally cooled. As the foggy mist of refrigerant enters, the air passing over the evaporator fins gives up its heat to evaporating refrigerant. At the inlet the refrigerant is liquid; it changes into gas at the outlet.

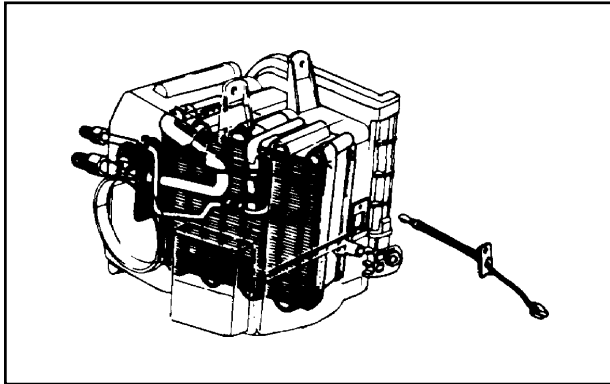


Fig. 28: Evaporator

**B. Automotive Refrigeration System**

1. COMPRESSOR draws off gaseous refrigerant from the evaporator and compresses it. This causes the refrigerant gas temperature and pressure to rise rapidly.
2. CONDENSER, through which the heated refrigerant gas gives off heat to the engine cooling air. The refrigerant gas cools off and once again becomes a liquid.
3. RECEIVER/DRIER removes and traces of moisture and filters out dirt in the system. It also serves as a reservoir for excessive refrigerant
4. EXPANSION VALVE controls liquid refrigerant into the evaporator cores, causing a drop in pressure and, consequently, a drop in temperature.
5. EVAPORATOR, in which the released refrigerant expands and flows through the evaporator tubes. It removes heat from the air blowing across the fins and tubes and evaporates, causing the temperature inside the car to be lowered gradually.

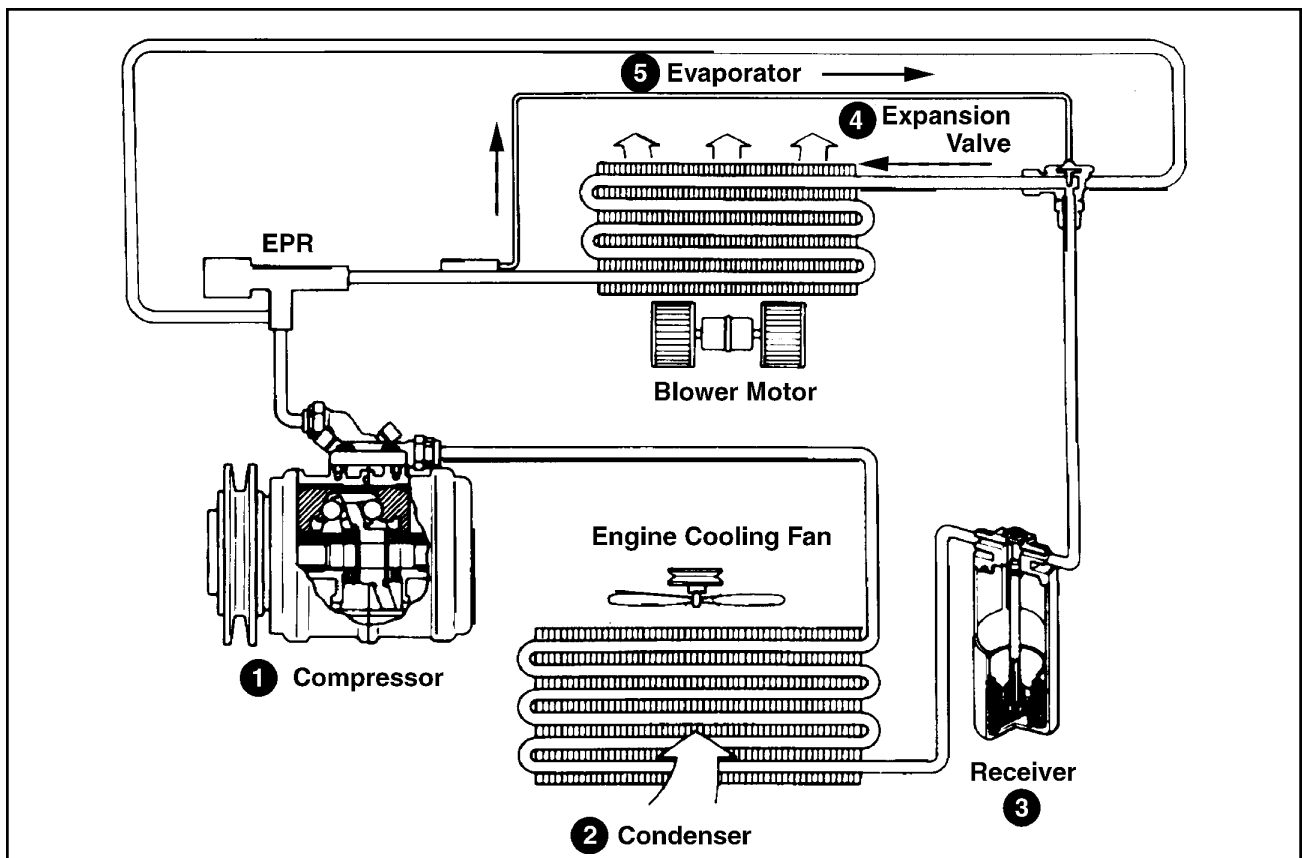


Fig. 29: Automotive Refrigeration System

# SAFETY PRECAUTIONS

## 1. Safety Precautions

When repairing air conditioning systems, the following precautions and rules must be observed.

### A. Wiring

- 1) Isolate the negative battery terminal to prevent short circuits.
- 2) All terminals and connectors should be connected securely.
- 3) When wire harnesses are routed through any hole in the vehicle, insert the rubber bushing into the hole to protect harness.
- 4) The air conditioner wire harness should be fastened to the main harness with the vinyl tape or clamps.
- 5) If disconnecting or moving original harnesses while repairing, they should be returned to the proper position.
- 6) Be careful not to pinch the original air conditioner wire harnesses when installing or repairing air conditioner parts.
- 7) When the lead wire is added to the wire harness by soldering, use the same or larger diameter lead wire, and cover the soldering position with the vinyl tape.
- 8) The wire harness should not be clamped at any moving or high temperature components.
- 9) Connecting portion of wire harness must be away from the joint of fuel pipe.
- 10) Be sure that the wire harness does not touch the sharp corners or edges.

### B. Piping

- 1) Never use a torch when bending tubes. When bending tubes, try to make the curve as wide as possible.
- 2) The insides of all air conditioner parts must be free of moisture and dust. When removing the piping parts, apply the blind plugs or caps on the fittings.
- 3) When cutting tubes, dress off the tube with a file, and clean the inside of tube of all burrs.
- 4) Before making any hose and tube connections, apply a few drops of refrigeration oil to the seat of coupling nuts and O-rings.

- 5) When tightening and loosening fittings, use two wrenches.
- 6) Pay special attention to the direction of receiver. Receiver inlet fitting must be connected to the tube from condenser outlet fitting.
- 7) Tighten coupling nuts according to specified torque.

Nut Size (inch)	Flare Nut Type	O-Ring Nut Type
0.375	2.0–3.0 kg-m (14.5–21.5 lbf•ft)	1.2–1.5 kg-m (9–11 lbf•ft)
0.5	3.0–4.0 kg-cm (21.5–29.0 lbf•ft)	2.0–2.5 kg-m (15–18 lbf•ft)
0.625	4.0–5.0 kg-m (29.0–36.0 lbf•ft)	3.0–3.5 kg-m (22–25 lbf•ft)

### C. Refrigerant

- 1) The following rules must be followed when handling refrigerant.
  - a) Use suitable eye protection such as safety goggles or glasses when handling the refrigeration or servicing the refrigeration system.
  - b) Keep your skin from direct contact with liquid refrigerant.
  - c) Do not heat the refrigerant container above 40°C (104°F).
  - d) Do not discharge the refrigerant into an enclosed area having an open flame.
  - e) Do not allow the liquid refrigerant to touch bright metal. Refrigerant in combination with moisture is corrosive and can tarnish bright metal and chrome surfaces.
  - f) Discharge the refrigerant very slowly when purging a refrigeration system. Otherwise, the refrigeration oil will discharge together with refrigerant.
- 2) If liquid refrigerant contacts your eye or skin.
  - a) Do not rub the eye or skin.

- b) Splash large quantities of cool water to the eye or skin to raise the temperature.
- c) Tape on a sterile eye patch to avoid the possibility of dirt entering the eye.
- d) Apply clean petroleum jelly to the skin.
- e) Rush to a physician or hospital for immediate professional treatment.
- f) Do not attempt to treat the wound yourself.

#### **D. Safety Gaps**

- 1) When installing the air conditioner parts, keep safety gaps or use insulators which do not interfere with surrounding parts.
  - a) Fan shroud—Radiator hose  
5 mm (0.20 in.) or more
  - b) Cooling fan (steel)—Radiator  
15 mm (0.59 in.) or more
  - Cooling fan (plastic)—Radiator  
20 mm (0.79 in.) or more
  - c) Cooling fan—Fan shroud  
15 mm (0.59 in.) or more
  - d) Cooling fan—Crankshaft and idle pulleys  
4 mm (0.16 in.) or more
  - e) Cooling fan—Radiator hose  
15 mm (0.59 in.) or more
  - f) Brake and Fuel pipes—Surrounding parts  
15 mm (0.59 in.) or more
  - g) Suction and discharge hoses—Surrounding parts  
15 mm (0.59 in.) or more (except clamping position or using rubber cushion)
  - h) High tension wire—Surrounding parts  
15 mm (0.59 in.) or more
  - i) Loose side of V-belt—Radiator hose  
20 mm (0.79 in.) or more
- 2) After finishing repair work, be sure that the air conditioner parts do not touch the surrounding parts of the vehicle.

#### **E. Mounting Parts**

- 1) Never forget the spring washer when installing the parts so that the vibration does not loosen the bolt.

- 2) Parts mounted on the engine must be tightened to specified torque. (See vehicle service manual).

#### **F. Others**

- 1) When repairing the air conditioning system, use fender and seat covers to protect the paint and upholstery.
- 2) When the air cleaner or water outlet are removed from the engine, cover the engine with the blind cover to keep free from dust or dirt.
- 3) Never rotate the compressor if the refrigerant is not charged into the refrigeration system.
- 4) When storing the compressor as stock, evacuate the inside and charge the refrigerant or dry nitrogen about 1-2 kg/cm<sup>2</sup> (14-28 psi) into compressor to prevent corrosion.
- 5) After finishing repair work, check if each component part of the vehicle operates as usual.

## **2. Ultraviolet Rays and Ozone Layer**

Specified chlorofluorocarbons, chemically stable substances which are superior for heat resistance and non-combustibility, have the characteristics of being colorless and odorless without being inflammable, corrosive, or toxic. For these reasons, they came to be used for a wide range of purposes such as refrigerants for air conditioners and refrigeration units, aerosol spray agents, cleaning agents for electronic systems, fire extinguisher materials, foam agents, and raw material for synthetic resins.

On the contrary, the most important characteristic of an alternative refrigerant is that the ozone depletion potential is small, and the indispensable minimum condition is that it can be used safely in each area.

CFC-12, which is used as a refrigerant for automotive air conditioners, is also subject to restriction as a substance which depletes the ozone. For an alternative substance which doesn't include chlorine, a source of ozone depletion, HFC-134a is considered to be the most suitable substance. Denso has developed an automotive air conditioning system which uses HFC-134a as a refrigerant in place of CFC-12.

## Service Tool and Testers

### 1. Service Tool Kit

- A. Recovery/Recycling/Recharging Machine
- B. Refrigerant Charging Hoses
- C. Refrigerant Leak Tester

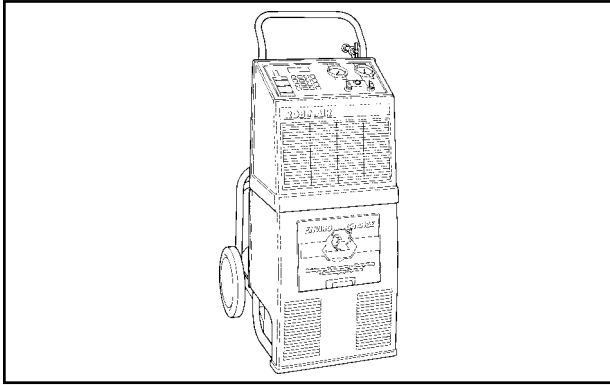


Figure 30: Charging Station

### 2. Handling of Service Tools

#### A. Manifold Gauge Set

NOTE: When recovery/recycling/recharging equipment such as a Robinair Enviro Charge Series 34700 or equivalent is used, the manifold gauge set is included with the system.

The hand valves (“LO” and “HI”) on the manifold gauge set are used to open and close the valve. The hand valve inscribed “LO” is for the low pressure side valve and “HI” is for the high pressure side valve. (Fig. 31)

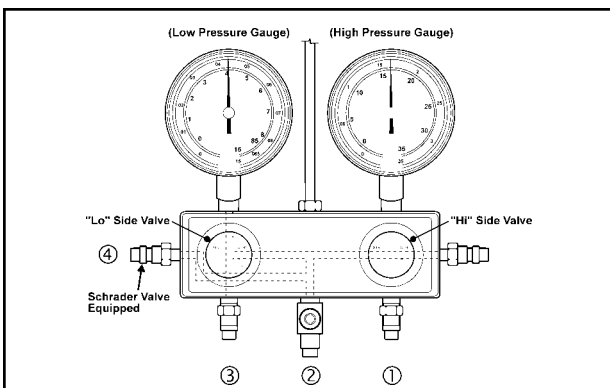
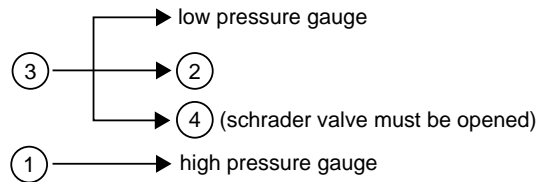


Figure 31: Manifold

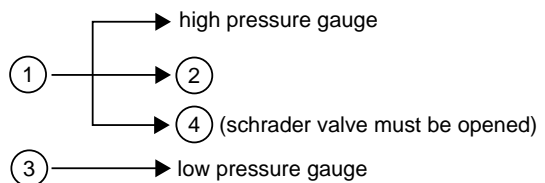
By opening or closing the high and low pressure hand valves, the following circuits are established.

- 1) When low pressure side valve (“LO”) is opened and high pressure side valve (“HI”) is closed.



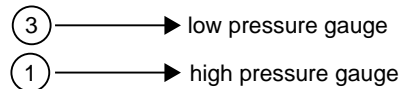
- 2) When low pressure side valve (“LO”) is closed and high pressure side valve (“HI”) is opened.

Two circuits are established:



- 3) When low and high pressure gauges are closed.

Two circuits are established:



#### B. Refrigerant Charging Hose

The charging hoses are classified into three colors.

Each charging hose must be handled as follows:

- 1) The air conditioner manufacturer recommends that the blue hose is used for the low pressure side (suction side), the green hose for refrigeration side (center connecting port) and the red hose for high pressure side (discharge side).
- 2) HFC-134a charging hoses are equipped with service couplers, which allow you to install your charging hoses to the charging valve on the vehicle. These service couplers are available from Robinair.

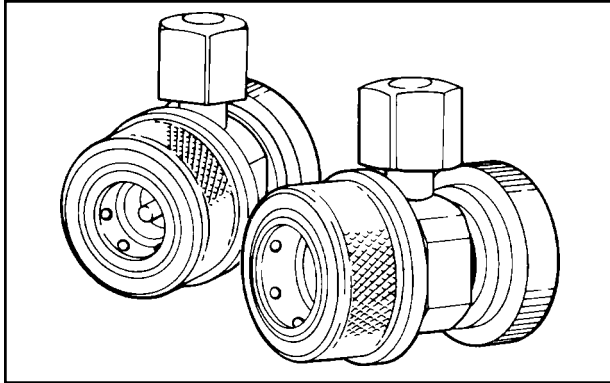


Figure 32: Couplers

- 3) When the manifold gauge set is not in use, connect the end of the hose to the spare fitting of the refrigerant charging hose. (Fig. 33)

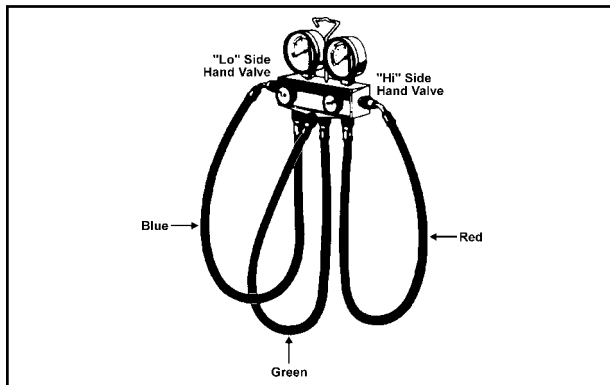


Figure 33: Manifold Gauge Set

### C. Service Stop Valve

The service stop valve is used to prevent leakage of refrigerant or oil when removing the "HI" side charging hose for the compressor provided with the schrader valve. (Fig. 34)

- 1) How to Install
  - a) Before connecting the service stop valve to the discharge service valve of the compressor, turn the hand valve completely counter-clockwise.
  - b) Install the service stop valve to the discharge service valve and connect the "HI" side charging hose to it.
  - c) Turn the hand valve clockwise until the stem completely engages the schrader valve.

- 2) How to Remove
  - a) Turn the hand valve completely counter-clockwise.
  - b) Remove the service stop valve from the discharge service valve.
  - c) Turn the hand valve clockwise slightly to remove the residual pressure in the charging hose.

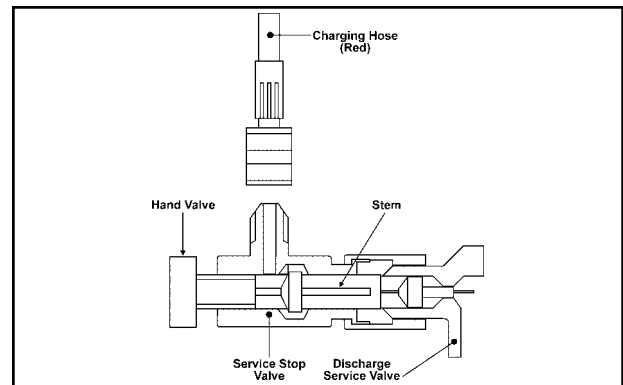


Figure 34: Stop Valve

### D. Gas Leak Tester (Detector)

The conventional gas leak detectors such as the halide torch type and electronic type cannot be used to detect a gas leak of HFC-134a. Since the conventional detector easily detects chlorine (Cl), which is contained in CFC-12 but not contained in HFC-134a.

Therefore, a new gas leak detector has been developed to detect HFC-134a

This new gas leak detector has a higher degree of sensitivity to the presence of HFC-134a and also can be used for CFC-12. (Fig. 35)

REFRIGERANT SENS. MODE	HFC-134a	CFC-12
HI-SENS	15g (0.5oz)–30g (1oz)/yr.	6g (0.2oz)/yr.
HFC-134a	40g (1.4oz)/yr.	
CFC-12		15g (0.5oz)/yr.

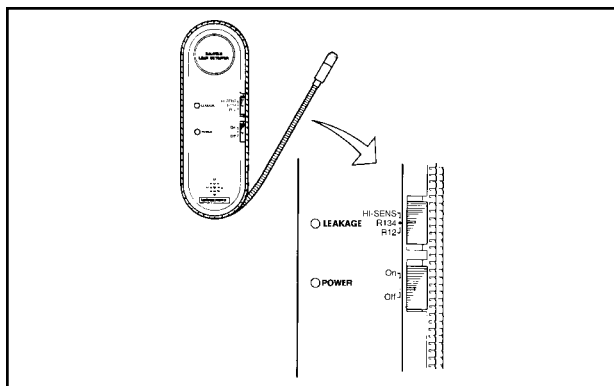


Figure 35: Gas Leak Detector

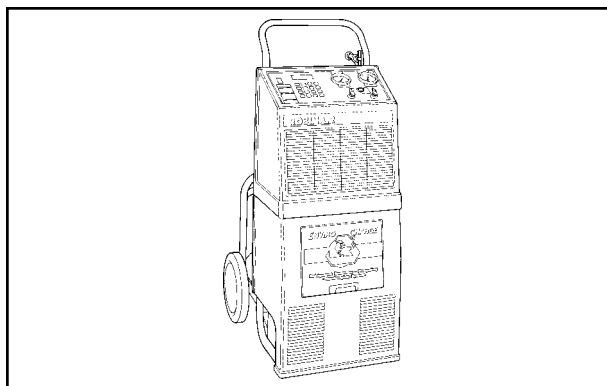


Figure 36: Charging Station (HFC-134a)

### 3. Robinair Enviro Charge 34700 Series

This unit is the recommended A/C recover/recycle station, it provides all-in-one service for HFC-134a recovery, recycling and recharging.

#### A. Features

- Built-in manifold
- Microprocessor controls
- 4 cfm vacuum pump
- Refrigerant passes through the filter on the way to the storage tank, providing UL certified single pass recycling
- Automatic recycling of refrigerant while system is being evacuated
- Moisture indicator changes color when refrigerant is ready for reuse
- Refrigerant charge can be programmed or controlled manually
- Automatic shut-off when all the refrigerant has been pulled from the system

#### B. Specifications

Voltage	115 V 60 Hz
Refrigerant Tank	One 50-lb. refillable DOT approved
Operating Range	50° to 120°F (11° to 49°C)
Recovery Rate	1/2 lb. per minute (.2 kg per minute)
Recycling Rate	1 lb. per minute flow rate (.4 kg/min.) time depends on moisture content
Recycling Filter	43 cu. in. (710 cc) Quick Change
Scale Resolution	1/100 lb.
Pump Free Air Displacement	4 cfm (93 L/M)
Dimensions	45" H x 22" W x 28" D
Weight	167 lbs. (76 kg) without tank

#### C. Replacement Parts

34430 Quick Change Recycling Filter

34750-50 Pound Refillable Tank

For additional information contact Robinair at 1-800-368-6787.



## 1. Standard Torque: Coupling Nut Type Fittings

Size of Tube (inch)	Fitting Torque N•m (kgf•cm, lbf•ft)
0.31	14 (140, 10)
0.50	23 (230, 17)
0.62	32 (330, 24)

## 2. Torque Specification for Bolts/Nuts/Screws

Diameter X Pitch	Bolt Strength	Tightening Torque N•m (kgf•cm, lbf•ft)
M6 X 1.0 M8 X 1.25 M10 X 1.25 M12 X 1.25	4T	5.4 (55, 4.0) 12.7 (130, 9.4) 25.0 (260, 18) 47.1 (480, 34.8)
M6 X 1.0 M8 X 1.25 M10 X 1.25 M12 X 1.25	6T	7.8 (80, 5.8) 19.1 (195, 14.1) 39.2 (400, 29.0) 71.6 (730, 52.8)
M6 X 1.0 M8 X 1.25 M10 X 1.25 M12 X 1.25	8T	29.4 (300, 21.7) 60.8 (620, 44.9) 107.8 (1100, 79.6)

# COMPONENT LOCATIONS AND POSITIONS

## 1. Interior Component Locations (All Models)

### A. Heater and Cooling Unit

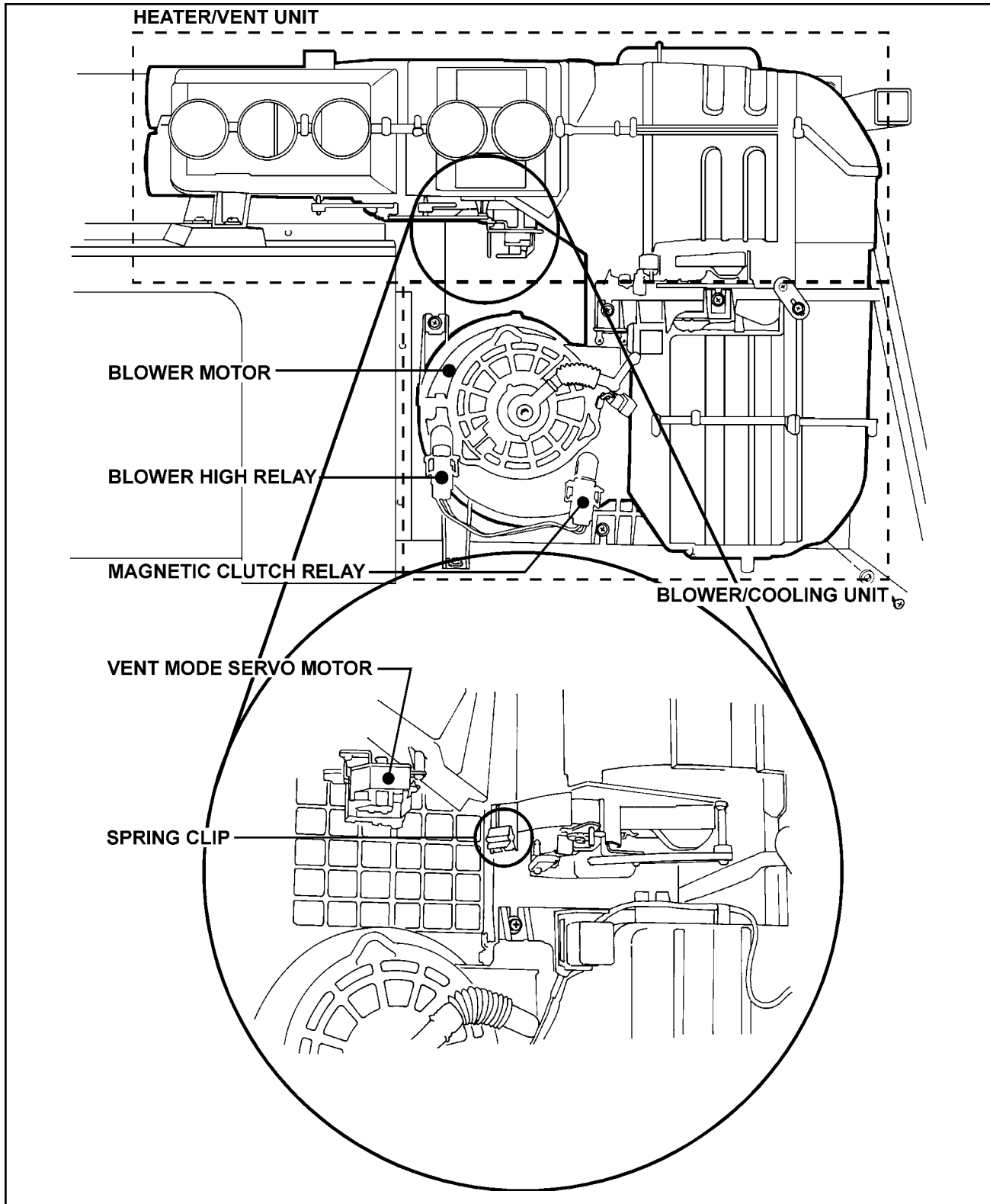


Fig. 37: Heater and Cooling Unit

**B. Cooling Unit Wire Harness**

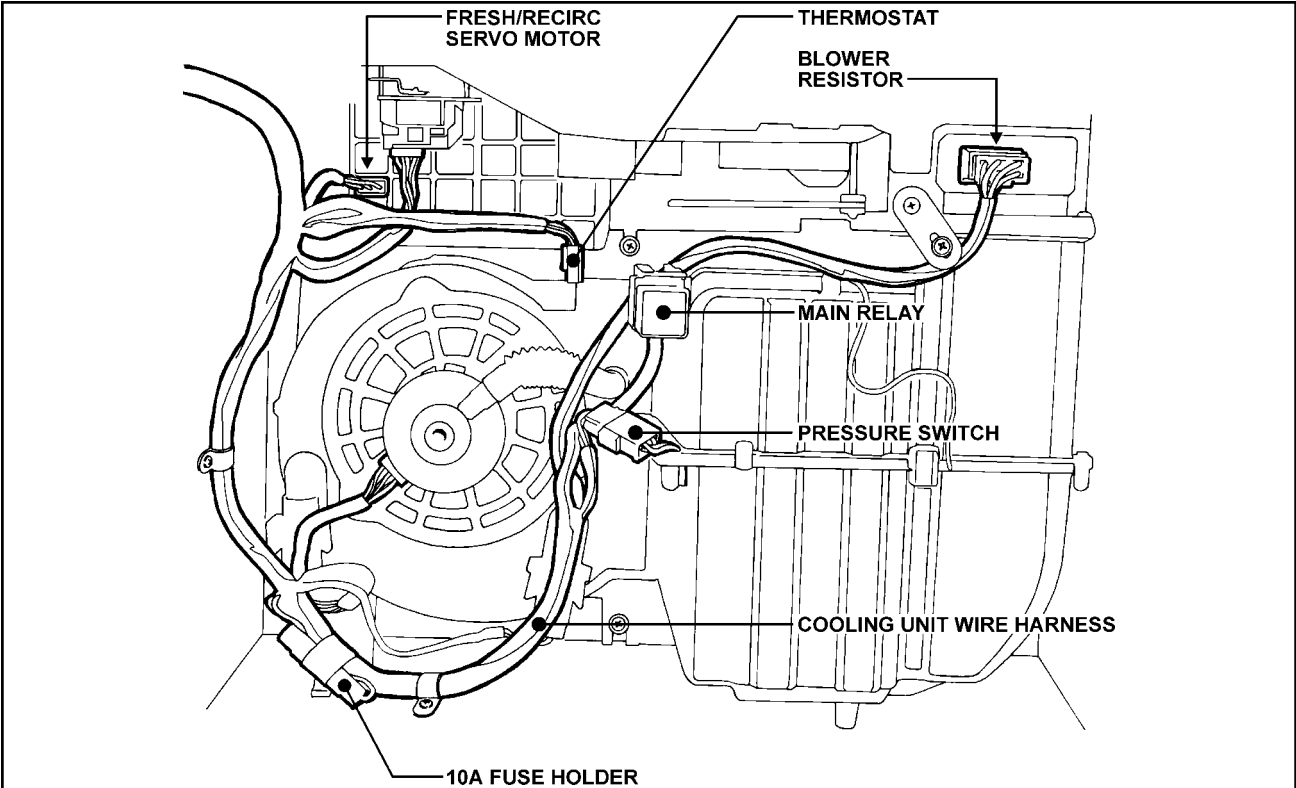


Fig. 38: Cooling Unit Wire Harness

**C. Dash Wire Harness and Control Panel**

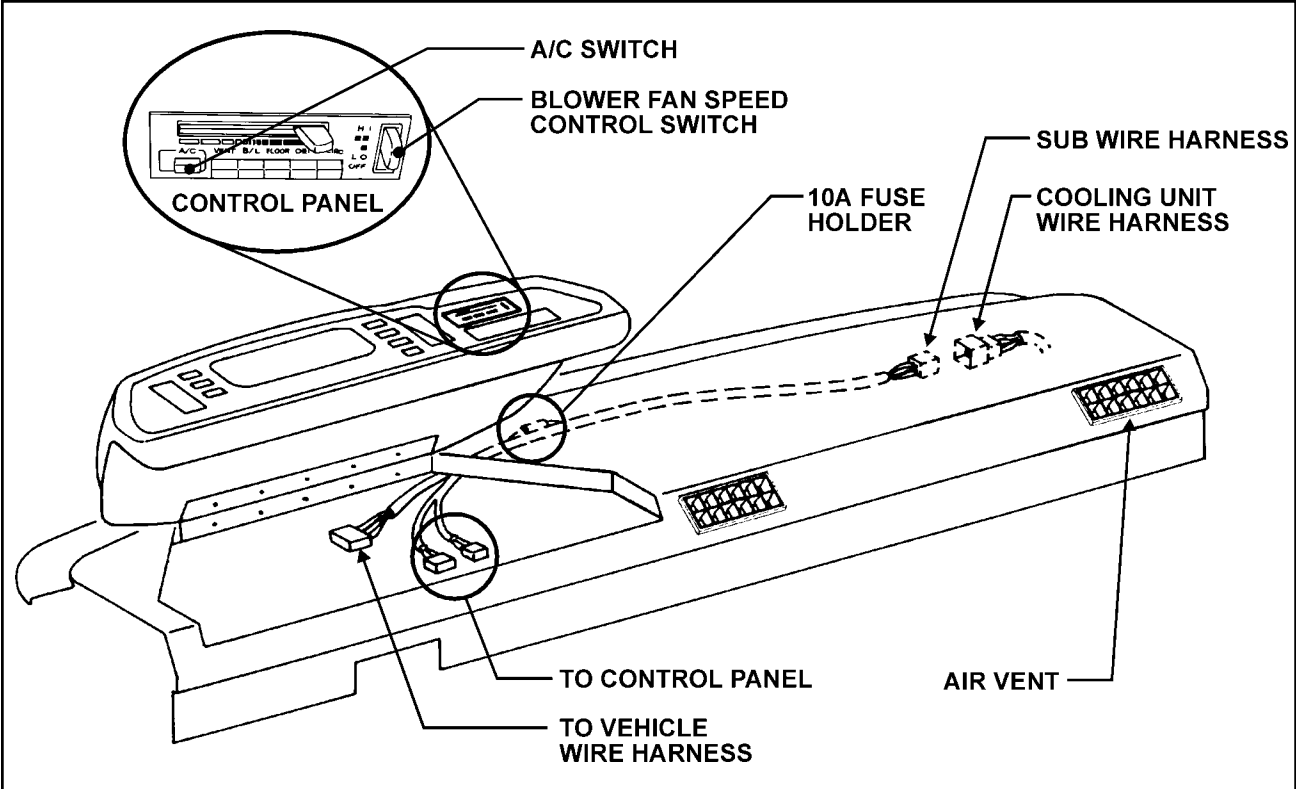


Fig. 39: Dash Wire Harness and Control Panel

# COMPONENT LOCATIONS AND POSITIONS

## D. Temperature Control Cable

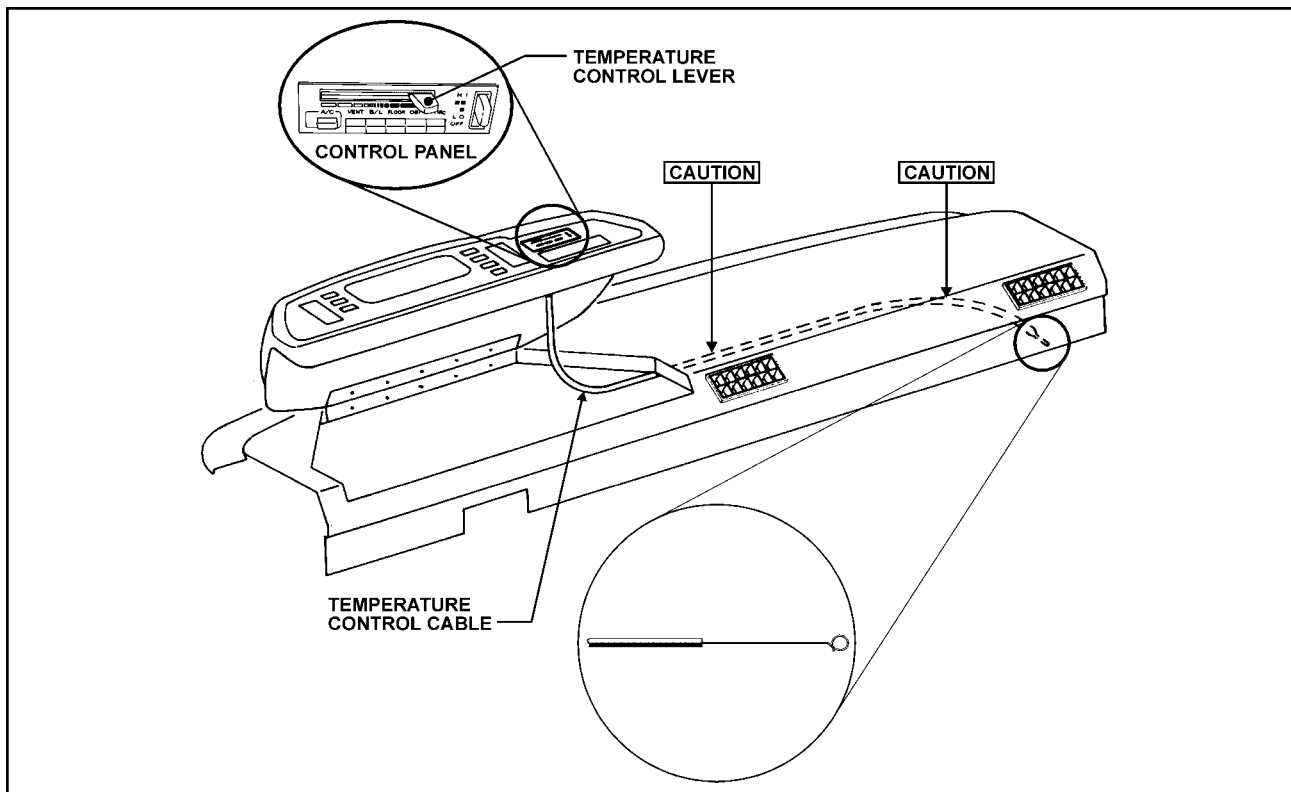


Fig. 40: Temperature Control Cable

## E. Fresh/Recirc. Damper Box

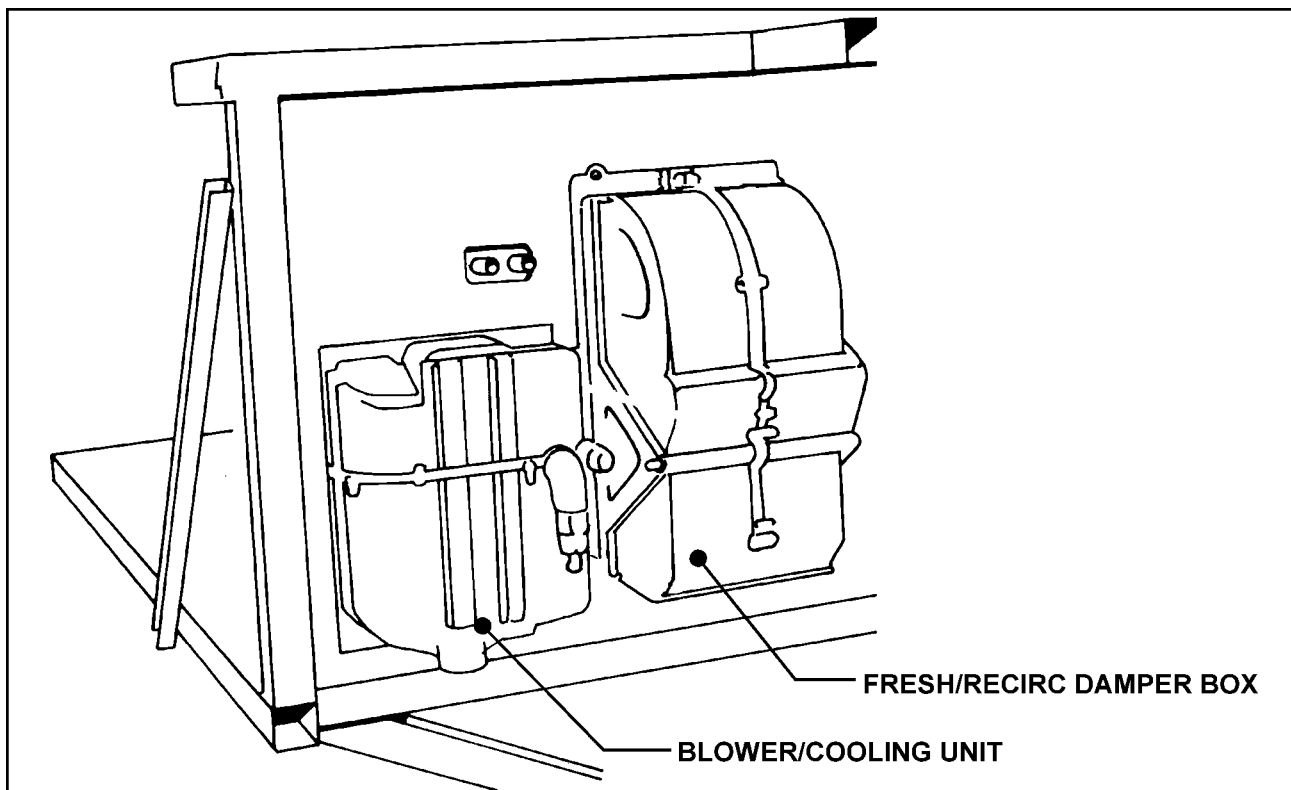


Fig. 41: Fresh/Recirc. Damper Box

2. Raised Floor Measurements and Cutouts

A. Front Engine

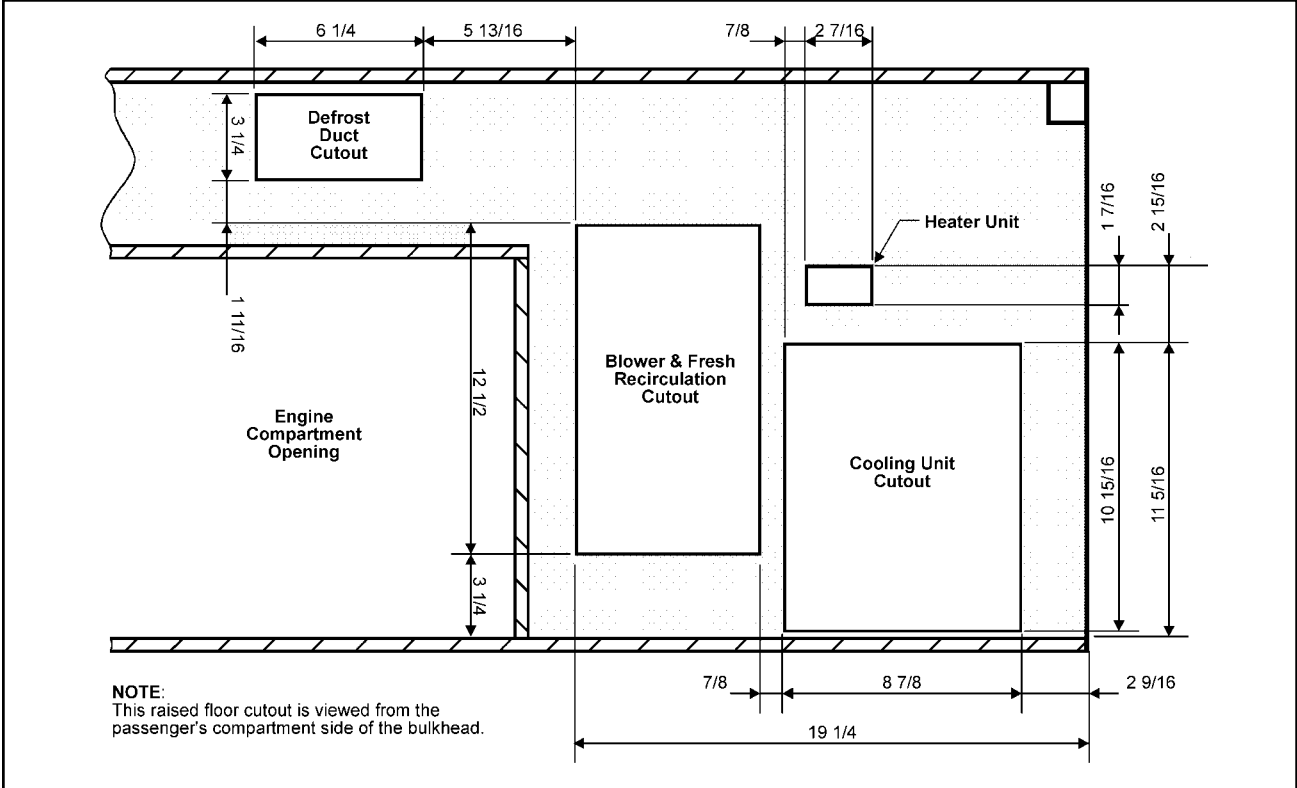


Fig. 42: Front Engine Floor Measurements and Cutouts

B. Rear Engine

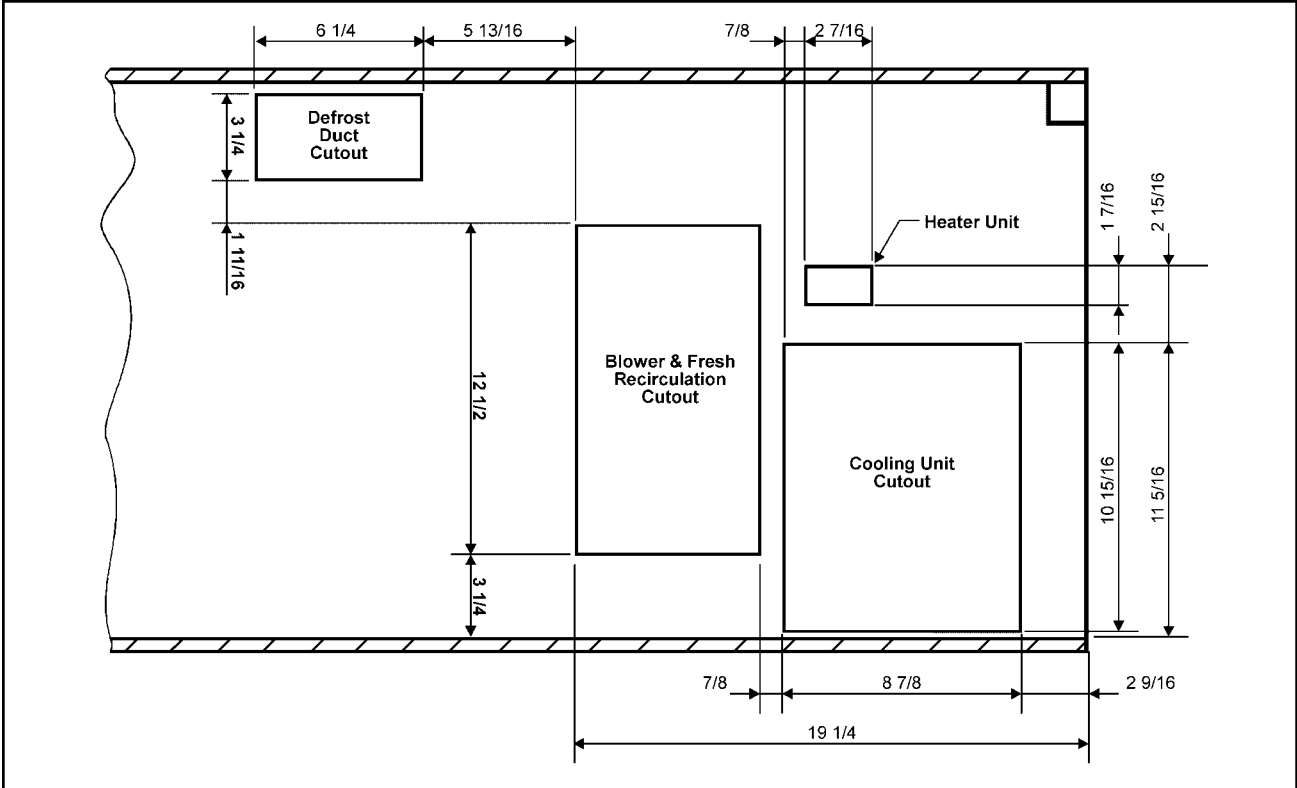


Fig. 43: Rear Engine Floor Measurements and Cutouts



## 2. Troubleshooting by Manifold Gauge

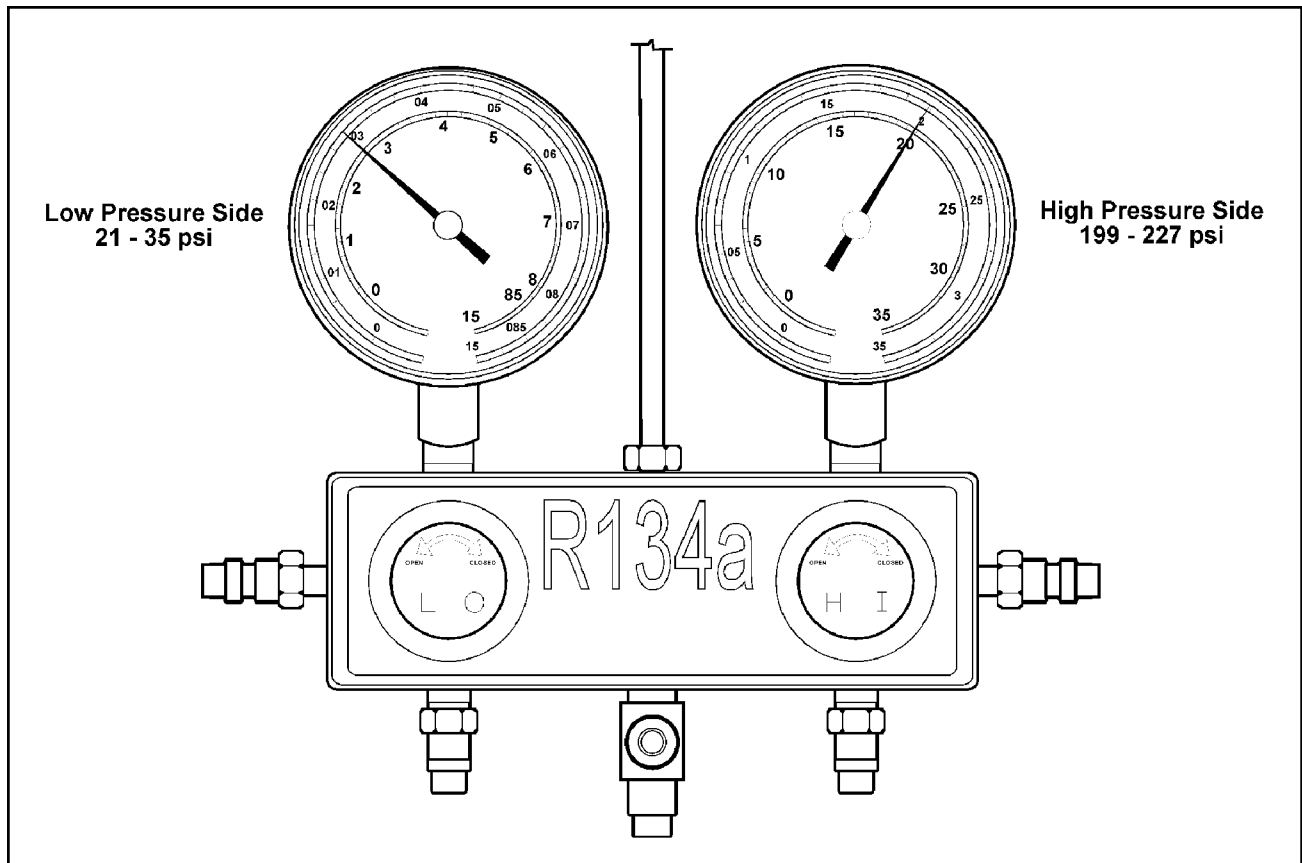


Figure 44: Normal Reading

### Condition A = Normal Reading

First, have the manifold gauge high and low pressure side valves tightly closed, and connect the charging hoses (red and blue) to the respective compressor service valves.

In this case, if the service valves are the valve plunger type, always make sure to set the plungers to the intermediate seat position (slightly toward back seat if the pointer vibrates) so as to enable taking measurements with the gauges.

*NOTE: Be sure to purge the air in the charging hoses at the manifold gauge connection end by utilizing the refrigerant pressure in the refrigerating cycle.*

If the refrigeration cycle is operating normally, the reading at the low pressure side should generally be around 21 - 35 psi and at the high pressure side around 199 - 227 psi when ambient air temperature is about 86° - 95°F, engine speed 1500 rpm, strongest cooling setting, and blower operating at top speed.

The gauge indications shown in the following diagrams are taken under the same conditions (ambient air 86° - 95°F, engine speed 1500 rpm, strongest cooling setting, maximum blower speed), so it should be noted that the gauge readings will differ somewhat with the ambient conditions.

*NOTE: Gauge should indicate static pressures before A/C operation both high and low pressure sides between 71~114 psi.*

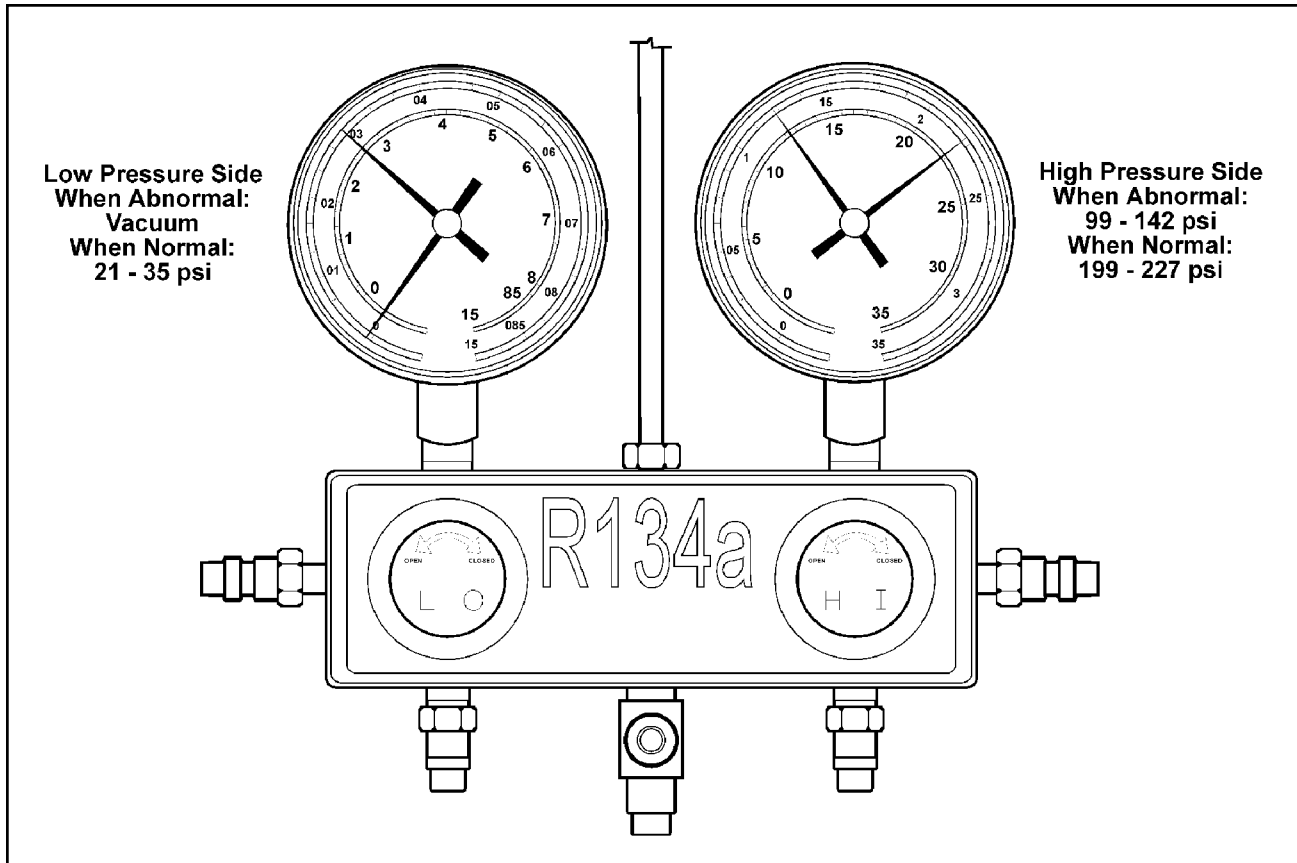


Figure 45: Moisture Entered in the Cycle

## Condition B = Moisture Entered in the Cycle

### Condition

1. Periodic cooling and no cooling at the evaporator.

### Symptoms seen in refrigeration cycle

1. During operation, low side pressure alternately becomes vacuum and normal.

#### When Abnormal:

Low Pressure Side: Vacuum  
 High Pressure Side: 99 ~ 142 psi

#### When Normal:

Low Pressure Side: 21 ~ 35 psi  
 High Pressure Side: 199 ~ 227 psi

### Cause

1. The moisture in the refrigeration cycle freezes in the expansion valve orifice and causes temporary blocking.

After a time, the ice melts and condition returns to normal.

### Diagnosis

1. Receiver/drier in oversaturated condition.
2. Moisture in refrigeration cycle freezes expansion valve orifice and obstructs refrigerant circulation.

### Remedy

1. Replace receiver/drier.
2. Remove moisture in cycle by means of repeated evacuation.
3. Check expansion valve.
4. Recharge new refrigerant to the proper quantity.



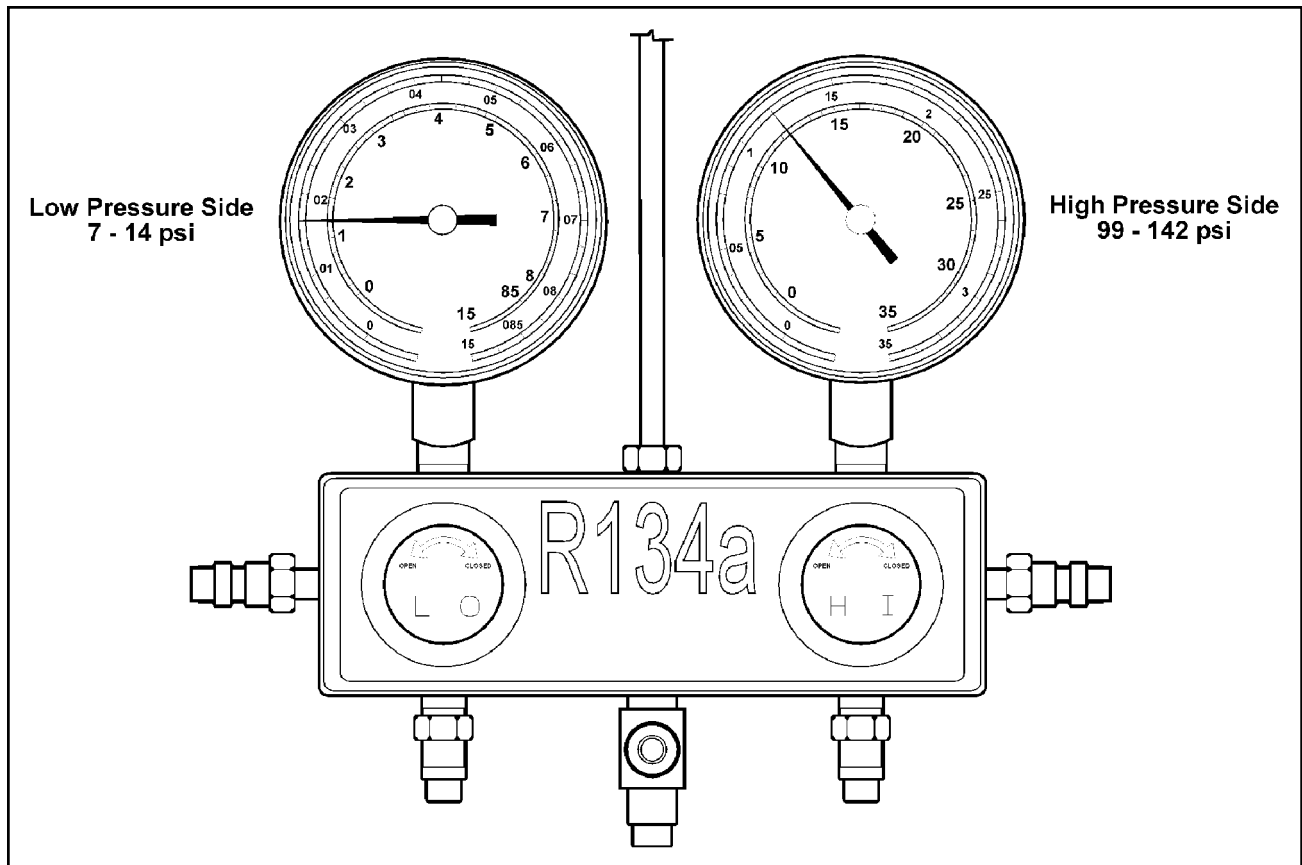


Figure 46: Insufficient Refrigerant

### Condition C = Insufficient Refrigerant

#### Condition

1. Would desire more cooling.

#### Symptoms seen in refrigeration cycle

1. High and low side pressures both low.  
Low Pressure Side: 7 ~14 psi  
High Pressure Side: 99 ~ 142 psi
2. Bubbles seen in sight glass.
3. Air discharged from air conditioner slightly cold.

#### Cause

1. Gas leaking someplace in refrigeration cycle.

#### Diagnosis

1. Refrigerant in cycle insufficient.
2. Refrigerant leaking.

#### Remedy

1. Check for leakage with leak detector and correct.
2. Evacuate and recharge refrigerant to proper amount.

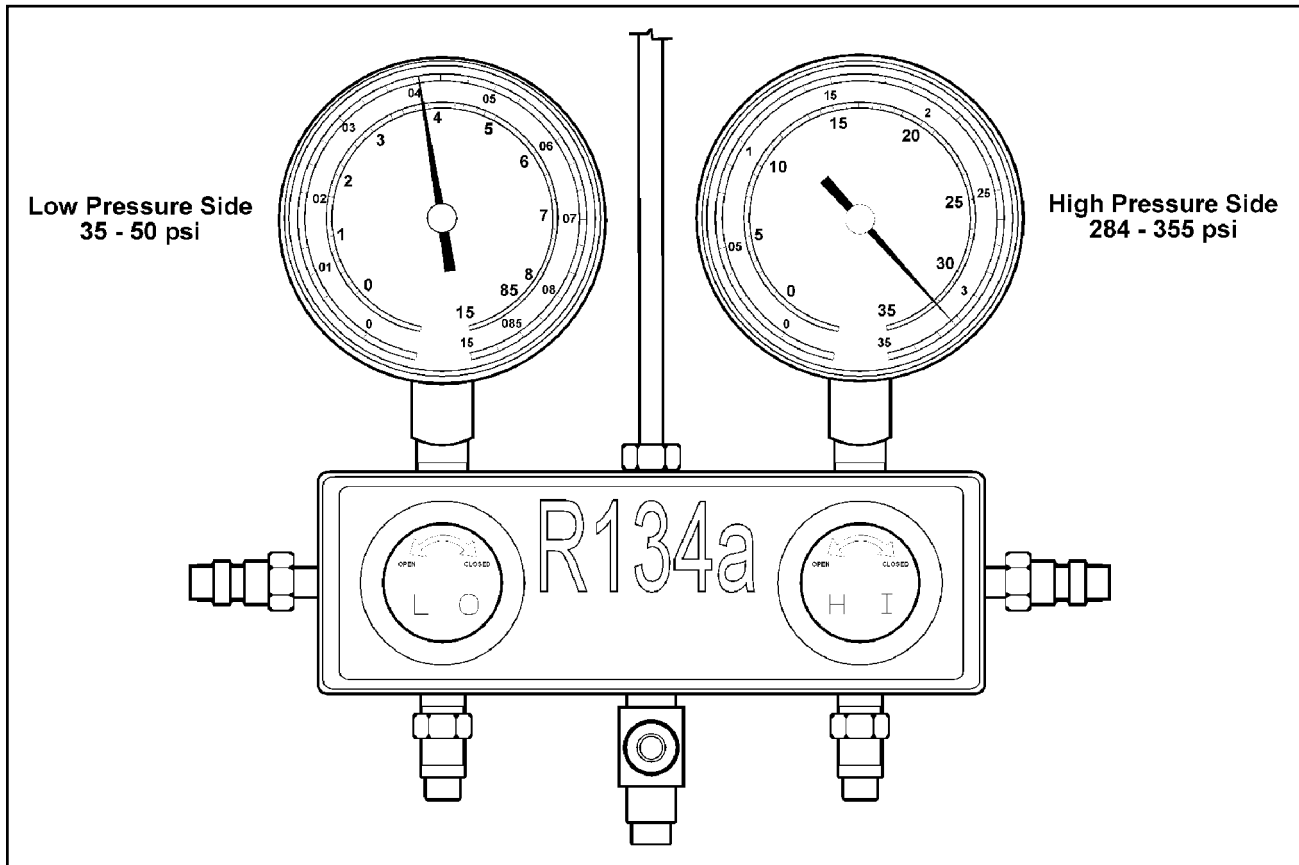


Figure 47: Excessive Refrigerant or Insufficient Condenser Cooling

## Condition D = Excessive Refrigerant or Insufficient Condenser Cooling

### Condition

1. Air conditioner fails to cool properly.

### Symptoms seen in refrigeration cycle

1. High and low side pressures both high.  
Low Pressure Side: 35 ~ 50 psi  
High Pressure Side: 284 ~ 355 psi
2. Bubbles cannot be seen in the sight glass.

### Cause

1. Due to overcharging refrigerant into cycle, proper performance cannot be shown.
2. Condenser cooling faulty.

### Diagnosis

1. Refrigerant overcharged.
2. Condenser cooling defective.
3. Condenser fins clogged or fan belt loose.
4. Radiator fan fluid coupling slipping or electric fan inoperative.

### Remedy

1. Clean condenser.
2. Adjust fan belt to proper tension.
3. If 1 and 2 are in normal condition, check refrigerant quantity.

*NOTE: If excessive refrigerant is to be discharged, You must use a refrigerant recovery station.*

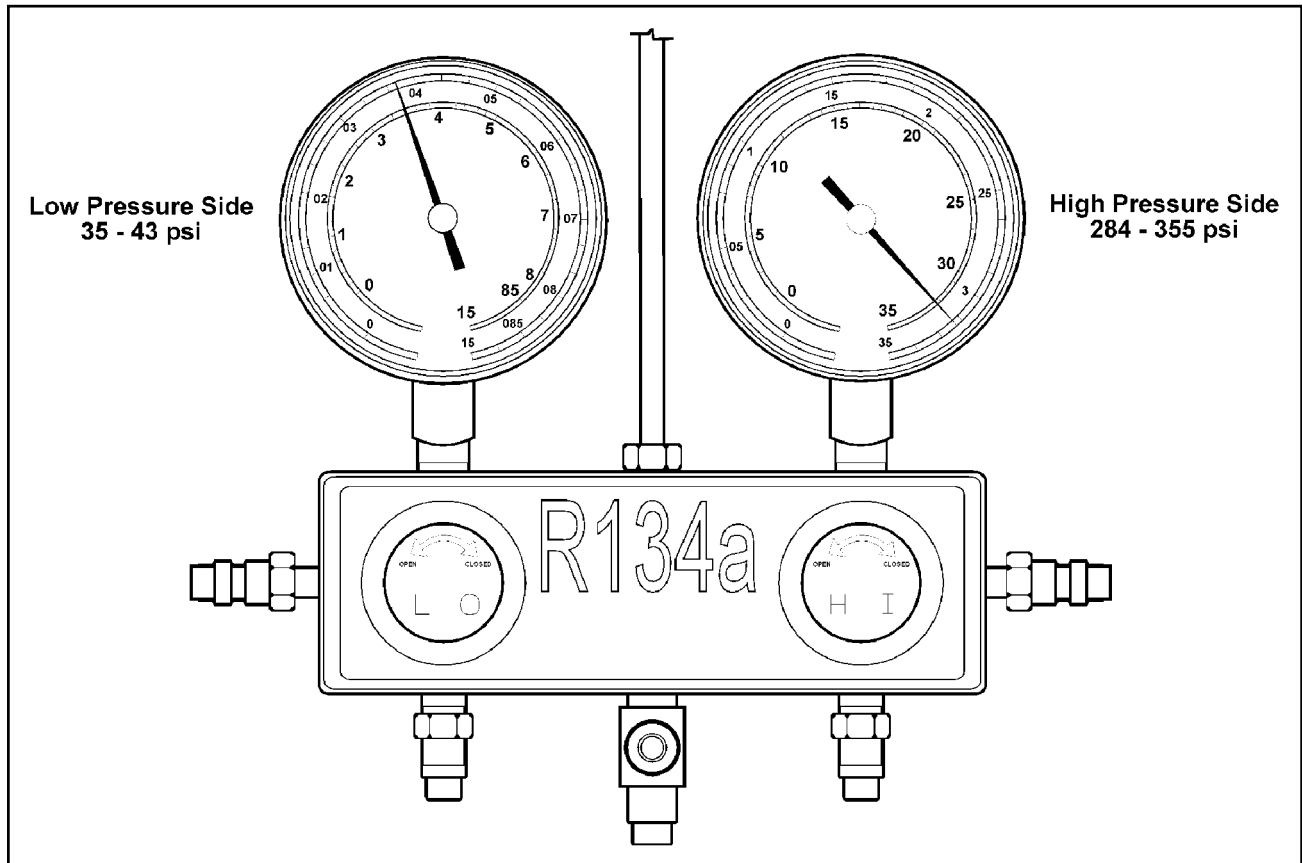


Figure 48: Air Entered in the Cycle

### Condition E = Air Entered in the Cycle

#### Condition

1. Air conditioner fails to cool sufficiently.

#### Symptoms seen in refrigeration cycles

1. High and low side pressures high.  
Low Pressure Side: 35 ~ 43 psi  
High Pressure Side: 284 ~ 355 psi.
2. Low pressure side piping not cold when touched.

#### Cause

1. Air entered in refrigeration cycle.

#### Diagnosis

1. Air in refrigeration cycle.
2. Evacuating insufficient.

#### Remedy

1. Replace receiver.
2. Check compressor oil contamination and quantity.
3. Recover refrigerant, evacuate and recharge new refrigerant.

*NOTE: The above cycle can be seen when after the cycle is opened, the refrigerant is charged without evacuation.*

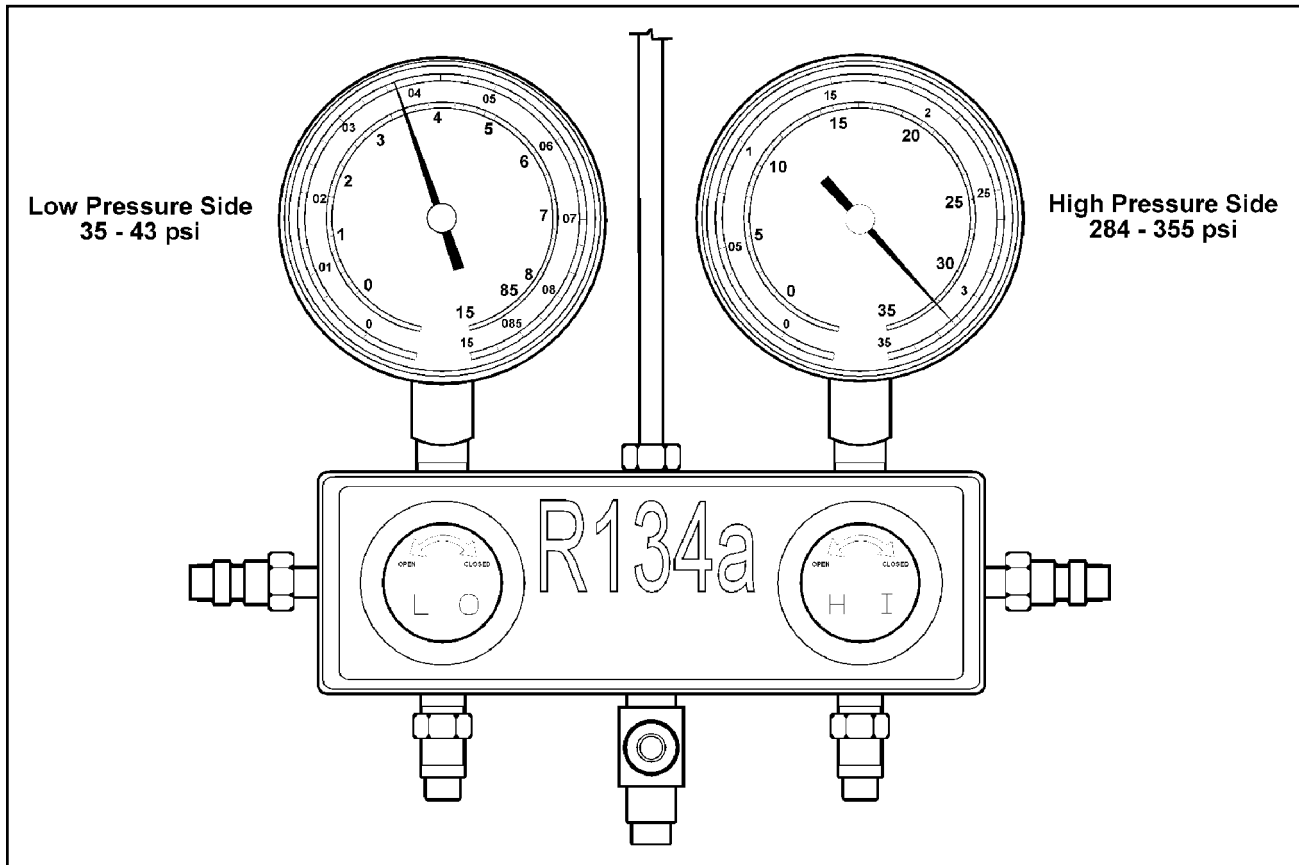


Figure 49: Expansion Valve Trouble or Improper Installation of Heat Sensitizing Tube

## Condition F = Expansion Valve Trouble or Improper Installation of Heat Sensitizing Tube

### Condition

1. More cooling desired.

### Symptoms seen in refrigeration cycle

1. Low and high side pressures both high.  
Low Pressure Side: 35 ~ 43 psi  
High Pressure Side: 284 ~ 355 psi.
2. Frost or heavy dew on low pressure side piping.

### Cause

1. Expansion valve trouble or heat sensitizing tube improperly installed.
2. Flow adjustment not properly done.

### Diagnosis

1. Excessive liquid refrigerant in low pressure side piping.
2. Expansion valve opened too far.

### Remedy

1. Check installed condition of heat sensitizing tube.
2. If remedy 1 is in normal condition, replace expansion valve.

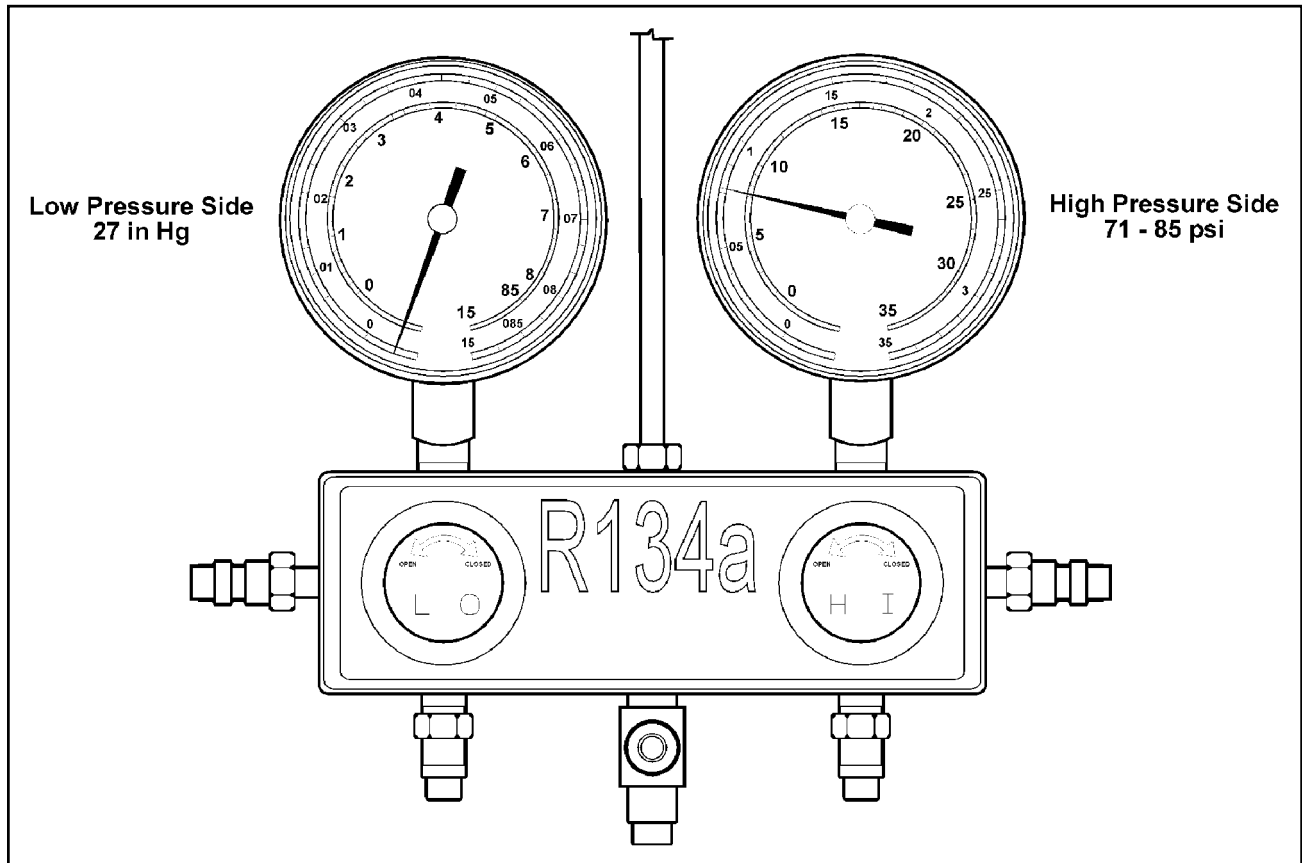


Figure 50: Refrigerant Fails to Circulate

### Condition G = Refrigerant Fails to Circulate

#### Condition

1. Intermittent cooling

#### Symptoms seen in refrigeration cycle

1. Vacuum shown at low side and very low pressure shown at high side.  
Low Pressure Side: 27 in. Hg  
High Pressure Side: 71 ~ 85 psi
2. Frost or dew formed on piping at inlet and outlet of expansion valve or receiver.

#### Cause

1. Refrigerant flow obstructed by moisture or dirt in the refrigerating cycle freezing or sticking on the expansion valve orifice.

#### Diagnosis

1. Expansion valve orifice plugged.
2. Refrigerant does not circulate.

#### Remedy

1. Allow to stand for some time and then resume operation to decide whether the plugging is due to moisture or dirt.
  - a. If caused by moisture – Correct by referring to instructions in condition B.
  - b. If caused by dirt – Remove the expansion valve and blow out the dirt with compressed air. If unable to remove the dirt, replace the expansion valve. Replace the receiver. Evacuate and recharge proper amount of new refrigerant.
  - c. If caused by gas leakage in heat sensitizing tube Replace the expansion valve.

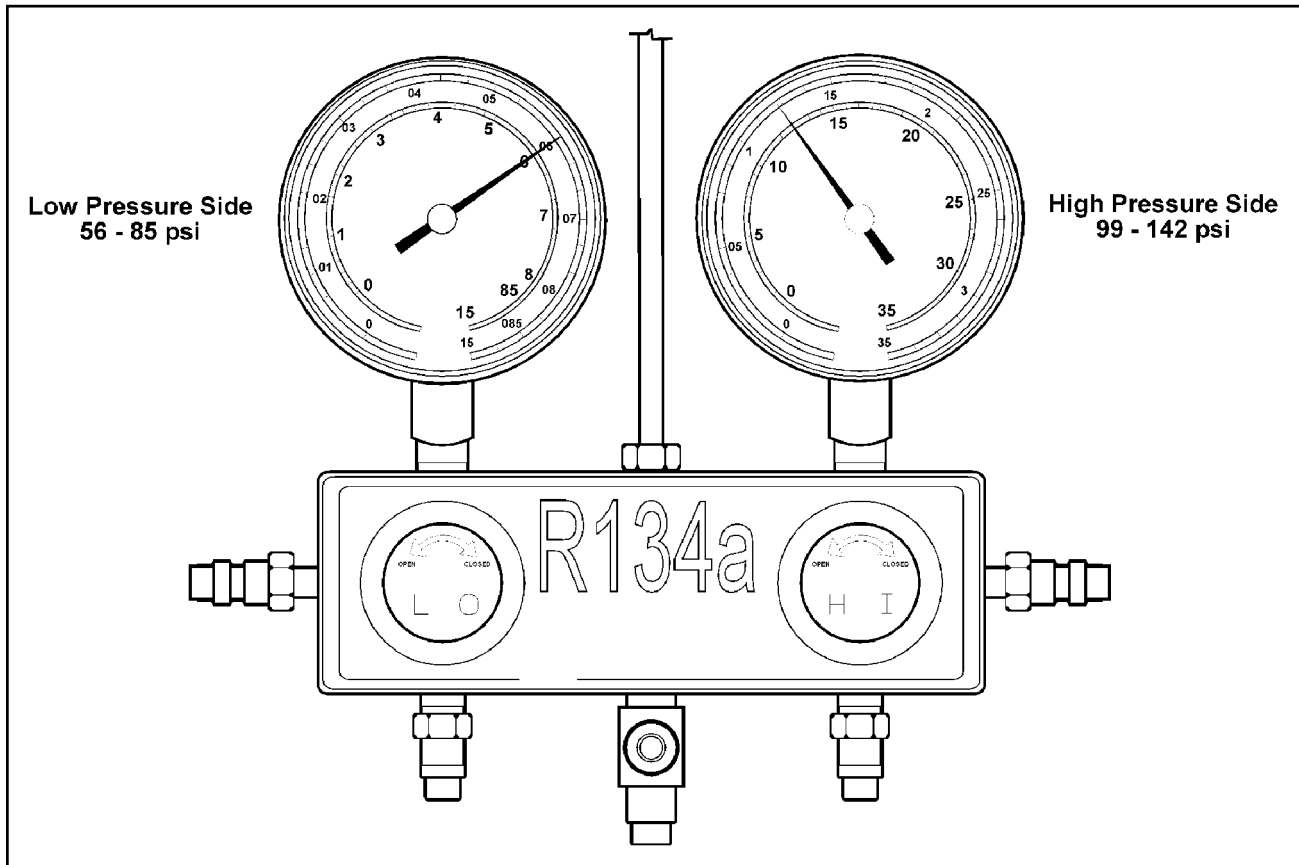


Figure 51: Faulty Compression of Compressor

## Condition H = Faulty Compression of Compressor

### Condition

1. Does not cool.

### Symptoms seen in refrigerating cycle

1. Low pressure side pressure too high.
2. High pressure side pressure too low.
3. Low pressure side: 56-85 psi
4. High pressure side: 99-142 psi

### Cause

1. Leak in compressor.

### Diagnosis

1. Compression faulty.
2. Valve leaking or broken, sliding parts (piston, cylinder, gasket, connecting rod, etc.) broken.

### Remedy

1. Disassemble and repair compressor. (Refer to appropriate GM, Ford, or Spartan repair manual.)

### 3. Visual and Audible Troubleshooting Questions

- A. Are there any loose V-belts?

If the V-belt is loose, it will slip and wear out faster. Adjust to the recommended tension or replace with a new V-belt if worn out.

- B. What if you hear noise near the compressor?

Check the compressor mounting bolts and the bracket mounting bolts to see if they are loose. Tighten all loose bolts.

- C. Do you hear noise inside the compressor?

This could be caused by a worn bearing or lack of refrigeration oil in system. Remove the compressor, disassemble, and make all necessary repairs or replacements.

- D. Are condenser fins covered with dirt and dust?

If the condenser fins are dirty, the cooling effect will be greatly reduced. To prevent this from happening, wash off all dirt and dust. Be careful not to damage or bend fins if you are using a stiff brush to wash condenser.

- E. Do you see oil stains in the refrigerating cycle connections and joints?

Any place where an oil stain can be seen usually indicates that refrigerant is leaking from that spot. This is because the compressor oil and the refrigerant will escape out of the system together. Thus, the location of the leak can be pinpointed by the spot where the oil stain is found. At this spot, all bolts should be retightened to the proper torque and parts replaced, if needed, to stop the leak.

Since compressor gasket joints and pipe connectors are the most likely spots where oil stains are found, special attention should be given to checking these places.

- F. Do you hear noise near blower?

Turn the blower motor to LOW, MEDIUM and HIGH speeds. If you hear any unusual sounds or the motor rotation appears defective, make sure there are no foreign objects lodged in the blower or loose bolts and parts which need tightening as this can sometimes be the cause of these problems.

If no foreign objects are found, replace the blower motor.

- G. What should you see when checking refrigerant quantity at sight glass?

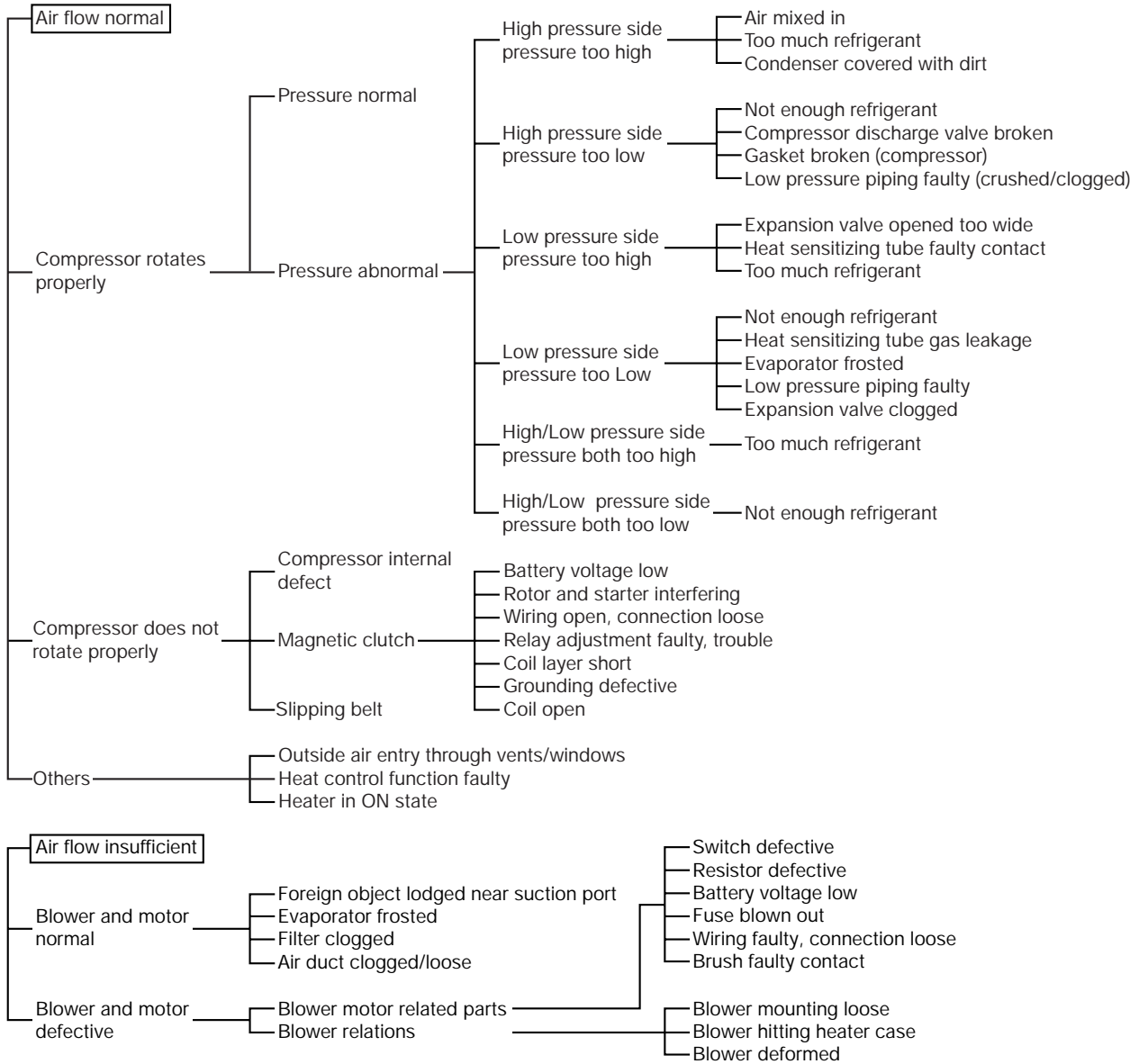
If a large flow of bubbles can be seen in the sight glass, there is insufficient refrigerant charged. Refrigerant should be replenished to its proper level. Also check for oil stains (as described previously) to make sure there is no refrigerant leak.

If bubbles cannot be seen in the sight glass, even when the condenser is cooled by pouring water, this is a sign that there is too much refrigerant in the system. Therefore, the excessive amount should be removed/recovered. One should be very careful when taking out refrigerant from the low pressure side service valve to avoid removing too much which may cause the compressor oil to blow out.

# TROUBLESHOOTING

## 4. Troubleshooting Chart

**⚠CAUTION:** When repairs are required on the compressor, condenser, discharge hose, receiver/drier, or the condenser fan motor, please refer to the appropriate chassis manufacturer repair manual.





**5. Insufficient Cooling**

**A. Compressor**

Symptom	Condition	Possible Cause	Remedy
Discharge pressure abnormally high.	Radiator fan air suction poor.	Fan belt broken or loose.  Condenser and radiator fins covered with dirt and dust.	Retighten or replace radiator.  Clean condenser and radiator.
	No bubbles appear in sight glass when condenser is cooled with water.	Excessive refrigerant charged.	Remove/recover refrigerant to proper amount.
	Pressure at high-pressure side abnormally high. Just after stopping compressor, pressure drops quickly to about 28 psi.	Air entered in refrigerant cycle.	Remove/recover refrigerant and after sufficient evacuating, recharge refrigerant.
Suction pressure abnormally high.	Abnormally cold around low-pressure hose and low-pressure side service valve.	Expansion valve opening too large.  Heat sensitzing tube has poor contact.	Reinstall or replace.
	Heat load too large.	Outside air temperature abnormally high.	Cool the condenser.
	High-pressure side pressure high but suction pressure drops when condenser is cooled.	Excessive refrigerant charge.	Remove/recover refrigerant to proper amount.
	Just after stopping compressor, high- and low-pressure side pressures become equal.	Failed gasket.  High- and low-pressure valve broken or foreign object lodged in valve.	Replace.  Replace valve or remove foreign object.
Discharge pressure abnormally low.	Low-pressure side pressure too low.  Low-pressure piping not cold.	Heat sensitzing tube gas leakage.  Expansion valve frozen or defective	Replace
	Large passage of bubbles through sight glass.	Not enough refrigerant	Charge to proper amount
	If compressor is stopped, high- and low-pressure side pressures immediately equalize.	Compressor discharge of suction valve broken. Foreign object stuck in compressor discharge valve	Repair or replace  Disassemble and remove

## TROUBLESHOOTING

### Compressor (cont'd)

Symptom	Condition	Possible Cause	Remedy
Suction pressure abnormally low.	Large passage of bubbles through sight glass.	Refrigerant insufficient.	Charge to proper amount
	High-pressure side pressure too low. Low-pressure piping not cold.	Heat sensitizing tube gas leakage. Expansion valve frozen or defective	Replace
	Discharge port temperature low, air not coming out.	Evaporator frosted.	Adjust stabilizer relay  Operate correctly (blower speed and temperature control combination)
	Expansion valve frosted.	Receiver clogged.	Clean (remove moisture) or replace
	Temperature difference at receiver front and rear pipings. When excessive, receivers rear piping frosts.	Receiver clogged.	Replace
Discharge and suction pressure both high.	Heavy covering of dirt and dust on condenser fins.	Condenser cooling insufficient	Wash off dirt and dust to improve air passage.
	No bubbles pass through sight glass when water is poured on condenser.	Refrigerant charged excessively.	Remove/recover refrigerant to proper quantity.
Discharge and suction pressure both low.	Large passage of bubbles through sight glass.	Refrigerant insufficient.	Charge to proper amount.
Gas leakage.	Shaft seal becomes noticeably dirty and gaskets leaking.	Gas leaking from shaft seal.	Replace shaft seal.
	Bolts get stained with oil.	Gas leaking from bolted parts.	Retighten bolts.
	Gasket joints get stained with oil.	Gas leaking from joints.	Replace gasket.
	Leakage from cracked part.	Gas leaking from part.	Replace cracked part.

***B. Magnetic Clutch***

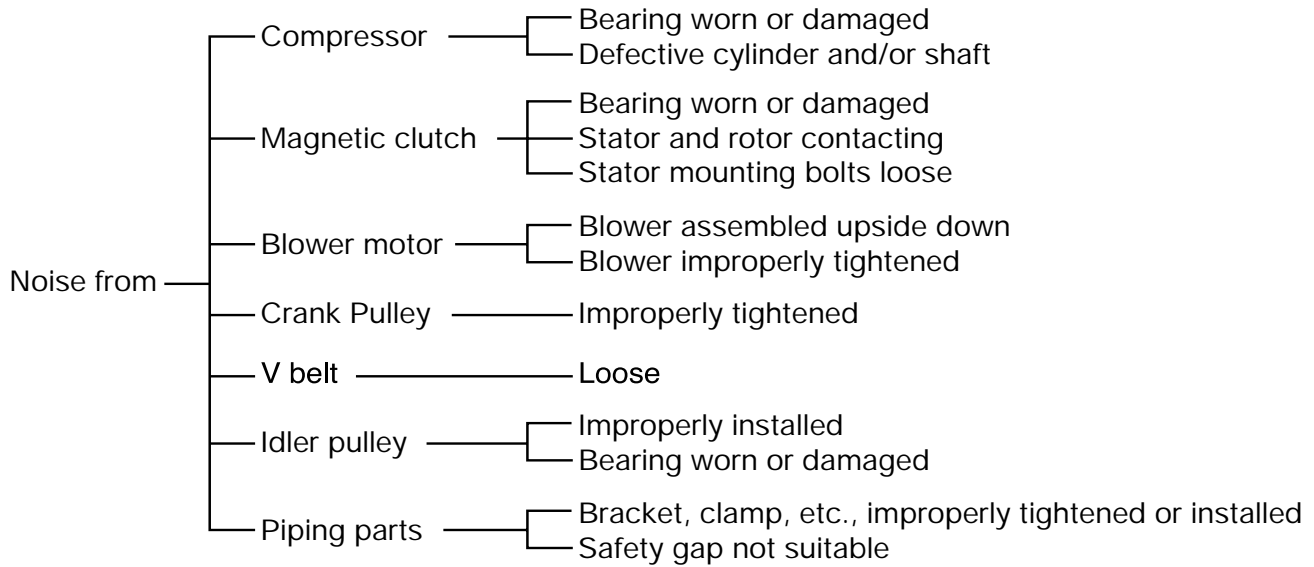
Symptom	Condition	Possible Cause	Remedy
No attraction.	Wiring normal.	Coil open.	Replace.
	No attraction even when cooler switch is on.	Wiring parts open, wiring or connection defective (ground, fuse).	Reconnect or replace open wiring parts.
		Switch parts contact defective, malfunction (thermostat, stabilizer, relay, cooler switch).	Repair or replace.
	At switch ON, rotor shows movement, and attracts when pushed.	Rotor or stator clearance too large.	Repair or replace.
Slips.	Clutch slips when rotating.	Battery voltage low. Oil on clutch face. Coil layer short.	Recharge battery. Clean off oil. Replace.

***C. Expansion Valve***

Symptom	Condition	Possible Cause	Remedy
Valve outlet not cold.	Temperature difference at outlet and inlet cannot be sensed.	Heat sensitizing tube gas leakage.	Replace expansion valve.
		Amount of refrigerant in cycle very small.	Repair gas leakage point and charge refrigerant.
Valve inlet cold or frosted.	High-pressure piping from receiver outlet feels cold.	Receiver clogged.	Replace.
	Frosts.	Expansion valve inside clogged.	Replace expansion valve and receiver.

# TROUBLESHOOTING

## 6. Abnormal Noise



Symptom	Condition	Possible Cause	Remedy
Compressor noisy.	Noise from inside compressor.	Bearing worn or damaged. Defective cylinder and/or shaft.	Disassemble and replace defective parts.
Magnetic clutch noisy.	Rattling noise when magnetic clutch is not engaged.	Bearing worn or damaged	Replace bearing.
Noise from piping.	Piping not secured.	Piping vibrating. Pulsating noise resonates into body.	Secure piping.
Noise from condenser.	Condenser vibration prominent.	Condenser mounting stay resonating with body.	Secure by inserting rubber between stay and body.
Noise produced by bracket.	Rattles when touched, continuous rattling heard when operating.	Bracket cracked or broken. Mounting bolts loose.	Replace. Retighten bolts.
Idler pulley noisy.	Clattering noise produced. Rattles when touched.	Bearing broken. Bracket cracked or loose.	Replace. Replace or retighten.
Noisy crankshaft pulley.	Rattles.	Improperly installed.	Retighten or replace.
V-Belt noisy.	V-Belt deflection big. V-Belt side surface torn.	V-Belt loose. V-Belt center misaligned.	Adjust tension. Align center.

Note: Please refer to the appropriate GM, Ford, Freightliner, or Spartan (thru mid-1998) manuals when On-Vehicle Diagnosis indicates that the problem is caused by the following components:

1. Compressor and Magnetic Clutch
2. Receiver/Drier
3. Models with Electric Fan Motor for Condenser

## 1. Blower/Cooling Unit

### A. On Vehicle Inspection of Expansion Valve

Inspect A/C system visually and audibly. Next, inspect the system with a ROBINAIR (manifold gauge) or equivalent equipment.

- 1) While turning A/C switch "ON" and BLOWER switch "HI", run engine at 1,500 RPM for at least five (5) minutes and check A/C performance in RECIRC mode.
- 2) If expansion valve is clogged, the low pressure reading will drop. If normal, the pressure will remain the same.
- 3) If the low pressure reading is normal and A/C is not cooling, check for malfunction of expansion valve.

### B. Blower/Cooling Unit Removal

- 1) Disconnect negative cable from battery.

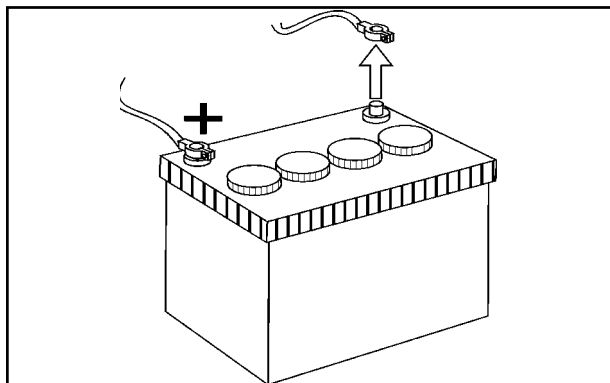


Figure 52: Battery Cable

- 2) Remove refrigerant from the system using ROBINAIR or equivalent equipment.
- 3) Remove HVAC cover on passenger side.

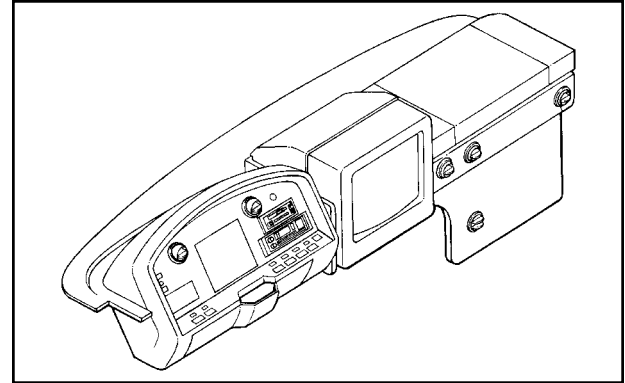


Figure 53: HVAC Cover

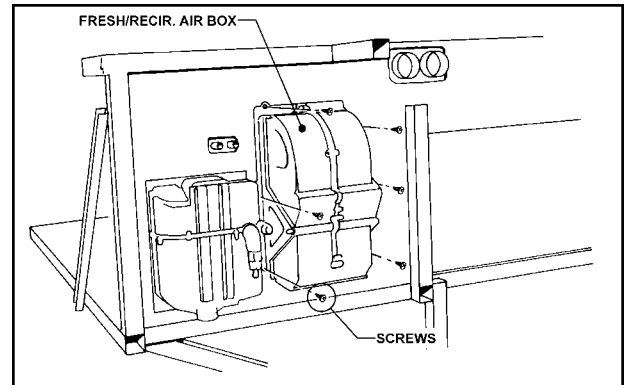


Figure 54: Fresh/Recirc Air Box

- 4) Remove fresh/recirculate air box. (Fig. 54)
- 5) Disconnect wire harness at: (Fig. 55)
  - Three (3) relays
  - Blower
  - Servo motor
  - Two (2) connectors from thermostat
  - Blower resistor
  - Fresh/recirculate connector
  - Pressure switch
  - Main harness connector

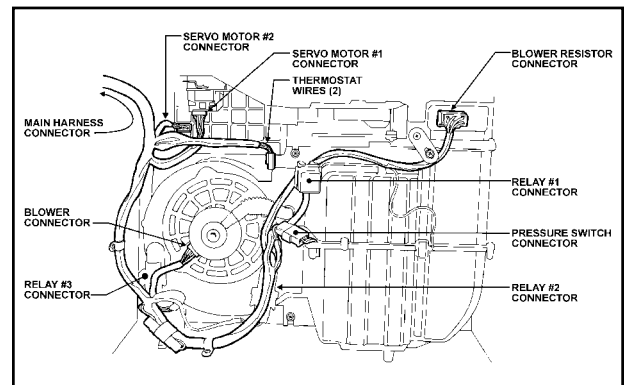


Figure 55: Blower/Cooling Unit

## COMPONENT TESTING

- Remove suction and liquid lines from cooling unit. (Fig. 56)

NOTE: Seal lines to prevent moisture from entering into the A/C system.

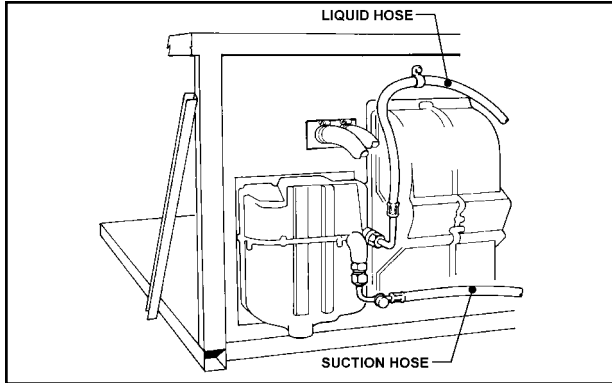


Figure 56: Liquid and Suction Hoses

- Remove bracket from heater to evaporator case. (Fig. 57)
- Remove the six (6) mounting screws and washers holding the blower/cooling unit to the bulkhead. (Fig. 57)

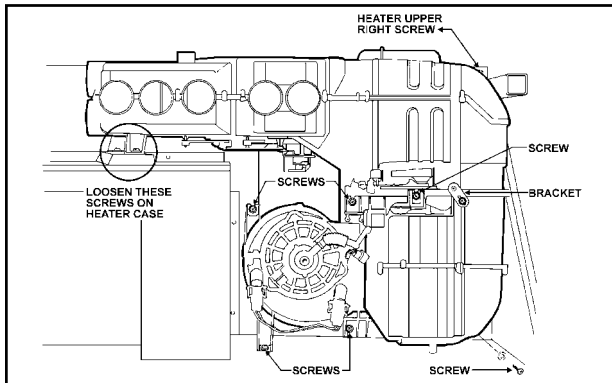


Figure 57: HVAC Screw Location

- Remove passenger far-right air vent grille assembly.
- Remove screw securing the heater unit by reaching through the vent hole in the upper right corner of the dash.
- Loosen the two (2) screws securing the heater unit to the engine compartment cover (or wood support - diesel models).

NOTE: These two screws may be removed by lifting the instrument panel and reaching under the dashboard (or HVAC cover on diesel models).

- Carefully slide blower/cooling unit assembly rearward.

### C. Blower/Cooling Unit Disassembly (Fig. 58)

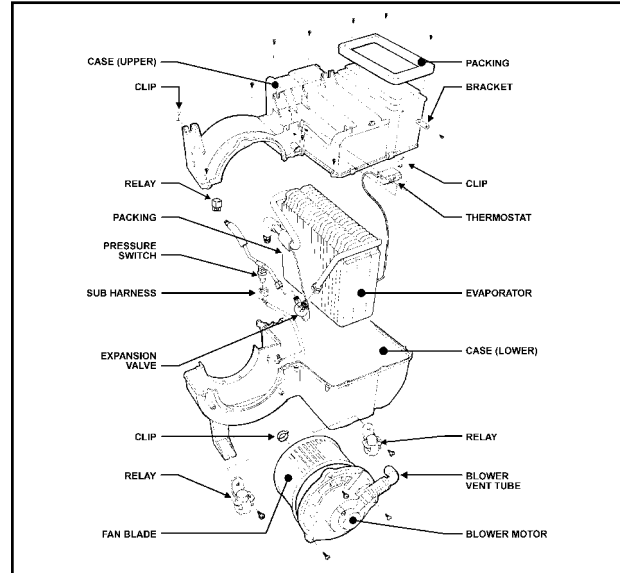


Figure 58: Blower/Cooling Unit (disassembled)

- Remove three (3) blower motor mounting screws from the case.
- Remove blower motor vent tube from upper case.
- Remove blower motor.
- Remove thermostat from upper case.
- Remove nine (9) screws from cooling unit case.
- Remove two (2) clips from cooling unit case.
- Remove upper and lower case halves from evaporator core.
- Remove packing from expansion valve sensing tube located on the evaporator suction tube.
- Remove "C" clip from sensing tube.
- Disconnect liquid tube from the inlet fitting of the expansion valve.
- Remove expansion valve.

**D. Evaporator Core Inspection**

- 1) Inspect evaporator core fins for blockage.
  - If fins are clogged, clean with compressed air.
  - Do not use water to clean evaporator core.
- 2) Inspect fittings for cracks or scratches. Repair or replace as required.

**E. Blower/Cooling Unit Assembly (Fig. 59)**

- 1) Connect the expansion valve to the evaporator and torque to 23 N•m (235 kgf•cm, 17 lbf•ft).

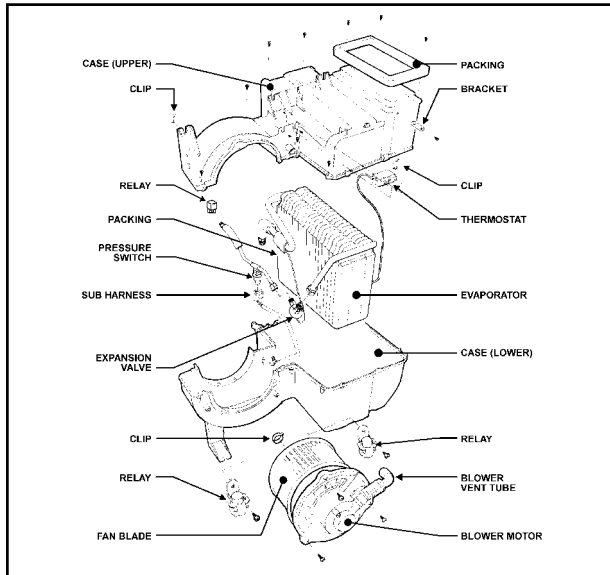


Figure 59: Blower/Cooling Unit (disassembled)

- 2) Install expansion valve sensing bulb to evaporator suction tube with "C" clip and insulate with packing.
- 3) Connect the liquid tube to the evaporator core and torque to 13 N•m (135 kgf•cm, 10 lbf•ft).
- 4) Install lower case.
- 5) Install thermostat.
- 6) Install upper case.
- 7) Install nine (9) screws.

- 8) Install two (2) clips.
- 9) Install blower motor and vent tube.
- 10) Reconnect wire harness. (Fig. 60)

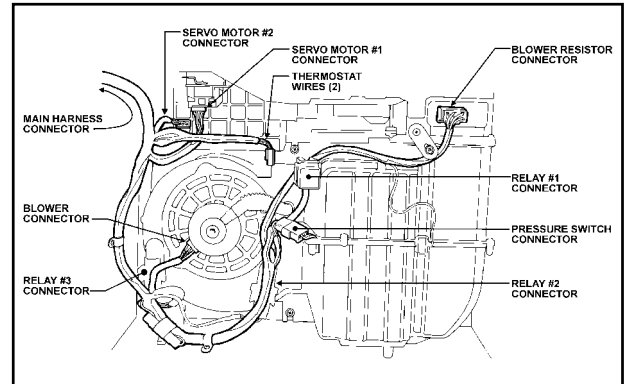


Figure 60: Harness Connections

**F. Blower/Cooling Unit Installation**

- 1) Install blower/cooling unit with six (6) screws.
- 2) Install heater to evaporator case bracket.
- 3) Reconnect wire harness. (Fig. 60)
- 4) Reconnect suction hose and torque to 32 N•m (325 kgf•cm, 24 lbf•ft)
- 5) Reconnect liquid hose and torque to 13 N•m (135 kgf•cm, 10 lbf•ft).
- 6) Install fresh/recirculate air box.
- 7) Install HVAC cover.
- 8) Reconnect negative cable to battery.
- 9) Evacuate and charge using ROBINAIR or equivalent equipment.

# COMPONENT TESTING

## 2. Compressor Fitting

*NOTE: DENSO supplied a suction side compressor fitting on Ford chassis thru mid-1996 model year.*

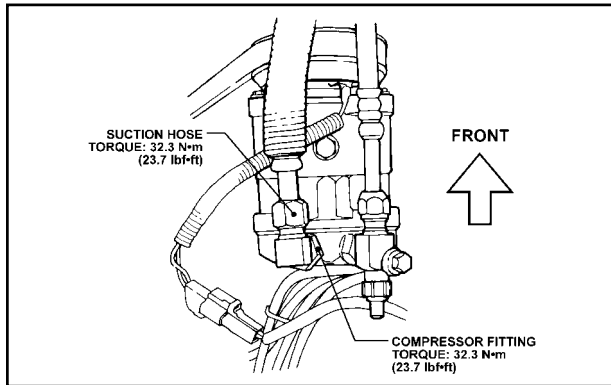


Figure 61: Ford Compressor Fitting (thru mid-1996)

### A. On Vehicle Inspection

- 1) Inspect service valves for leakage using a gas leak detector.
- 2) Replace if necessary

### B. Replacement

- 1) Recover refrigerant from system.
- 2) Replace failed part and torque to 32 N•m (325 kgf•cm, 24 lbf•ft).
- 3) Evacuate and charge using Robinair charging station or equivalent.

## 3. Refrigerant Hoses/Tubes

### A. On Vehicle Inspection

- 1) Inspect hoses/tubes for leakage using a gas leak detector.
- 2) Replace if necessary.

### B. Replacement

- 1) Recover refrigerant from system.
- 2) Replace failed part and torque to proper spec.
  - Suction Hose 32 N•m (325 kgf•cm, 24 lbf•ft)
  - Liquid Hose 13 N•m (135 kgf•cm, 10 lbf•ft)
- 3) Evacuate and charge using Robinair charging station or equivalent.

## 4. Heater Hoses: On Vehicle Inspection

- A. Inspect hoses for leakage.
- B. Replace if necessary.

(Only Ford and GM chassis heater hoses are DENSO supplied.)

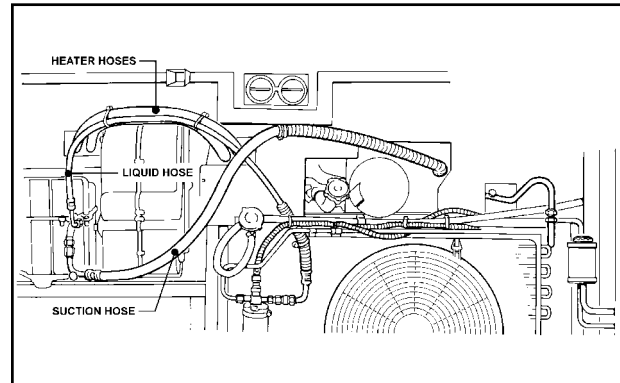


Figure 62: GM Hose Routing (thru mid-1996)

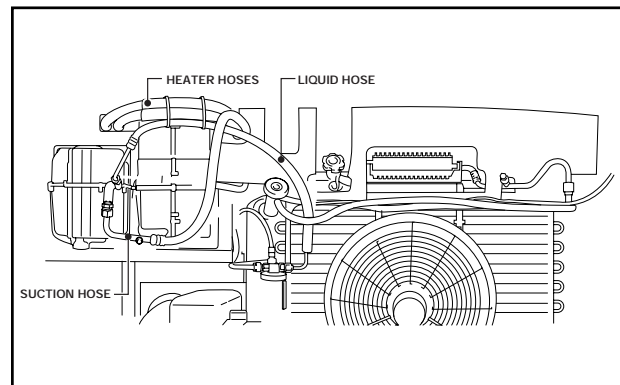


Figure 63: GM Chassis (L29) Hose Routing (from mid-1996)

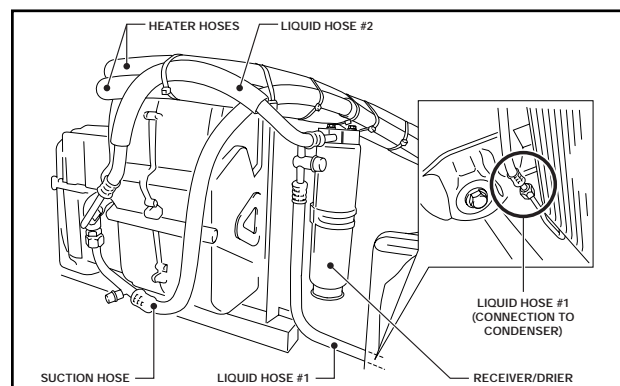


Figure 64: GM Chassis (P12) Hose Routing (from mid-1998)



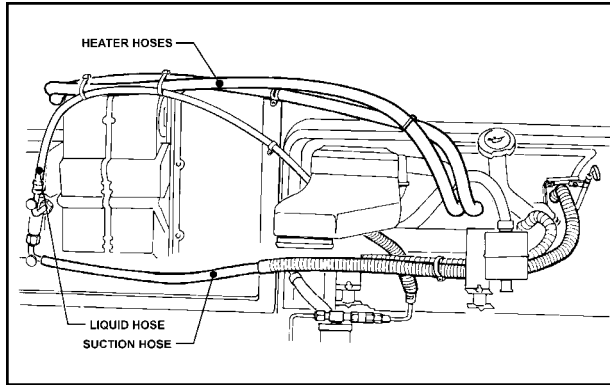


Figure 65: Ford Hose Routing (thru mid-1998)

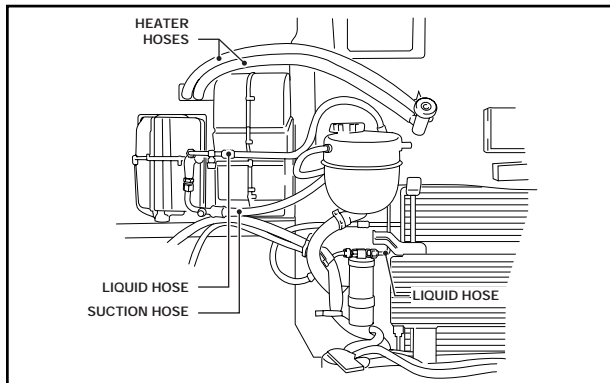


Figure 66: Ford Hose Routing (from mid-1998)

## 5. Heater

### A. On Vehicle Inspection and Adjustment

- 1) Inspect HVAC control panel. Move the temperature control lever to see if cable moves freely without binding and has full range of travel.

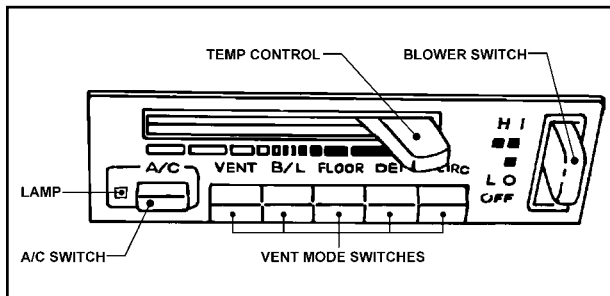


Figure 73: A/C Control 67

- 2) Check routing of the temperature control cable so it is free of any sharp bends or interference with linkages.

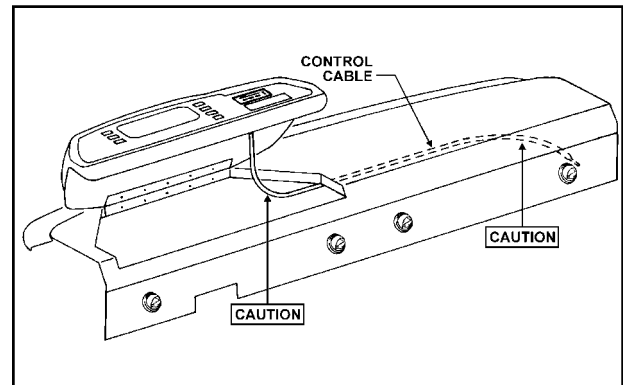


Figure 68: A/C Control Cable Routing

### B. Control Cable Adjustment

**NOTE:** On the control panel, check that the control cable insulation extrudes no less than  $\frac{1}{16}$ " past the metal clamp on the control panel mounting base. If less than  $\frac{1}{16}$ ", go to next step. (Fig. 69)

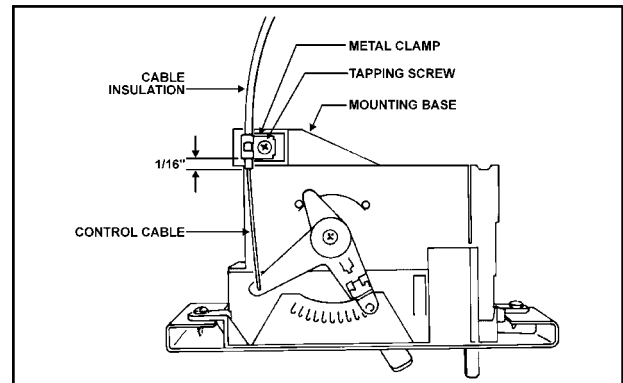


Figure 69: Cable Adjustment at Control Panel

- 1) Loosen the tapping screw and push the control cable insulation forward past the metal clamp approximately  $\frac{1}{16}$ ". Retighten the tapping screw.

**⚠CAUTION:** Do not overtighten the tapping screw. This could result in damage to the mounting base of the control panel.

# COMPONENT TESTING

- 2) On the bottom of the HVAC unit, locate the spring clip and carefully remove the control cable insulation. (Fig. 70)

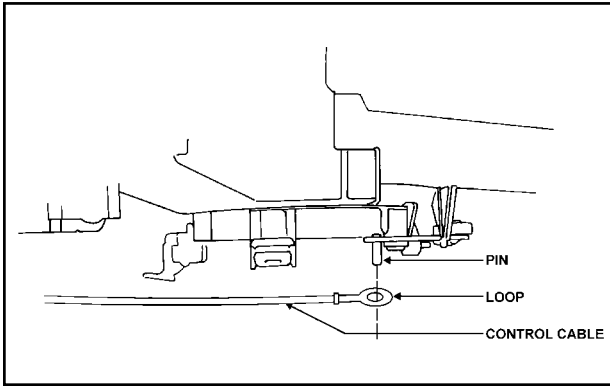


Figure 70: Cable Adjustment at Heater

- 3) Move the temperature control lever on the control panel to the maximum cool position (all the way to the left). (Fig. 71)

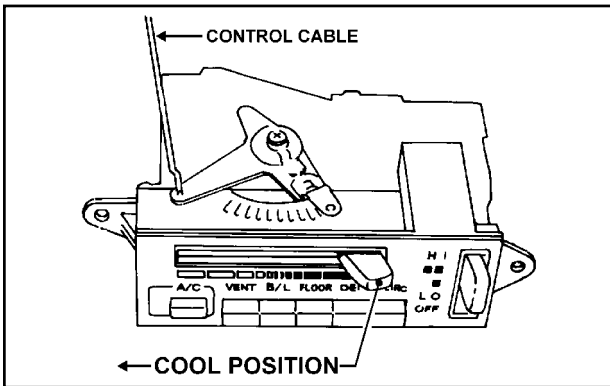


Figure 71: Max Cool Position of Control Panel

- 4) Looking at the bottom of the HVAC unit, push and hold the cam lever with the control cable attached to the pin to maximum cool (clockwise) position. (Fig. 72)

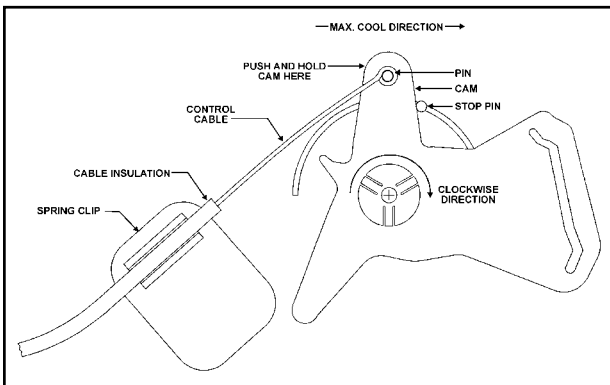


Figure 72: Bottom of HVAC Unit

- 5) While holding the cam lever in the proper position, recheck that the temperature control lever on the control panel is in the maximum cool position. (Fig. 71)
- 6) While holding the cam lever in the maximum cool position, snap the control cable insulation into the spring clip by pushing upward. (Fig. 73)

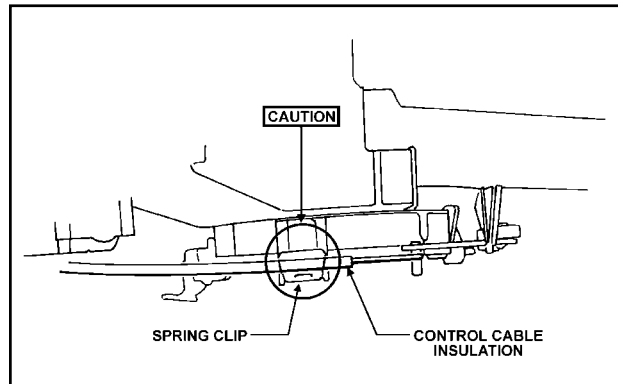


Figure 73: Spring Clip Connection of Cable

## C. Heater Core Removal

- 1) Remove blower/cooling unit case (see page 40).
- 2) Remove control cable from heater unit. (Fig. 74)

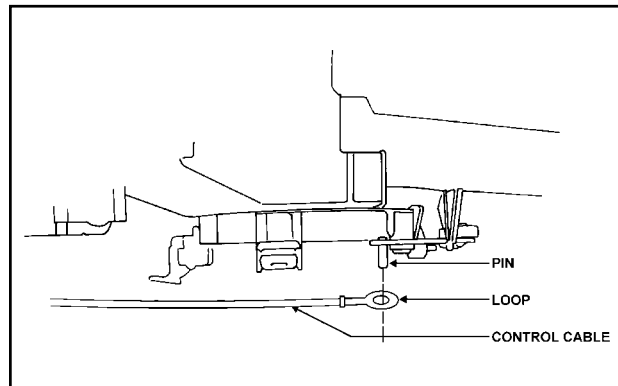


Figure 74: Removing Control Cable

- 3) Remove heater hose from heater core.

**NOTE:** Hoses should be marked so they can be easily identified and reconnected to their proper connections.

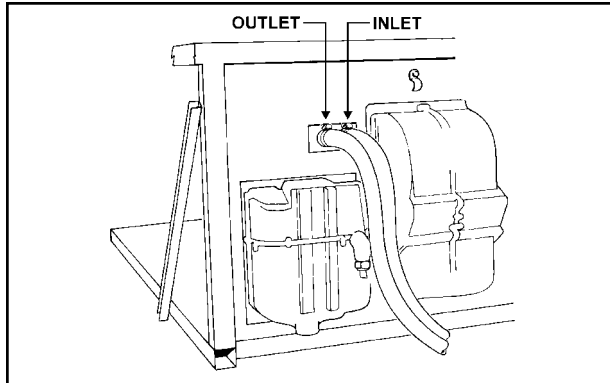


Figure 75: Heater Hose Location

- 4) Remove temperature control damper door cam which is secured by one (1) screw with a plastic washer.

**⚠CAUTION: Do not attempt to remove heater core without removing damper door cam.**

- 5) Remove plastic lever which is mounted over heater core.

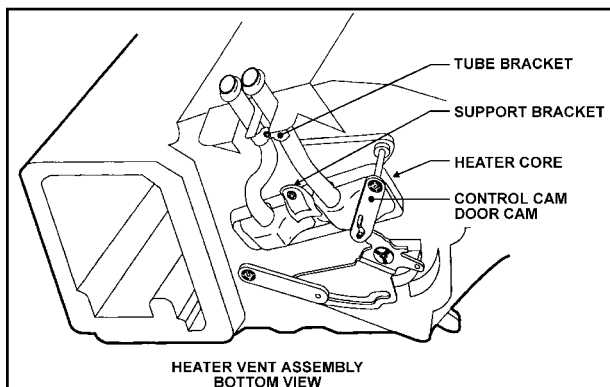


Figure 76: Bottom View of Heater Core

- 6) Remove heater core support bracket.
- 7) Remove heater core tube bracket.
- 8) Carefully slide the heater casing backwards toward the passenger compartment until the heater core tubes are clear of the bulkhead.
- 9) Pull out the heater core by sliding the unit downward and away from the heater core case.

### D. Heater Core Inspection

Inspect the heater core and repair or replace as required.

### E. Heater Core Installation

Follow reversal of steps for removal.

## 6. Thermostat

### A. Thermostat Operation

The thermostat is wired in series with the high-low side of the pressure switch and prevents the evaporator from freezing over by controlling the ground to the coil of the magnetic clutch relay.

When the thermostat is set to the max cold position (full clockwise), the thermostat contacts will be closed at evaporator temperatures above 4.5°C (40.1°F) and open between 1°C and 25°C (32.9°F and 36.5°F).

When the thermostat is set to the max warm position (full counterclockwise), the contacts will be closed at evaporator temperatures above 7.5°C (45.5°F).

If the thermostat does not perform as specified, replace the thermostat.

NOTE: The thermostat is preset at the factory and should not be adjusted. This information is supplied for diagnostic purposes only.

### B. Thermostat Removal

- 1) Remove and disassemble blower/cooling unit.
- 2) Remove thermostat from unit.

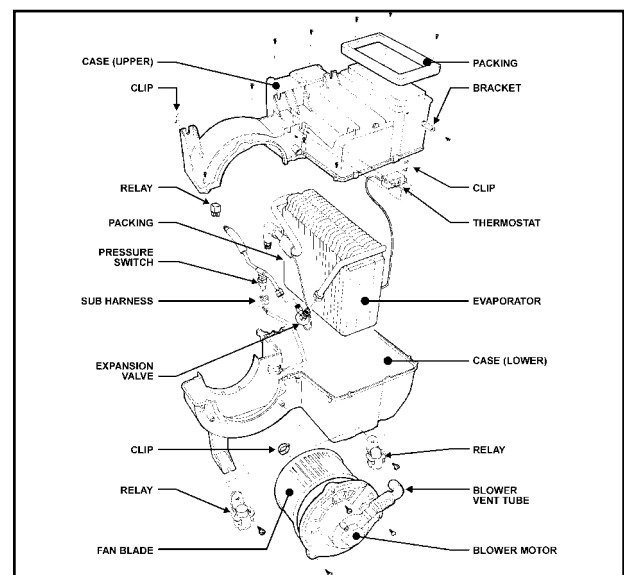


Figure 77: Blower/Cooling Unit (disassembled)

# COMPONENT TESTING

## C. Thermostat Installation

Follow reversal of steps for removal.

## 7. A/C Control System: On Vehicle Inspection

- A. Inspect A/C Switch for continuity.
- B. Inspect A/C Blower Speed Control Switch for continuity.
- C. A/C Control Levers Inspection
  - 1) Inspect the control lever at control panel for smooth operation.
  - 2) Inspect the control lever at HVAC for smooth operation.

### Blower speed control switch

Terminal No. / Switch Position	1	2	3	4	5
Low				○	○
Medium ■ Low	○			○	○
Medium ■ Hi		○		○	○
Hi			○	○	○

○—○ Indicates there is continuity between these terminals

### Blower speed control switch connector

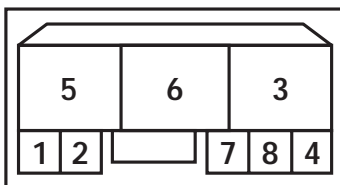


Figure 78: Blower Speed Control Switch

## D. A/C Control Cable Inspection

Inspect control cable for proper adjustment and kinks.

## 8. Control Panel Removal

- A. Disconnect negative cable from battery.
- B. Open instrument control panel (if equipped).

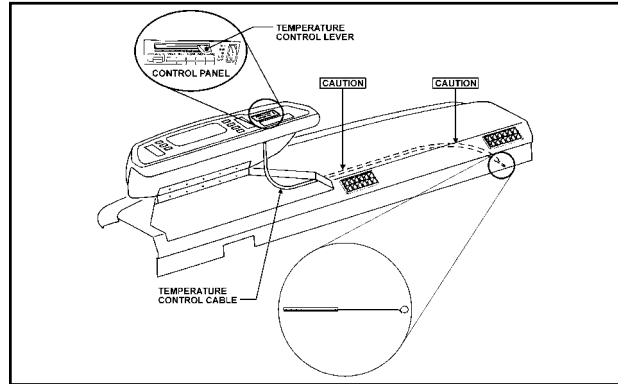


Figure 79: Control Panel Location

- C. Remove four (4) screws on control panel bezel plate (if equipped). (Fig. 80)

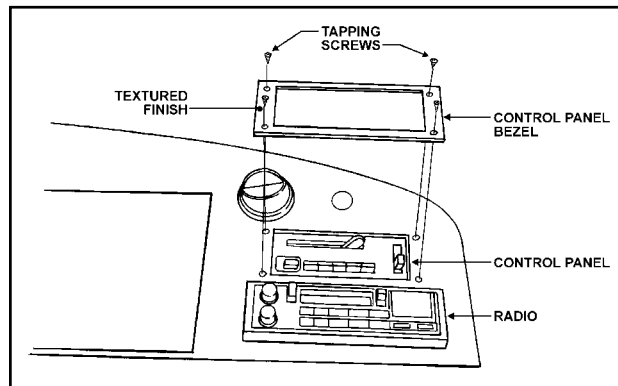


Figure 80: Removal of Control Panel Bezel

- D. Remove control panel from rear of dash panel.
- E. Remove control cable from control panel. (Fig. 81)

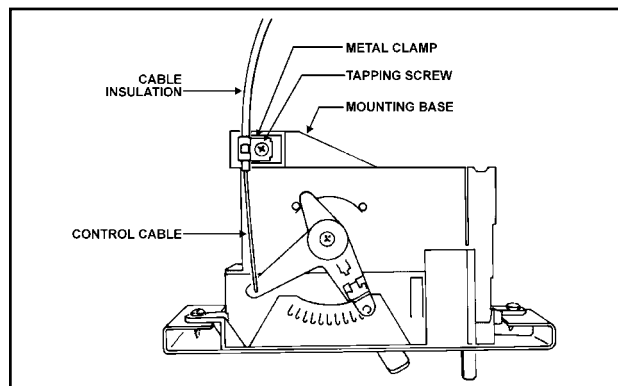


Figure 81: Removal of Control Cable

- F. Remove two (2) wire harness connectors from control panel.

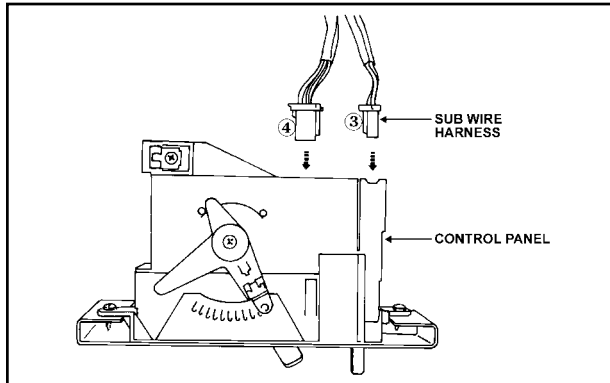


Figure 82: Removal of Subwire Harness

- G. Remove and save metal support bracket from control panel (if equipped).

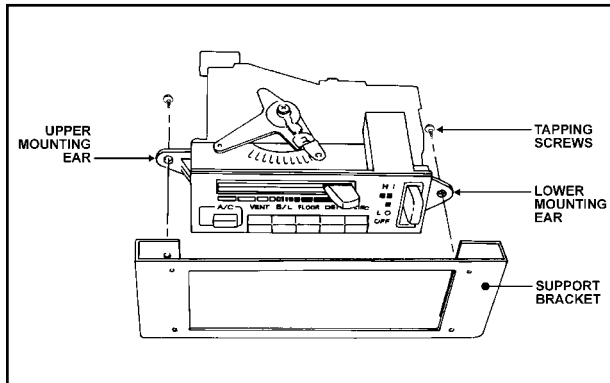


Figure 83: Metal Support Bracket

## A. Inspection

Inspect control panel for continuity.

Terminal No.	1	2	3	4	6 (Ground)	7	8	9	10	11
A/C (on)					○		○			
Vent (face)	○									
B/L		○								
Floor						○			○	
DEF				○		○		○		
Recirc (Button Depressed)						○				○
Fresh (Recirc Button Out)						○				○

○—○ Indicates there is continuity between these terminals

Control Panel Connector

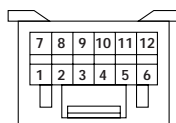


Figure 84: Control Panel Circuit

## B. Installation

Follow reversal of steps for removal.

NOTE: See Control cable adjustment on page 43.

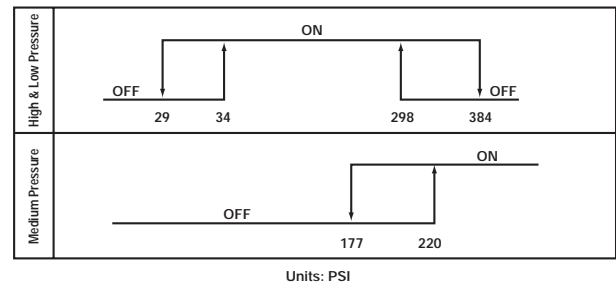
## 9. Pressure Switch

### A. Pressure Switch Operation

The pressure switch is a triple pressure switch with a high and low pressure set of contacts and a medium pressure set of contacts. The high-low side is wired in series with the thermostat and controls the ground to the coil of the magnetic clutch relay. On vehicles equipped with a condenser fan, the medium side is wired in parallel with the water temperature switch and controls the ground to the coil of the condenser fan relay.

### B. On Vehicle Inspection

- 1) Disconnect negative cable from battery.
- 2) Remove HVAC cover on passenger side.
- 3) Confirm refrigerant charge status with ROBINAIR or equivalent equipment.
- 4) Disconnect the pressure switch harness connector from the cooling unit harness.



Units: PSI

Item	Switch	
	Off → On kg/cm <sup>2</sup> (psi)	On → Off kg/cm <sup>2</sup> (psi)
Low Pressure Side	2.4 (34.1)	2.1 (29.9)
High Pressure Side	21 (298.6)	27 (383.9)
Medium Pressure Side	15.5 (220.4)	12.5 (177.8)

Figure 85: Pressure Switch Operation

# COMPONENT TESTING

- 5) Connect a jumper wire between terminals 13B and 14A of the cooling unit harness.

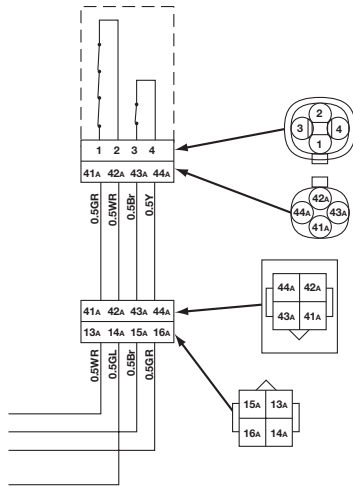


Figure 86: Pressure Switch Connector

- 6) With the A/C system at normal operating pressures, check for continuity between terminals 41A and 42A for the high-low side and terminals 43A and 44A for the medium side.
- 7) If there is no continuity, replace the switch.

## C. Pressure Switch Removal

- 1) Remove and disassemble blower/cooling unit. (Fig. 87)

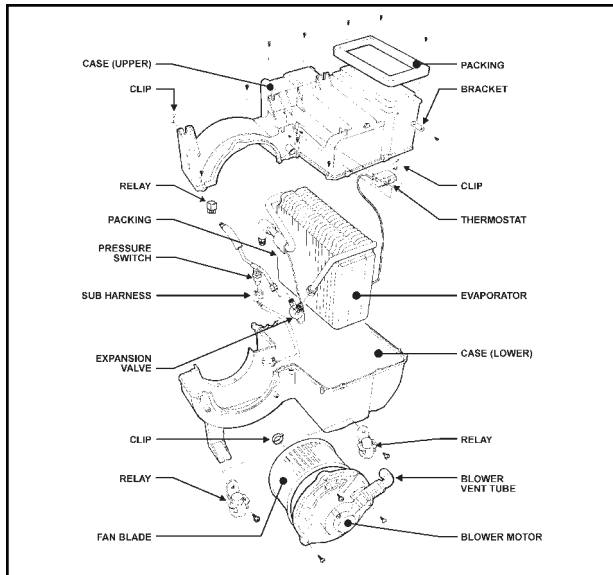


Figure 87: Blower/Cooling Unit (disassembled)

- 2) Remove wire harness from pressure switch.
- 3) Remove pressure switch from liquid line.

## D. Installation

Follow reversal of steps for removal.

## 10. Blower

### A. On Vehicle Inspection

- 1) Blower and Fan Operation

Connect positive (+) lead from battery to terminal #1 and negative (-) lead to terminal #2 to confirm smooth operation of motor.

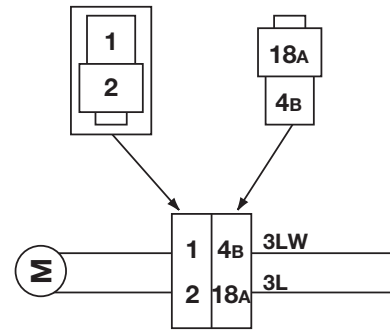


Figure 88: Blower and Fan Circuit

- 2) Blower Resistor Inspection. Inspect the resistor for specification.

Checking for proper resistance of the blower motor resistor

Resistance Value \ Pins	1	2	4	5
.5Ω	○—○			
.8Ω		○—○		
1.68Ω			○—○	

○—○ Indicates there is continuity between these terminals

### Blower Resistor connector

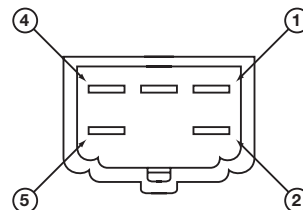


Figure 89: Blower Resistor

**B. Blower and Fan Removal**

- 1) Disconnect negative cable from battery.
- 2) Remove HVAC cover on passenger side.
- 3) Remove blower motor 2-pin connector.
- 4) Remove blower motor vent tube.
- 5) Remove three (3) screws mounting blower motor to the case.
- 6) Remove the blower motor and fan.

NOTE: If the blower motor or fan replacement is required, follow the steps below.

- a) Remove clip from fan.
- b) Remove fan from blower motor.
- c) Replace fan or blower motor as required.

**C. Blower Resistor Removal**

- 1) Disconnect negative cable from battery.

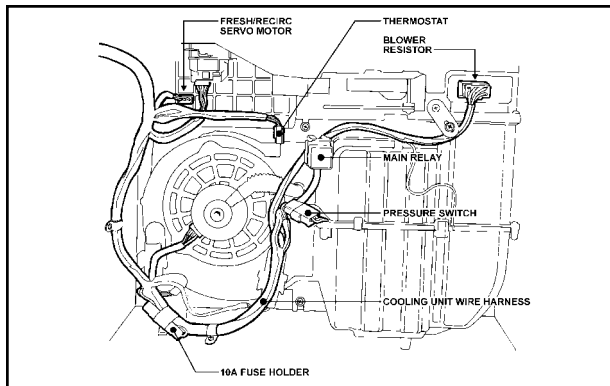


Figure 90: HVAC Component Location

- 2) Remove HVAC cover on passenger side.
- 3) Disconnect 4-pin connector from blower resistor.
- 4) Remove two (2) screws from blower resistor.
- 5) Remove blower resistor.

**D. Installation**

Follow reversal of steps for removal.

**11. Relays**

Remove HVAC cover on passenger side to access the following three (3) relays:

**A. Main Relay**

Inspect five 5-pin main relay for continuity and replace the relay as required.

Terminal No. / Battery Voltage	30	85	86	87	87A
Not Supplied		○—○			
Supplied	○—○		⊖—⊕		○—○

○—○ Indicates there is continuity between these terminals  
 ⊖—⊕ Indicates terminals to which battery voltage is supplied

Main Relay connector

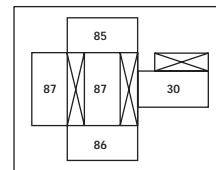


Figure 91: Main Relay

**B. Blower HI Relay**

Inspect 4-pin Blower HI Relay for continuity and replace the relay as required.

Terminal No. / Battery Voltage	21A	2B	50	18B
Not Supplied		○—○		
Supplied	⊕—⊖			○—○

○—○ Indicates there is continuity between these terminals  
 ⊕—⊖ Indicates terminals to which battery voltage is supplied

Blower High Relay connector

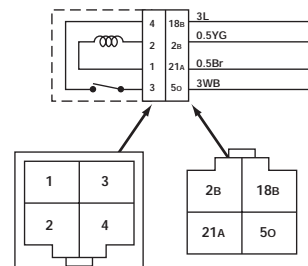


Figure 92: Blower Hi Relay

# COMPONENT TESTING

## C. Mg/CI (Magnetic Clutch Relay)

Inspect 4-pin Mg/CI Relay for continuity and replace the relay as required.

Terminal No. / Battery Voltage	13A	4I	12A	4E
Not Supplied	○—○			
Supplied	⊖—⊕		○—○	

- Indicates there is continuity between these terminals
- ⊖—⊕ Indicates terminals to which battery voltage is supplied

### Magnetic Clutch Relay connector

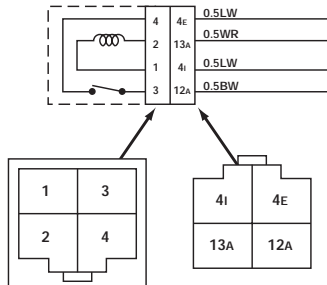


Fig. 93: Magnetic Clutch Relay

## 12. Air Intake Servo

### A. Air Intake Servo Operation

The air intake servo changes the air intake door between the FRESH and RECIRC positions by rotating 180° in the clockwise direction every time the RECIRC switch on the control panel is depressed (RECIRC mode) or released (FRESH mode).

NOTE: To check for proper operation of the Air Intake Servo, the ignition switch must be in the "ON" position.

### B. Air Intake (Air Box Fresh/Recirculate) Servo Removal

- 1) Remove HVAC cover on passenger side to access the servo.
- 2) Disconnect negative cable from battery.
- 3) Disconnect connector for air box fresh/recirculate servo motor.
- 4) Remove fresh/recirc air box.

- 5) Remove linkage rod from servo motor.
- 6) Remove wire harness from servo motor.
- 7) Remove two (2) screws from servo motor.
- 8) Remove servo motor from air box.

### C. Air Intake Servo Inspection

Check continuity of the servo according to the chart as shown.

To check for voltage at the Air Intake Servo Sub Harness female connector, use chart below

Main Harness Pin / Switch Position	1 .5YG	2 .5YG	4 .5YL
Recirc (in)	⊕	—	⊖
Fresh (recirc out)	⊕	⊖	

⊖—⊕ Indicates terminals to which battery voltage is supplied

### Air Intake Servo connector

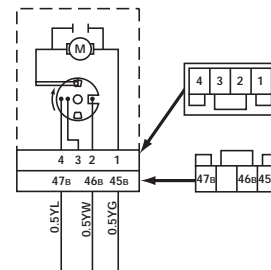


Fig. 94: Air Intake Servo Circuit

### D. Air Intake Servo Installation

Follow reversal of steps for removal.



### 13. Vent Mode Servo

#### A. Vent Mode Servo Operation

The mode servo controls the distribution of outlet air between vent/face, bi-level, foot, or defrost.

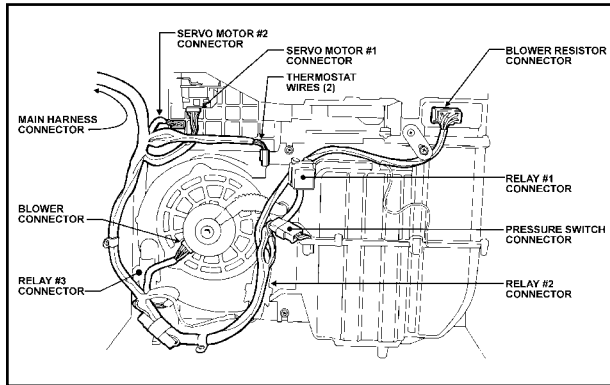


Figure 95: HVAC Wire Harness Connectors

#### B. Vent Mode Servo Motor Removal

- 1) Remove HVAC cover on passenger side to access the servo.
- 2) Disconnect negative cable from battery.
- 3) Remove passenger side floor/vent cover.
- 4) Remove wire harness from servo motor.
- 5) Remove linkage from servo motor.
- 6) Remove three (3) mounting screws from servo motor.
- 7) Remove servo motor.

#### C. Vent Mode Servo Inspection

- 1) With the harness connected and the ignition switch in the "ON" position, verify the following lever positions by depressing the corresponding control panel mode switch.

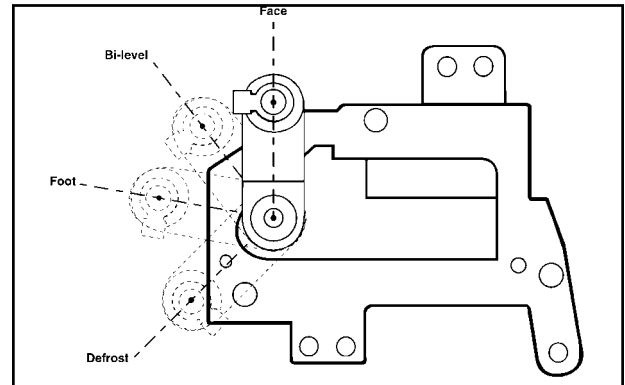


Figure 96: Vent Servo Positions

- 2) If no movement is detected, check the following conditions:
  - a) Battery voltage between pins 2D and 5A.
  - b) Continuity of both wire harnesses between the mode servo connector and control panel connector.
  - c) Continuity of the control panel. (Refer to the control panel testing section).

#### D. Vent Mode Installation

Follow reversal of steps for removal.

# REFRIGERANT LINE REPLACEMENT

## 1. On Vehicle Inspection

- A. Check that hose and tube connections are not loose.
- B. Inspect hoses and tube for leakage.
  - Use an electronic gas leak detector to check for leakage of refrigerant in the A/C system.

## 2. Refrigerant Lines Replacement

- A. Recover refrigerant from A/C system.
 

Use a ROBINAIR or equivalent Recovery/ Recycling Machine to recover refrigerant in the system before removing any component to prevent any release of refrigerant into the atmosphere.
- B. Immediately cap the open fittings to prevent moisture, dust and air from entering the system.
 

DO NOT REMOVE the end caps on replacement hoses until just before installation.
- C. Replace faulty components as required.
- D. Before connecting, apply a few drops of compressor lubricant to "O" rings and coupling nut fittings.
- E. Securely torque connections to specifications to assure there is no refrigerant leak. Be sure to use two (2) wrenches to avoid twisting tubes.
- F. Evacuate air in the system and recharge.
- G. Inspect for leakage with electronic leak detector.
- H. Check air conditioning system operation and performance.

## 3. Torque Specifications

### A. Standard Torque for Coupling Nut Type Fittings

Size of Tube (inch)	Fitting Torque N•m (kgf•cm, lbf•ft)
0.31	14 (140, 10)
0.50	23 (230, 17)
0.62	32 (330, 24)

### B. Torque Specification for Bolts/ Nuts/Screws

Diameter X Pitch	Bolt Strength	Tightening Torque N•m (kgf•cm, lbf•ft)
M6 X 1.0 M8 X 1.25 M10 X 1.25 M12 X 1.25	4T	5.4 (55, 4.0) 12.7 (130, 9.4) 25.0 (260, 18) 47.1 (480, 34.8)
M6 X 1.0 M8 X 1.25 M10 X 1.25 M12 X 1.25	6T	7.8 (80, 5.8) 19.1 (195, 14.1) 39.2 (400, 29.0) 71.6 (730, 52.8)
M6 X 1.0 M8 X 1.25 M10 X 1.25 M12 X 1.25	8T	----- 29.4 (300, 21.7) 60.8 (620, 44.9) 107.8 (1100, 79.6)

## 4. CHASSIS

### A. GM Chassis: Liquid, Suction, and Heater Hoses (thru mid-1996)

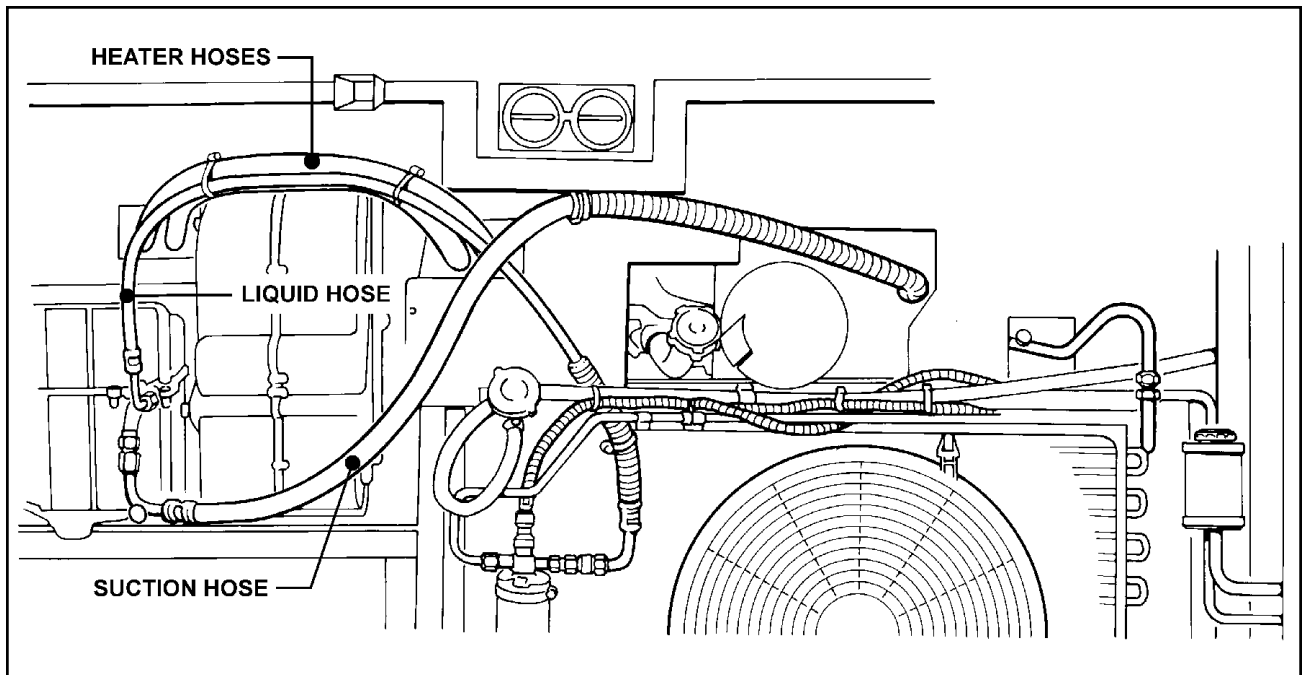


Fig. 97: GM Chassis: Liquid, Suction, and Heater Hoses (thru mid-1996)

### B. GM L29 Chassis: Liquid, Suction, and Heater Hoses (from mid-1996)

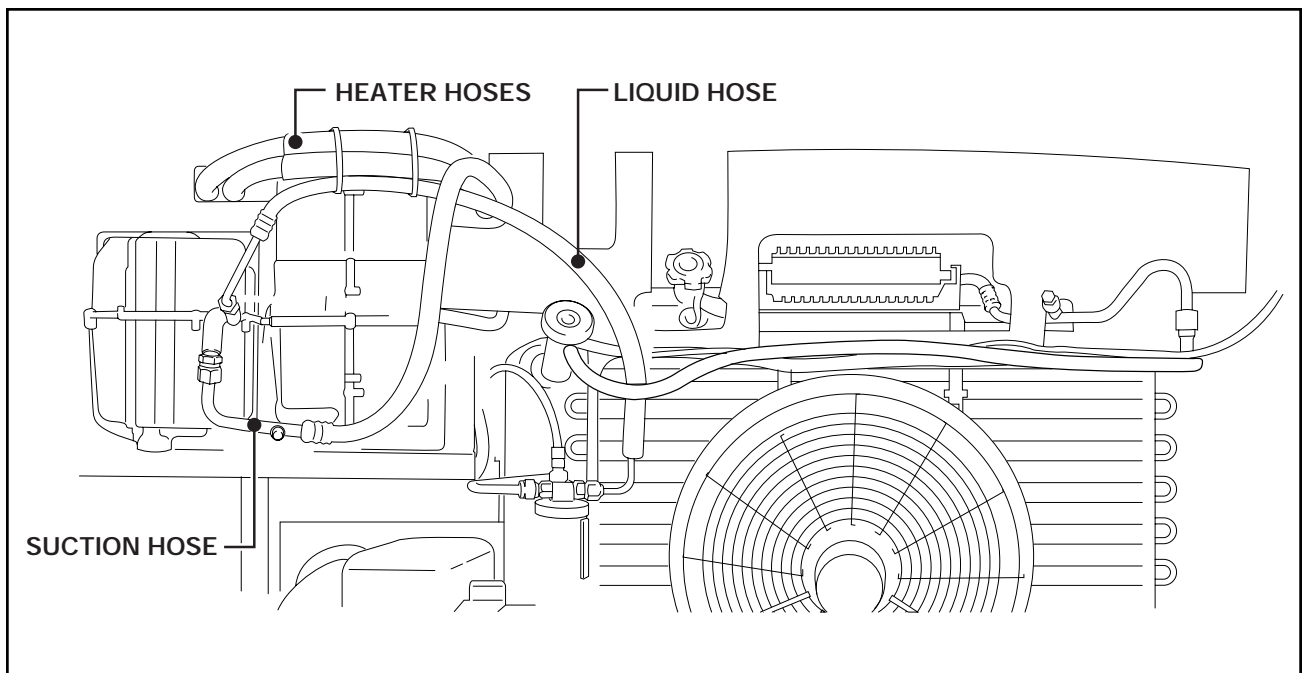


Fig. 98: GM Chassis (L29): Liquid, Suction, and Heater Hoses (from mid-1998)

# REFRIGERANT LINE REPLACEMENT

## C. GM P12 Chassis

Liquid, Suction, and Heater Hoses

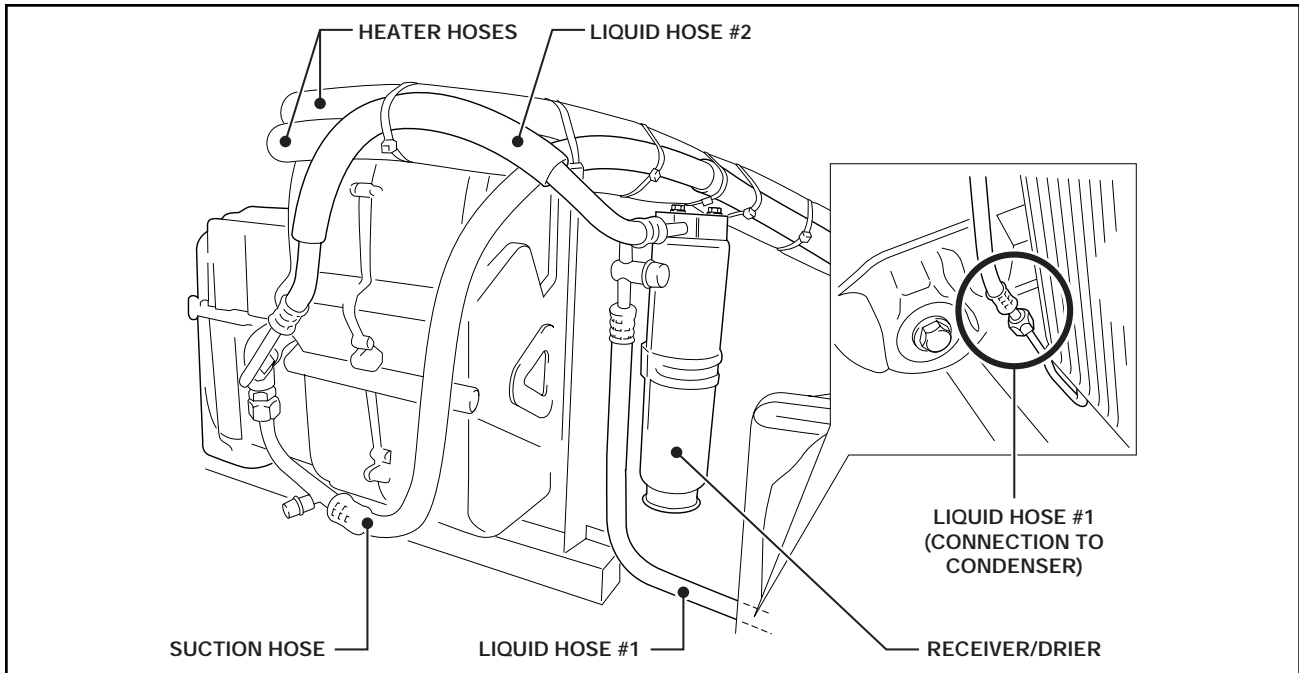


Fig. 99: GM Chassis (P12) Liquid, Suction, and Heater Hoses

## D. Ford Chassis (thru mid-1998)

Liquid, Suction, and Heater Hoses

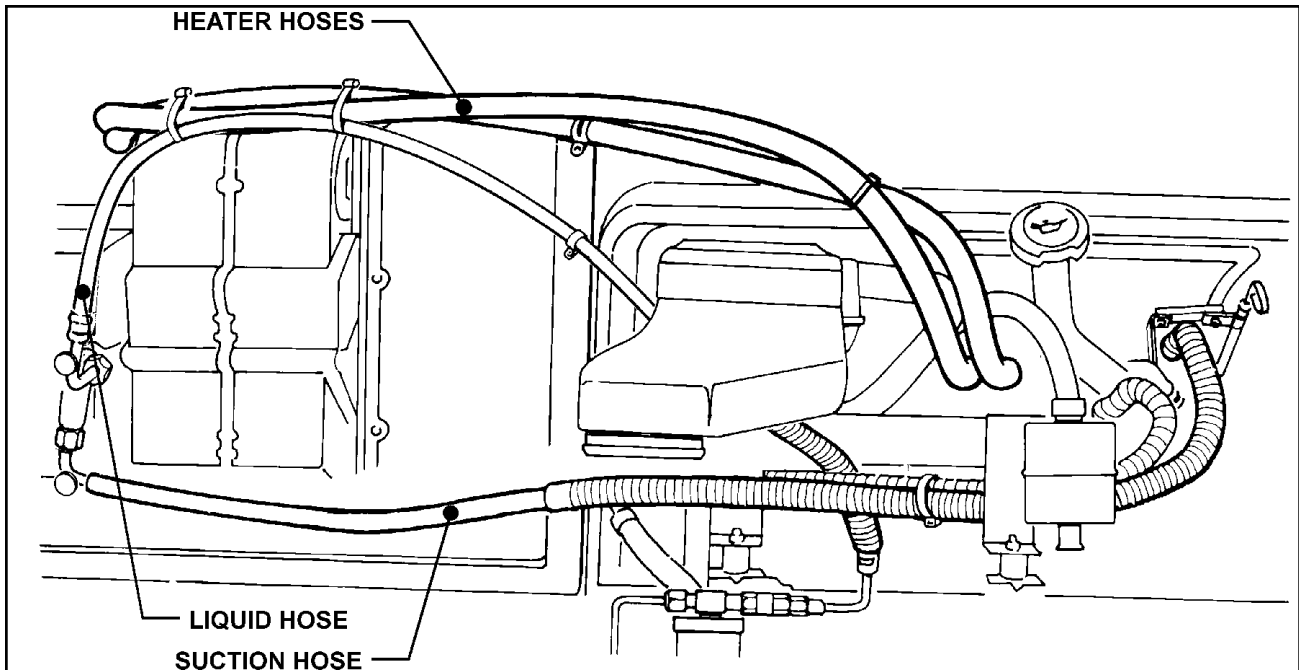


Fig. 100: Ford Chassis (thru mid-1998) Liquid, Suction, and Heater Hoses

**E. Ford Chassis (from mid-1998)**

Liquid, Suction, and Heater Hoses

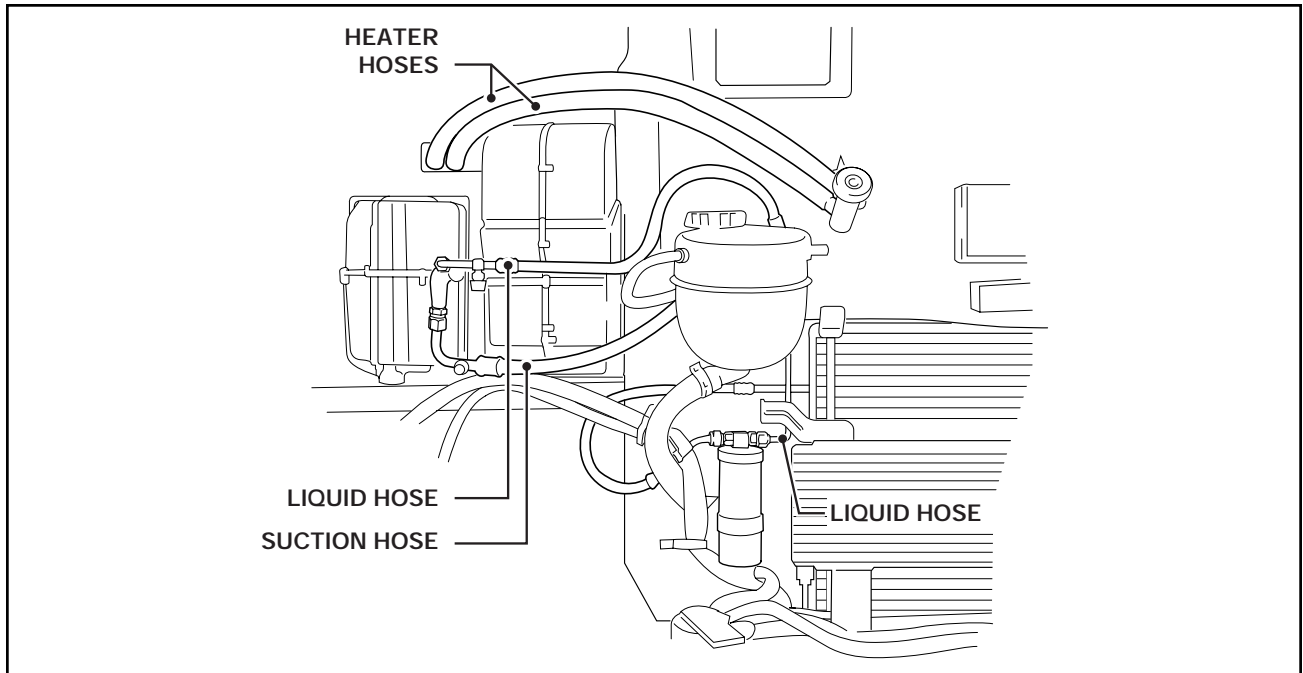


Fig. 101: Ford Chassis (from mid-1998) Liquid, Suction, and Heater Hoses

**F. Freightliner Chassis/Spartan Chassis (thru mid-1998)**

1) Liquid and Suction Hoses

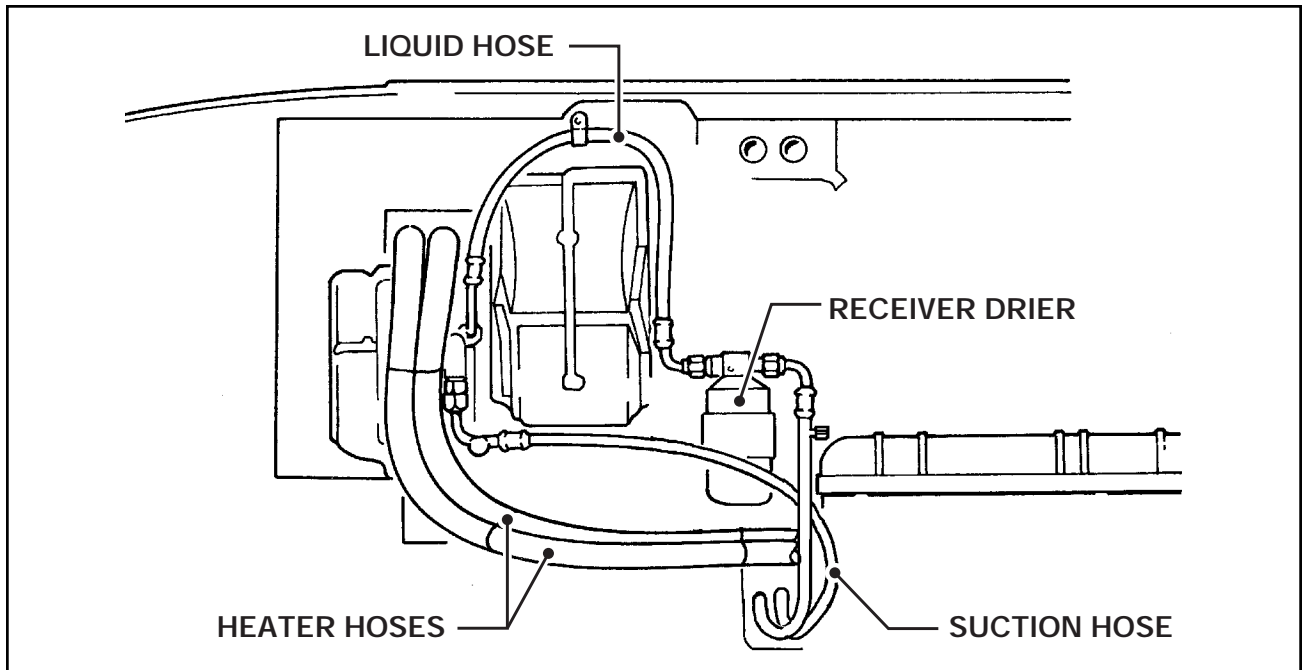


Fig. 102: Diesel Pusher Chassis Liquid and Suction Hoses

# REFRIGERANT LINE REPLACEMENT

## 2) Suction Tube

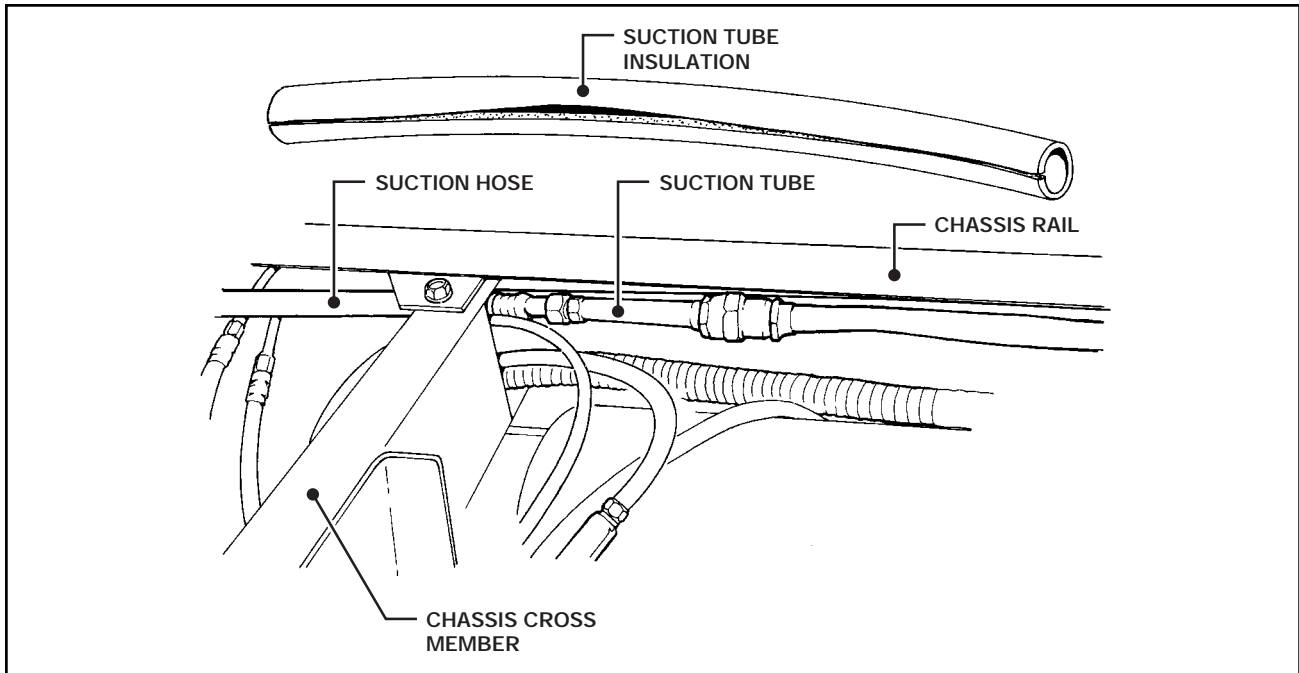


Fig. 103: Diesel Pusher Chassis Suction Tube

## G. Spartan Chassis (mid-1998 and on)

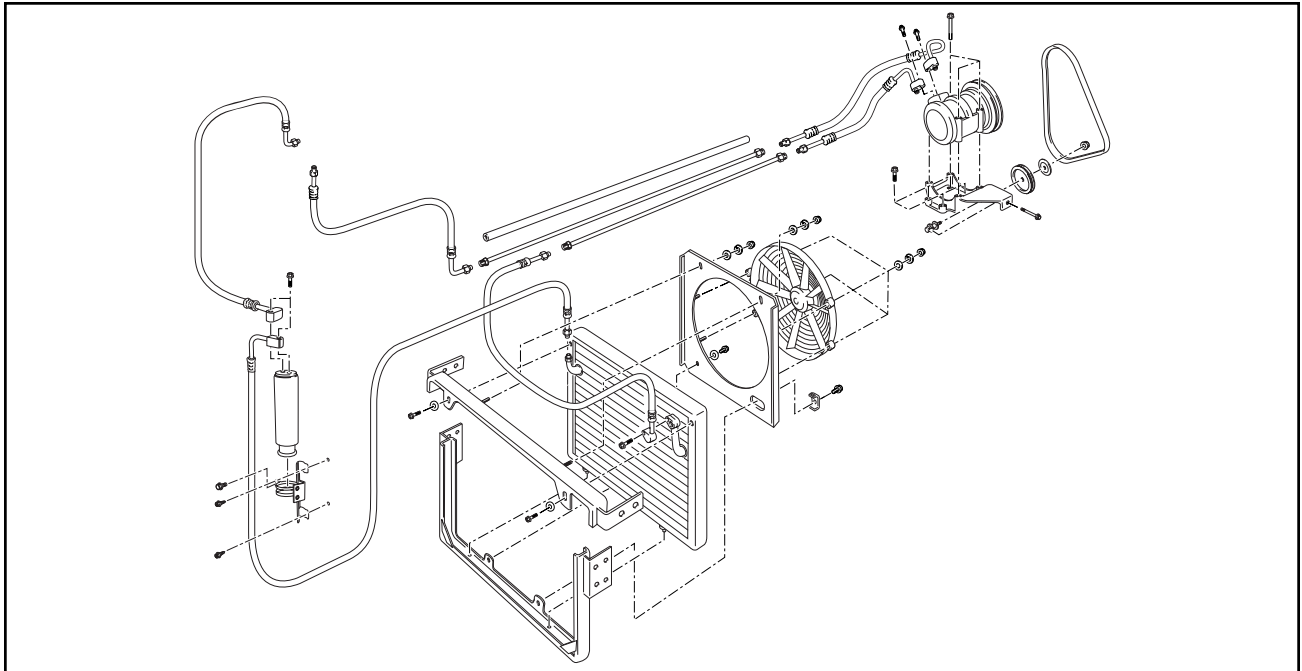


Fig. 104: Spartan Chassis A/C System Overview

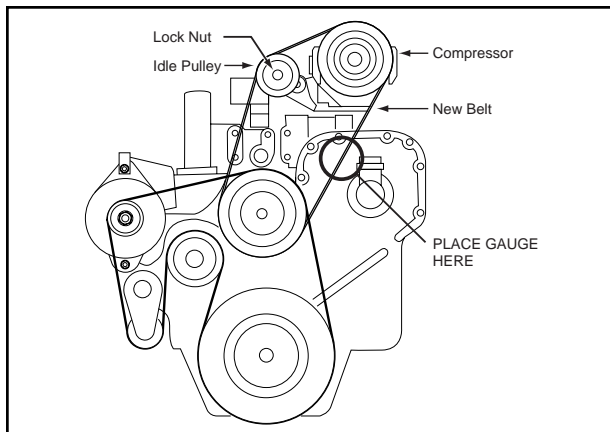


Fig. 105: Belt Tension

### (1) Drive Belt Tension

- (a) Check belt tension using a belt tension gauge.

Belt Tension:  $80 \pm 10$  lbs.

- (b) Adjust as needed by loosening idle pulley lock nut and turning adjusting bolt until belt reaches specified tension.
- (c) Tighten and torque the idle pulley lock nut.

Tightening Torque:  $39.2 \text{ N}\cdot\text{m}$  (29 lbf•ft)

# REFRIGERANT LINE REPLACEMENT

## (2) On Vehicle Inspection: Compressor Magnetic Clutch

- (a) Inspect compressor and clutch assembly for signs of oil.
- (b) Check clutch bearings for abnormal noise, grease leakage, or excessive play.
- (c) Check if clutch is energized when positive (+) lead from battery is applied directly to the clutch lead wire and negative (-) lead to the clutch ground wire.
- (d) Measure resistance of the stator coil using an ohmmeter.

Standard Resistance @ 20°C  
(68°F):  $3.75 \pm 0.2\Omega$

## (3) On Vehicle Inspection: Compressor

- (a) Install manifold gauge set.
- (b) Run engine at approximately 1,500 RPM with compressor engaged.
- (c) Check for abnormal noise or abnormal pressures (high side too low and low side too high).
- (d) With engine off, check for any leakage from shaft seal on compressor. If defects are found, replace compressor.

## (4) Compressor Removal

- (a) Run engine at idle with A/C on for approximately 5–10 minutes.
- (b) Stop engine.
- (c) Disconnect negative battery cable.
- (d) Disconnect clutch lead wire.
- (e) Recover refrigerant from A/C system.
- (f) Disconnect compressor hoses.

**⚠CAUTION: Cap ends of hoses IMMEDIATELY after disconnecting from compressor to prevent moisture or other contaminants from entering the system.**

- (g) Loosen compressor belt.
- (h) Remove compressor mounting bolts and the compressor.

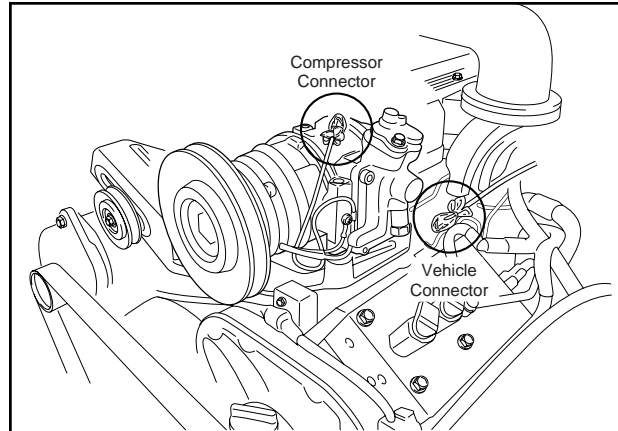


Figure 106: Compressor Inspection—Magnetic Clutch

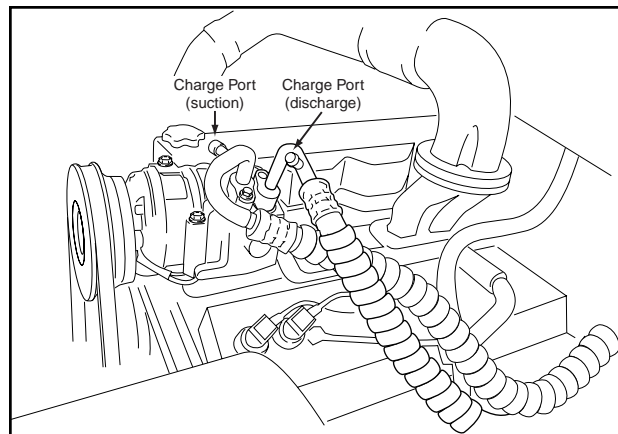


Figure 107: Compressor Inspection

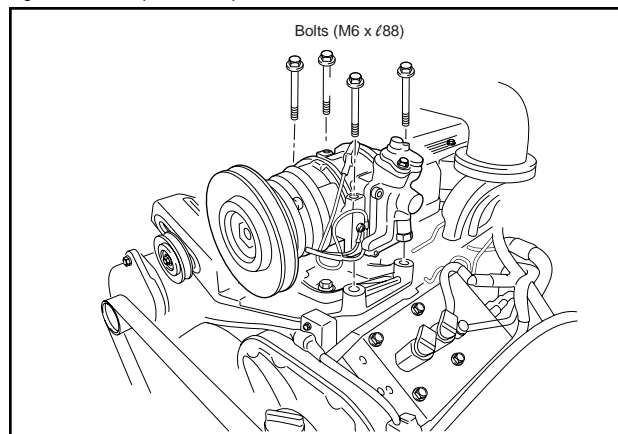


Figure 108: Compressor Removal



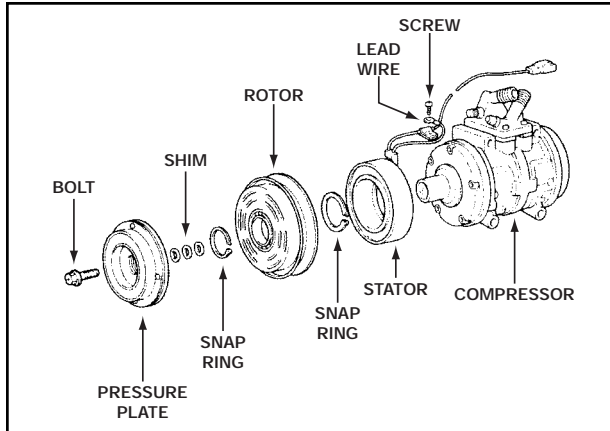


Figure 109: Magnetic Clutch

## (5) Magnetic Clutch Disassembly

- (a) Remove the shaft bolt.
- (b) Remove the pressure plate.
- (c) Remove the shims from the pressure plate.
- (d) Remove the snap ring that secures the rotor.
- (e) Remove the rotor from the compressor shaft by carefully tapping with a plastic hammer.
- (f) Disconnect stator lead wire from the compressor body.
- (g) Remove the snap ring that secures the stator.
- (h) Remove the stator.

## (6) Magnetic Clutch Assembly

Follow the steps in Paragraph (5) in reverse order for assembly.

**⚠IMPORTANT: DO NOT reuse snap rings. Use new snap rings to secure rotor and stator.**

Shaft Bolt Tightening Torque: 14 N•m (10 lbf•ft)

Check air gap between pressure plate and rotor.

Standard Clearance: 0.5 ± 0.15 mm (0.020 ± 0.0059 in.)

If the clearance is not within specified range, change the number of shims until the required clearance is reached.

## (7) Compressor Installation

Follow the steps in Paragraph (4) in reverse order for installation.

Tightening Torques:

Compressor Mounting Bolts: 24.5 N•m (18.1 lbf•ft)

Compressor Hoses: 9.8 N•m (7.2 lbf•ft)

After installation, evacuate air in the system and recharge.

HFC-134a: 48oz. ± 2 oz.

Inspect system for leaks using a refrigerant leak detector. Check air conditioning system for proper operation and performance.

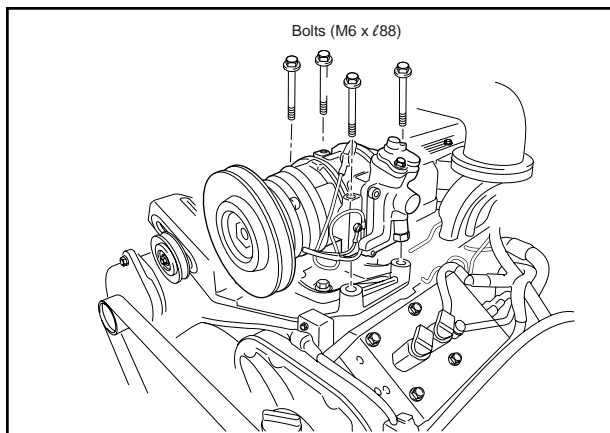


Figure 110: Compressor Installation

## REFRIGERANT LINE REPLACEMENT

### (8) On Vehicle Inspection: Condenser Fan

- (a) Check if condenser fan operates when air conditioning system is on. If fan is rotating in the proper direction, it will be pulling air through the condenser.
- (b) Check if the fan operates when the positive (+) lead wire from the battery is applied directly to the fan wire and the negative (-) lead wire is applied to the fan ground wire. If the fan fails to operate when wired directly, replace the fan. If fan operates normally when wired directly but fails to operate when air conditioning system is on, confirm proper wiring connection where interface harness (including condenser fan relay) connects dash A/C to chassis.

The dash A/C system output (to energize the magnetic clutch) is the black wire with white tracer (BW). It is also used to energize the condenser fan relay.

### (9) Condenser Fan Removal

- (a) Disconnect 2-Pin connector from fan.
- (b) Remove four (4) nuts securing fan to fan bracket.
- (c) Remove fan.

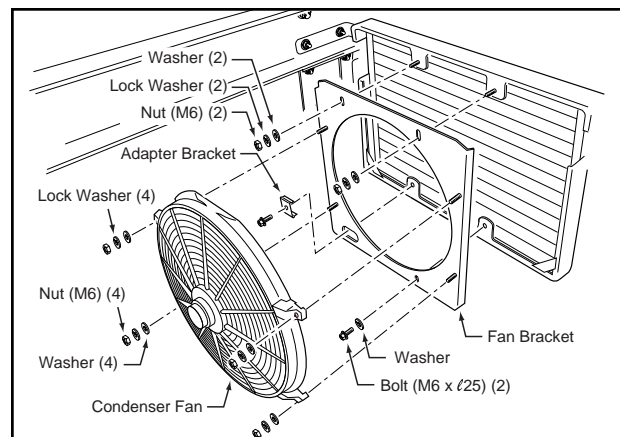


Figure 111: Condenser Fan

### (10) On Vehicle Inspection: Condenser

- (a) Inspect condenser fins for blockage or damage. If clogged, wash with water and blow with compressed air. If fins are bent, straighten with a fin straightening tool.
- (b) Check hose connections for leakage using a refrigerant leak detector. Repair as needed.

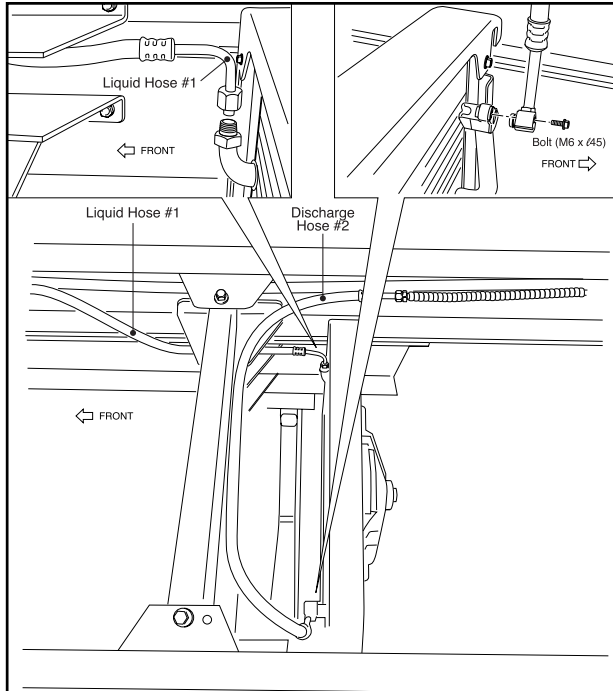


Fig. 112: Condenser Removal

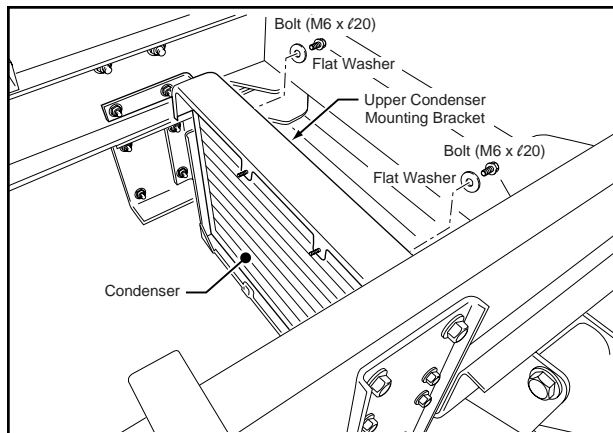


Fig. 113: Condenser Removal

## (11) Condenser Removal

- (a) Recover refrigerant from air conditioning system.
- (b) Disconnect hoses from condenser.

**⚠CAUTION: Cap ends of hoses IMMEDIATELY after disconnecting from condenser to prevent moisture or other contaminants from entering the system.**

- (c) Disconnect 2-Pin connector from condenser fan.
- (d) Remove fan and fan bracket together by removing two (2) nuts and two (2) bolts securing fan bracket to condenser bracket.

- (e) Remove two (2) bolts securing condenser to upper condenser bracket.
- (f) Remove bolts securing upper condenser bracket to frame rails and slide bracket forward.
- (g) Lift condenser out of lower bracket and remove.

## (12) Condenser Installation

Follow the steps in Paragraph 11 in reverse order for installation.

Tightening Torques:

Upper Condenser Bracket to Side Rails: 280 N•m (200 lbf•ft)

Discharge Hose: 9.8 N•m (7.2 lbf•ft)

Liquid Hose: 7.8 N•m (5.8 lbf•ft)

If the condenser was replaced, add oil to compressor.

ND Oil 8: 40–50 cc (1.4–1.7 oz.)

After installation, evacuate the system and recharge.

HFC-134a: 48 oz. ± 2 oz.

Inspect system for leaks with a refrigerant leak detector. Check the system for proper operation and performance.

# REFRIGERANT LINE REPLACEMENT

## (13) On Vehicle Inspection: Receiver/Drier

- (a) Check that bolts securing hoses and tubes are not loose.
- (b) Check connections for leakage with a refrigerant leak detector and repair if needed.

## (14) Receiver/Drier Removal

- (a) Recover refrigerant from A/C system.
- (b) Disconnect hoses from receiver/drier.

**⚠CAUTION: Cap ends of hoses IMMEDIATELY after disconnecting from condenser to prevent moisture or other contaminants from entering the system.**

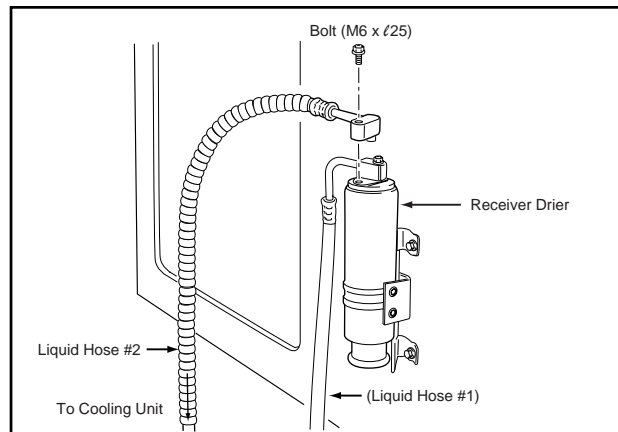


Fig. 114: Receiver/Drier Removal

- (c) Remove receiver/drier from receiver/drier bracket.

## (15) Receiver/Drier Installation

Follow the steps in Paragraph 14 in reverse order for installation.

Tightening Torques for Liquid Hoses:  
5.4 N•m (4.0 lbf•ft)

If the receiver/drier was replaced, add oil to the compressor.

ND Oil 8: 20 cc (0.7 oz.)

After installation, evacuate the system and recharge.

HFC-134a: 48 oz.  $\pm$ 2 oz.

Inspect system for leaks with a refrigerant leak detector. Check the system for proper operation and performance.

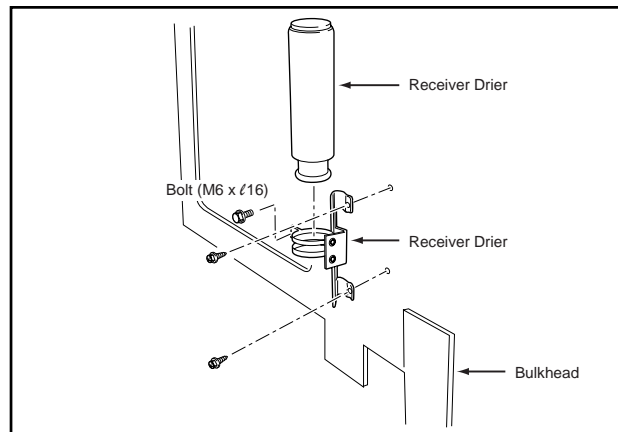


Fig. 115: Receiver/Drier Installation

## 1. About Certification

### A. Ozone Layer and CFCs

Recent scientific findings indicate that CFCs, like CFC-12 as well as bromines from halons used in fire extinguishers, are depleting the Earth's protective ozone layer located in the stratosphere some 10 to 30 miles above this planet's surface.

This ozone layer filters out most of the harmful ultraviolet rays from the sun.

### B. Montreal Protocol

In 1985 scientists confirmed a large hole in the ozone layer and on September 16, 1987, the United States and 22 industrial countries signed an agreement in Montreal, Canada, known as the "Montreal Protocol".

This agreement restricted CFC production to 1986 levels beginning from July 1989.

### C. London Meeting

Because the ozone layer depletion was worse than predicted, a reassessment meeting was held in London in June 1990.

At this meeting all the member nations agreed to accelerated cutbacks of CFCs with a total phaseout by the year 2000.

### D. Federal Clean Air Act

In relation to these agreements, President Bush signed Section 609 of the amended Clean Air Act on November 15, 1990.

The Section 609 states that persons servicing motor vehicle air conditioning systems must be properly trained and certified.

Some states and jurisdictions have adopted their own deadlines and regulations in addition to federal requirements.

Effective January 1, 1990 the federal law requires that:

1. Each affected establishment shall certify that the establishment has acquired and is properly using approved refrigerant recycling equipment.

2. Each person authorized by the establishment to perform that service must be properly trained and certified.

### E. SAE Standards

SAE (The Society of Automotive Engineers) established 3 standards regarding refrigerant recovery and recycling, all of which are mentioned in Section 609 of the Clean Air Act.

#### *J1989 Standard*

This standard establishes guidelines for the use of recovery/recycling equipment when servicing automotive air-conditioning systems.

#### *J1990 Standard*

This standard is for equipment and all recovery/recycling equipment must meet SAE J1990.

#### *J1991 Standard*

This standard is for a purity of recycled refrigerant and recovery/recycling equipment must have UL (Underwriter's Laboratories) approval to meet J1991.

## 2. Section 609 of the Clean Air Act Amendments of 1990

The most important part of the amendments to Section 609 of the Federal Clean Air Act have to do with servicing motor vehicle air conditioning and technician certification. The act states:

Service Motor Vehicle Air Conditioners—Effective January 1, 1992, no person repairing or servicing motor vehicles for consideration may perform any service on a motor vehicle air conditioner involving the refrigerant for such air conditioner without properly using approved refrigerant recycling equipment and no such service unless such person has been properly trained and certified. The requirements of the previous sentence shall not apply until January 1, 1993 in the case of a person repairing or servicing motor vehicles for consideration at an entity which performed service on fewer than 100 motor vehicle air conditioners during calendar year 1990 and if such person so certifies to the Administrator by January 1, 1992.

### Certification

- (1) . . . each person performing service on motor vehicle air conditioners for consideration shall certify to the Administrator—  
that such person has acquired, and is properly using, approved refrigerant recycling equipment in service on motor vehicle air conditioners involving refrigerant and that each individual authorized by such person to perform such service is properly trained and certified;
- (2) Effective January 1, 1993 each person . . . Shall submit a certification under paragraph (1) (A).
- (3) Each certification under this subsection shall contain the name and address of the person certifying under this subsection and the serial number of each unit of approved recycling equipment acquired by such person and shall be signed and attested by the owner or another responsible officer. Certifications under paragraph (1)(A) may be made by submitting the required information to the Administrator on a standard form provided by the manufacturer or certified refrigerant recycling equipment.

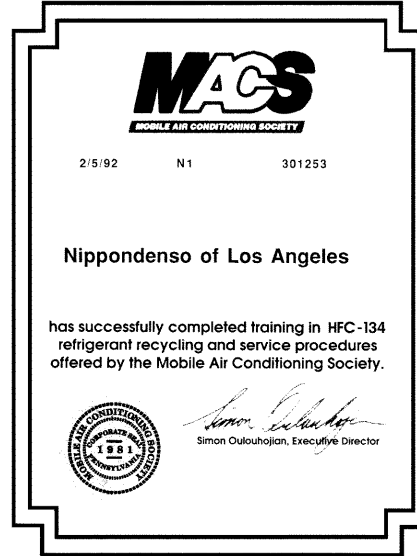


Fig 116: Mobile Air Conditioning Society Certificate



Fig. 117: Automotive Service Excellence Certificate



Fig. 118: California Air Quality Management Certificate

## 3. Evacuating and Charging Refrigerant

**⚠CAUTION:** To prevent the release of refrigerant into the atmosphere, charging hoses equipped with stop valves must be used when installing the manifold gauge set to the A/C system.

### A. Install Manifold Gauge Set With Stop Valves

Make sure the correct hoses are connected to the high pressure sides and low pressure sides.

Do not apply lubricant to connection seating area.

- 1) Close the stop valves on manifold gauge charging hoses.
- 2) Close both shut-off valves on manifold gauge set.
- 3) Remove caps from charge ports and stop valves on compressor service valves.
- 4) Connect charging hoses with stop valves to charge ports.
  - a) Tighten fittings by hand.
  - b) Make sure the correct hoses are connected to the high pressure side and low pressure sides.
  - c) Do not apply lubricant to connection seating area.

*NOTE: On Ford Chassis (with stop valve on compressor fitting) viewed from the rear of engine, turn the stop valve in the clockwise direction four full turns (half open).*

- 5) Open stop valves on both charging hoses.

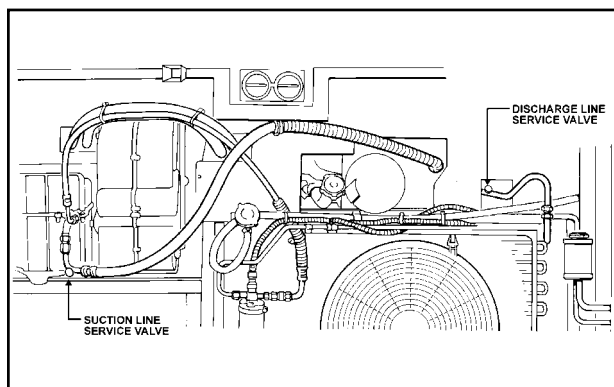


Fig. 119: GM Chassis (thru mid-1996)

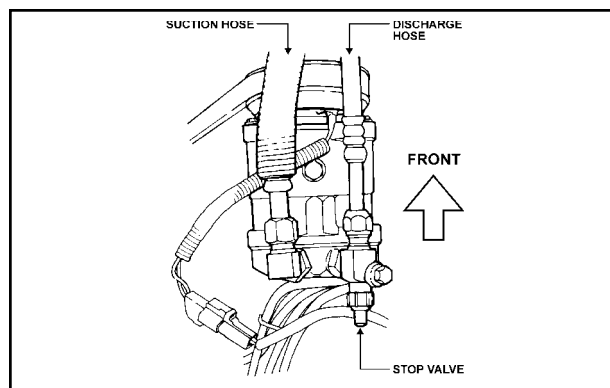


Fig. 120: Ford Chassis (thru mid-1998)

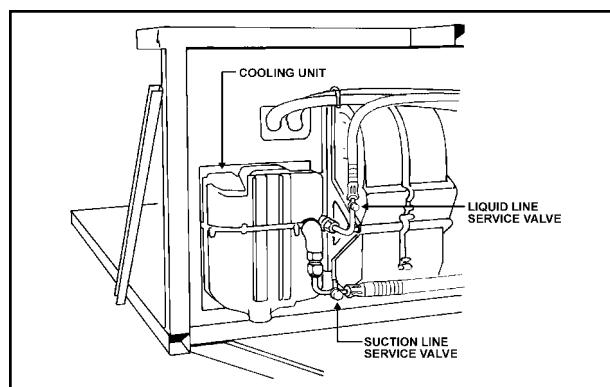


Fig. 121: Ford Chassis

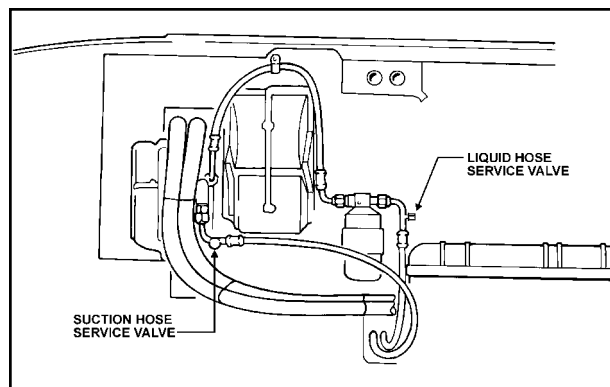


Fig. 122: Freightliner, and Spartan Chassis

### B. Evacuate Refrigeration System

- 1) Connect the center hose of the manifold gauge set to the vacuum pump. (Fig. 123)
- 2) Open both high and low hand valves; then run the vacuum pump.

*NOTE: If opening the low pressure hand valve causes the high pressure gauge to go into the vacuum range, this does not mean there is blockage in the system.*

# REFRIGERANT CHARGING

- 3) After ten (10) minutes or more, make sure the low pressure gauge indicates 750 mmHg (30 in. Hg) or more of vacuum.

*NOTE: If the reading is not 750 mmHg (30 in. Hg) or more of vacuum, close both hand valves of the manifold gauge set and stop vacuum pump. Check the system for leaks and make necessary repairs.*

- 4) Close both high and low hand valves; then stop the vacuum pump.
- 5) Leave the system in this condition for five (5) minutes or longer, and check that there is no change in the gauge indicator.

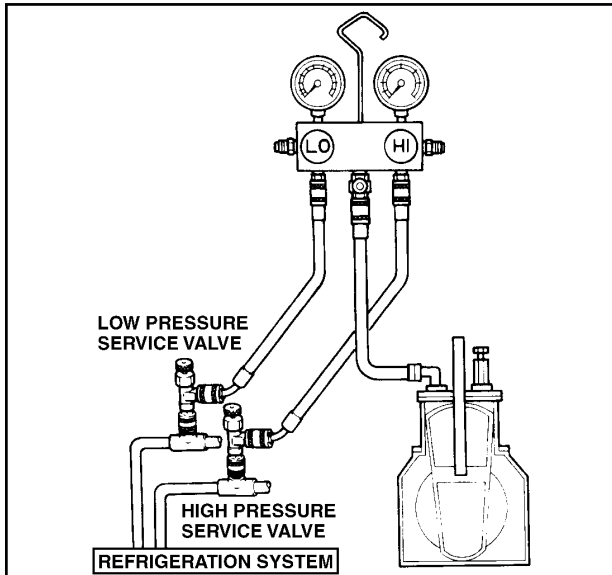


Fig. 123: System Evacuation

## C. Install Charging Cylinder

*NOTE: When handling the charging cylinder, always follow the directions given in the instruction manual.*

- 1) Charge the proper amount of refrigerant in charging cylinder.
- 2) Connect the center hose to charging cylinder.

**⚠CAUTION: Do not open both high and low hand valves of manifold gauge set.**

- 3) Press on the schrader valve, which is on the side of the manifold gauge, and expel the air inside the center hose. (Fig. 124)

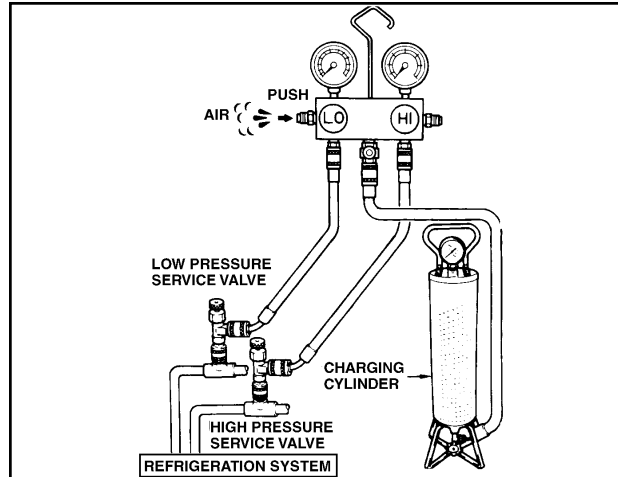


Fig. 124: Purging the System

## D. Inspect Refrigeration System for Leaks

After evacuating the air in system, check the system for leakage.

- 1) Open the high pressure hand valve and charge refrigerant.
- 2) When the low pressure gauge indicates 98 KPa (1 kg/cm<sup>2</sup>, 14 Psi), close the high pressure hand valve.
- 3) Using a leak detector, check the system for leaks.
- 4) If a leak is found, repair the faulty component or connection, and evacuate air in refrigerant system.

**⚠CAUTION: Use refrigerant recovery/recycling machine to recover the refrigerant when replacing parts.**

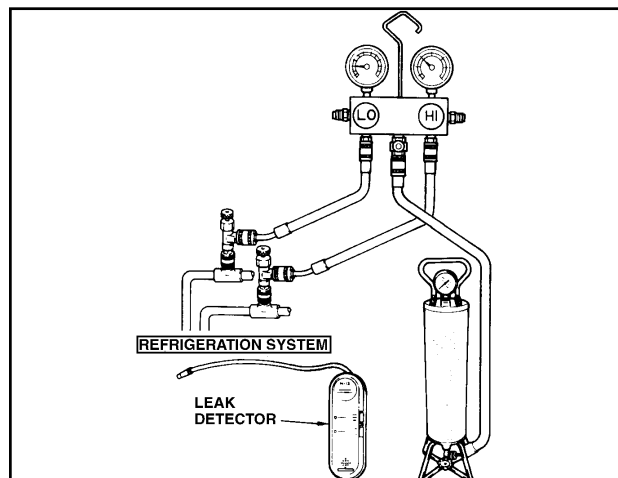


Fig. 125: System Leak Check



## E. Charge Refrigerant Into Refrigerant System

After refrigerant leak check, if there is no leak, charge the proper amount of refrigerant into the refrigeration system.

**⚠CAUTION: Never run the engine when charging the system through the high pressure side and do not open the low pressure hand valve when the system is being charged with liquid refrigerant.**

- 1) Open the high pressure hand valve completely.
- 2) Charge specified amount of refrigerant; then close the high pressure hand valve.

*NOTE: A fully charged system is indicated by the sight glass being free of any bubbles.*

(See the following Refrigerant Volume Section for Sight Glass Inspection.)

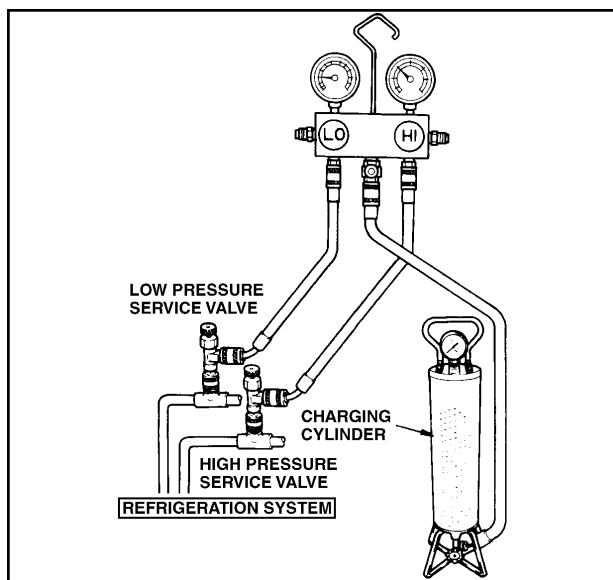


Fig. 126: Checking Charge Amount

## F. Remove Manifold Gauge Set From Service Valves

- 1) Close both hand valves of manifold gauge set.
- 2) Close hand valves of both stop valves.

*NOTE: On Ford chassis (with stop valve on compressor fitting) turn the stop valve in the counter clockwise direction until it is fully back seated (four turns).*

- 3) Disconnect charging hoses from charging ports on compressor service valves.

## G. Install Caps to charge ports and stop valves on compressor service valves

### 4. Refrigerant Volume

#### A. Refrigerant Volume Inspection

- 1) Run engine at approximately 1,500 RPM.
- 2) Operate A/C "ON" and Blower "HI" for at least five (5) minutes.
- 3) Open front hood and inspect sight glass on the receiver/drier for the following conditions:

- a) Bubbles in Sight Glass  
Refrigerant = Insufficient

Bubbles in sight glass may indicate normal when ambient temperature is higher than 95°F (35°C) if the A/C cooling performance is satisfactory.

Remedy = Check for gas leakage in the system, repair as required and recharge the system to the specified amount.

- b) No Bubbles in Sight Glass  
Refrigerant = None, enough or overcharged  
Remedy = Refer to steps (c) and (d).

- c) No Temperature Variance Between Compressor Inlet and Outlet

Refrigerant = Empty or nearly empty

Remedy = Evacuate and recharge system to the specified amount; then check for gas leak in the system.

- d) Temperature Between Compressor Outlet and Inlet Differ Abnormally  
Refrigerant = Proper or overcharged

Remedy = Refer to steps (e) and (f).

- e) Sight Glass Stays Clear Immediately After A/C Is Turned Off  
Refrigerant = Overcharged

# REFRIGERANT CHARGING

Remedy = Recover excess refrigerant to proper volume. Refer to step (f).

- f. Sight Glass Foams and Becomes Clear When A/C Is Turned Off  
Refrigerant = Normal

## B. Refrigerant Volume

- 1) Gas Front Engine Models:  
Ford = 2.8 lbs.  
GM = 2.0 lbs.
- 2) Diesel Models:  
Freightliner = 3.8 lbs.  
Spartan (thru mid-1998) = 4.2 lbs.  
Spartan (from mid-1998) using complete DENSO system = 3.0 lbs.

## 5. Performance Test

After completing repairs, make sure to carry out the performance test of the air conditioning system as follows:

### A. Procedure

1. Connect the high and low side charging hose of manifold gauge set to the hose fittings of compressor.
2. Run the engine, and keep the compressor speed at 1,500 RPM.
3. Operate the air conditioner, and set the blower switch at "HI," the temperature lever at "COOL" and in "recirc" mode.
4. Keep all windows and doors open.

5. Insert a dry bulb thermometer in the cool air outlet, and place the psychrometer (dry and wet bulb thermometer) close to the inlet of cooling unit.

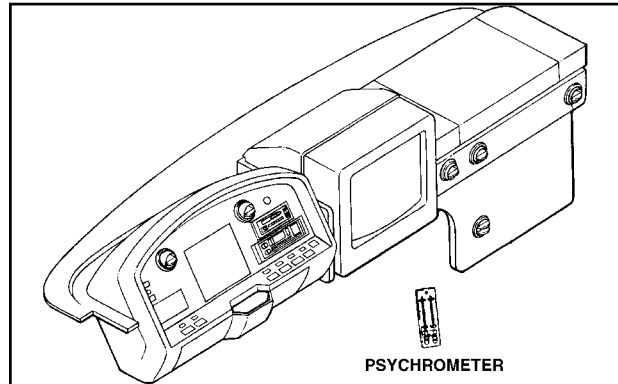


Fig. 127: Performance Testing

6. The high pressure gauge reading should be within the specified pressure range, 14.0 - 16.0 kg/cm<sup>2</sup> (199-227 psi)..

*NOTE: If the gauge indicates too high, pour water on the condenser, or if it is too low, cover the front surface of condenser.*

7. The dry bulb thermometer at the air inlet should be within 25-35°C (77-95°F).

With the above conditions, operate air conditioning system until a stabilized condition on high and low pressure gauges and the thermometers have been established.

- Calculate the relative humidity from the psychrometric graph by comparing the wet and dry bulb readings of the psychrometer at the air inlet. (Fig 128)

**HOW TO READ THIS GRAPH:**

After measuring the temperatures of the wet- and dry-bulb thermometers at the evaporator air inlet, relative humidity can be obtained.

Example: Supposing dry- and wet-bulb temperatures at the evaporator air inlet are 25°C (77°F) and 19.5°C (67°F) respectively. The point of intersection of the dotted lines in the graph is 60%.

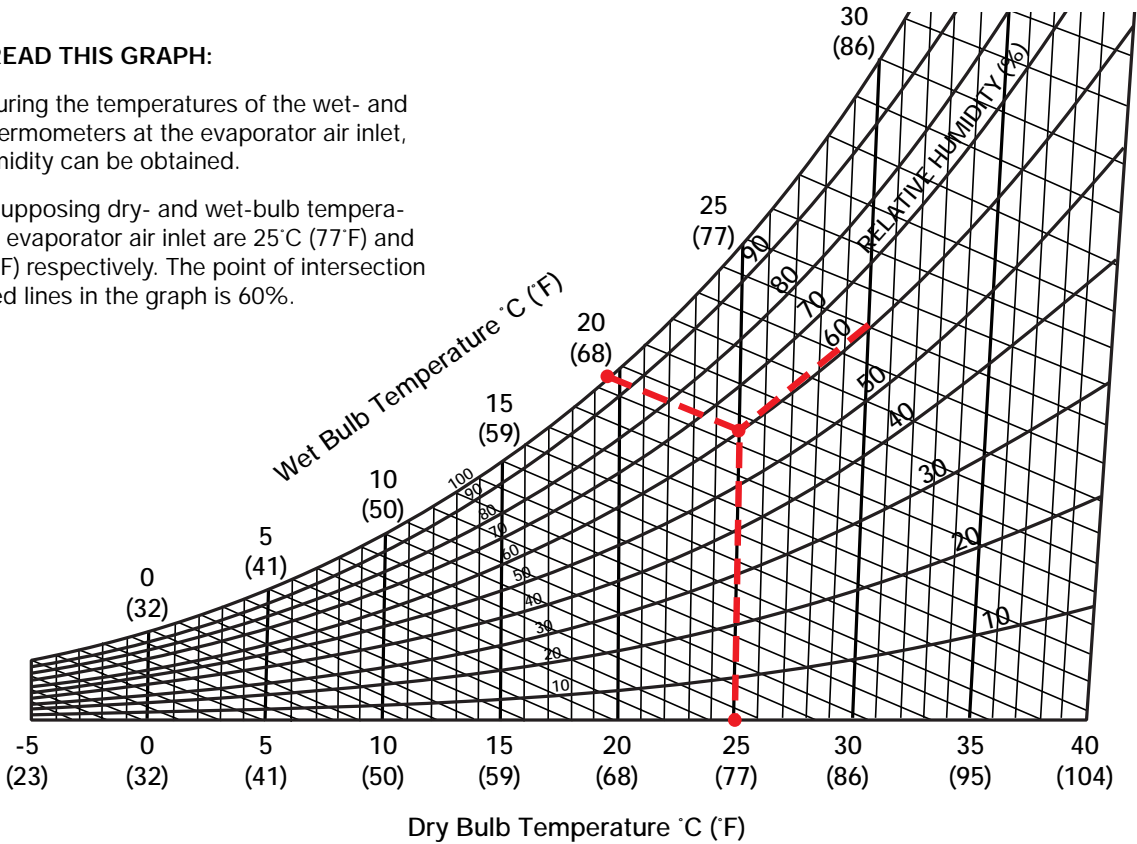


Fig. 128: Psychrometric Graph

- Measure the dry-bulb temperature at the cool air outlet, and calculate the difference between the inlet dry bulb and outlet dry bulb temperatures (Fig. 129).
- Check that the intersection of the relative humidity and temperature difference is above the line. If the intersection is within the two lines, cooling performance is satisfactory.

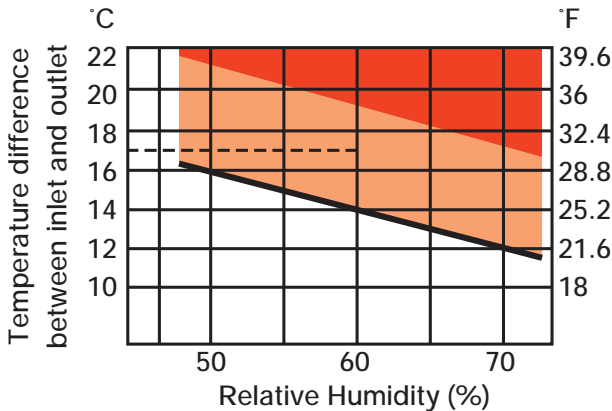


Fig. 129: Temperature Difference

# WIRING DIAGRAMS

## Main Relay

Terminal No. / Battery Voltage	30	85	86	87	87A
Not Supplied		○—○			
	○—				○
Supplied		⊖—⊕			
	○—				○

○—○ Indicates there is continuity between these terminals  
 ⊖—⊕ Indicates terminals to which battery voltage is supplied

### Main Relay connector

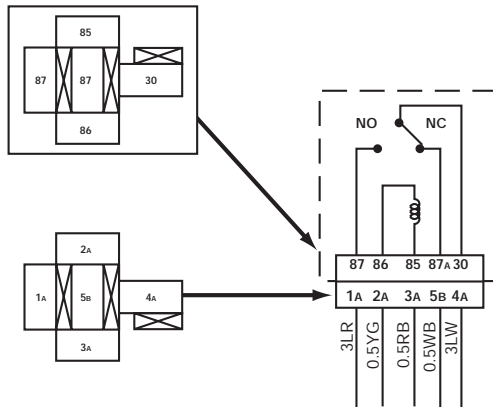


Fig. 130: Main Relay

## Blower High Relay

Terminal No. / Battery Voltage	21A	2B	50	18B
Not Supplied	○—○			
Supplied	⊕—	⊖	○—○	

○—○ Indicates there is continuity between these terminals  
 ⊖—⊕ Indicates terminals to which battery voltage is supplied

### Blower High Relay connector

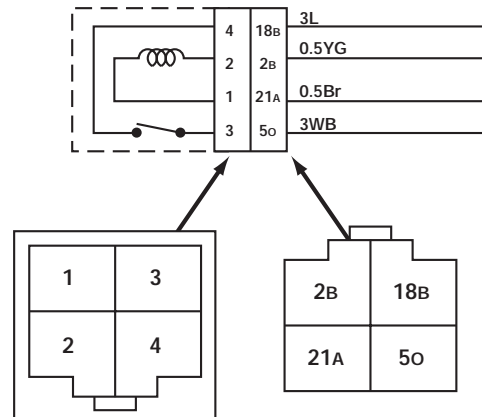


Fig. 131: Blower High Relay

L = BLUE  
 G = GREEN  
 R = RED  
 Y = YELLOW  
 W = WHITE  
 B = BLACK  
 Br = BROWN

**Magnetic Clutch Relay**

Terminal No. \ Battery Voltage	13A	4I	12A	4E
Not Supplied	○—○			
Supplied	⊖—⊕		○—○	

- Indicates there is continuity between these terminals
- ⊖—⊕ Indicates terminals to which battery voltage is supplied

**Magnetic Clutch Relay connector**

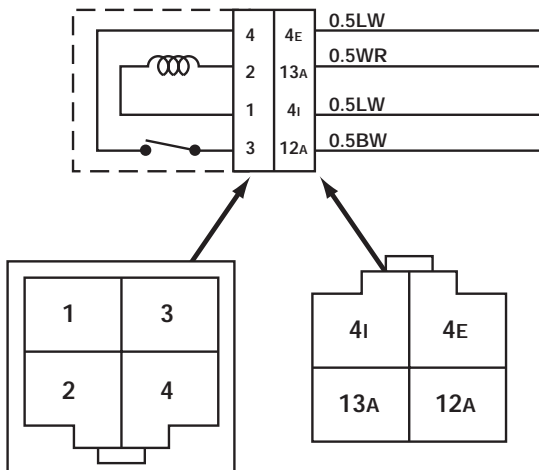


Fig. 132: Magnetic Clutch Relay

**Mode Servo**

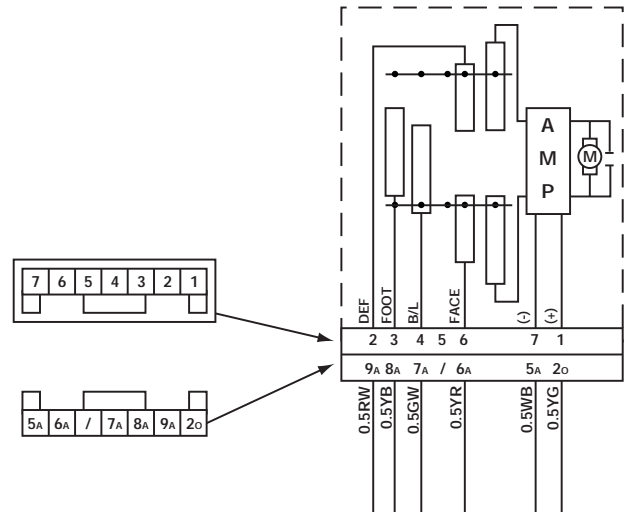


Fig. 133: Mode Servo

- L = BLUE**
- G = GREEN**
- R = RED**
- Y = YELLOW**
- W = WHITE**
- B = BLACK**
- Br = BROWN**

# WIRING DIAGRAMS

## Air Intake Servo

To check for voltage at the Air Intake Servo Sub Harness female connector, use chart below

Switch Position \ Main Harness Pin	1	2	4
	.5YG	.5YG	.5YL
Recirc (in)	+	---	-
Fresh (recirc out)	+	-	

⊖--⊕ Indicates terminals to which battery voltage is supplied

### Air Intake Servo connector

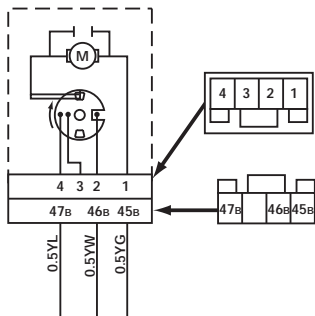


Fig. 134: Air Intake Servo

## Pressure Switch

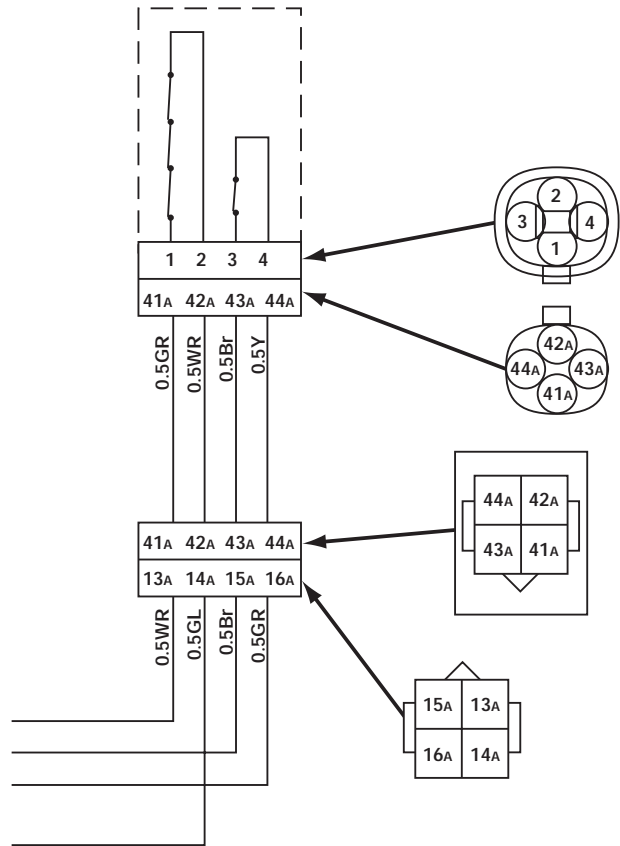


Fig. 135: Pressure Switch

L = BLUE  
 G = GREEN  
 R = RED  
 Y = YELLOW  
 W = WHITE  
 B = BLACK  
 Br = BROWN

System Schematic (All Models)

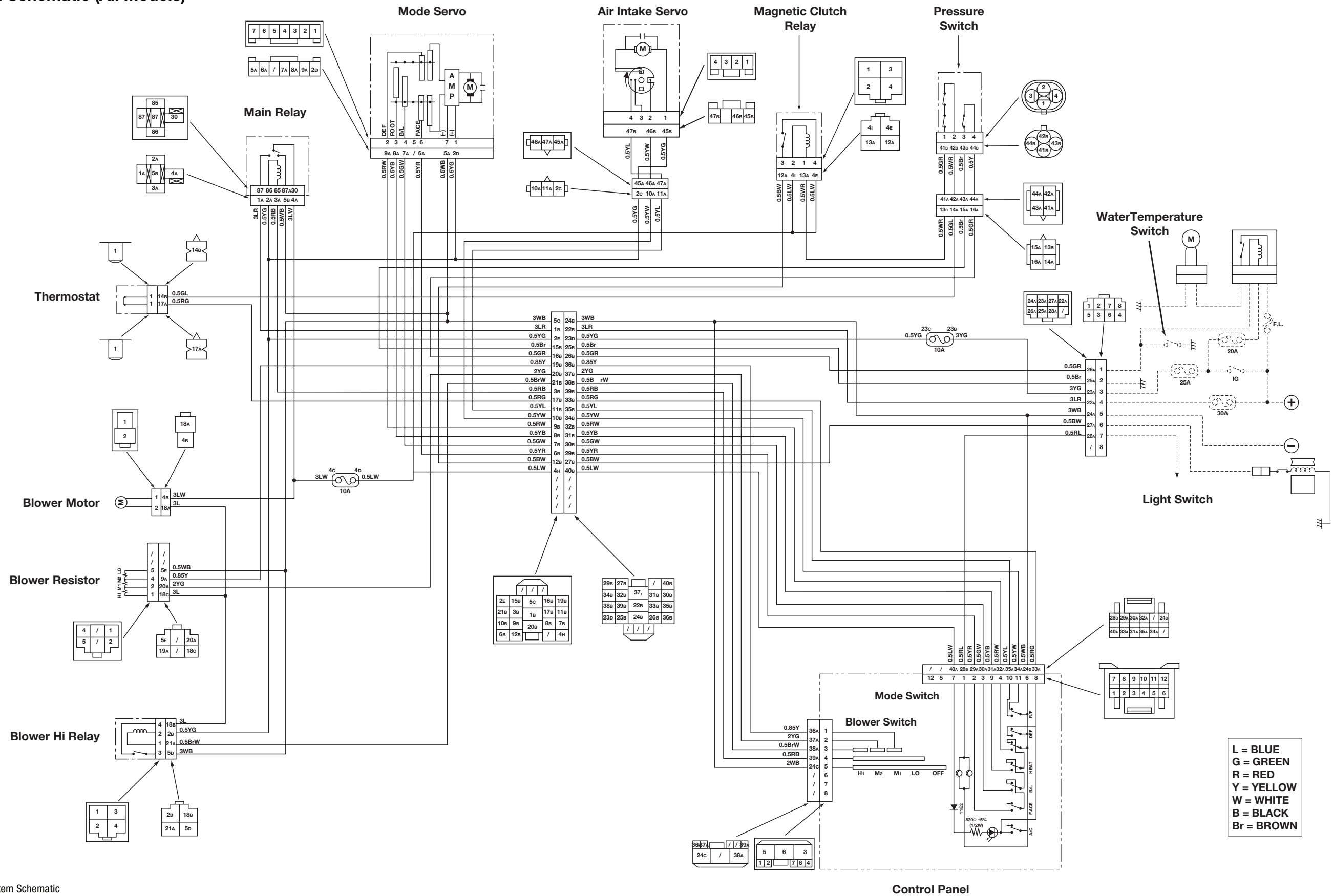


Fig. 136: System Schematic

***DENSO***

DENSO SALES CALIFORNIA, INC.

TECHNICAL SERVICE DEPARTMENT

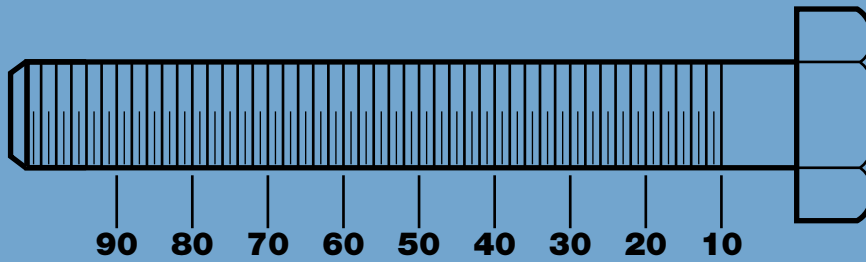
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**BOLT LENGTH RULER (mm)**



**BOLT DIAMETER (mm)**

