
CONTENT OUTLINE

Refrigeration Cycle

- Objectives
- Component Overview

Components and Operation

- Compressor
- Condenser
- Receiver-Drier
- Expansion Valve
- Orifice Tube
- Evaporator
- Accumulator
- Activities

Airflow Management

- Objectives
- Fresh Air/Recirculate
- Blower Fan
- Temperature Blend Door
- Defrost Door
- Vent/Face and Heater Doors
- Activities

Automatic Temperature Control

- Objectives
- Automatic Temperature Control
- A/C Amplifier
- Ambient Temperature Sensor
- Passenger Compartment Temperature Sensor
- Water Temperature Sensor
- Evaporator Temperature Sensor
- Solar Radiation Sensor
- Air Intake Actuator
- Air Mix Actuator
- Airflow Mode Actuator
- Blower Motor
- Power Transistor
- Max-High Relay
- On-Board Diagnosis
- Activities

COURSE OBJECTIVES

After completing this course, you will be able to:

- Describe a refrigeration cycle and what part the components play in the cooling process
- Identify major components of a manual A/C system
- Perform A/C system performance checks
- Perform evacuation, charging and leak detection of an A/C system
- Describe passenger compartment airflow management and it's effect on the cooling process
- Explain the various airflow modes and their purpose

Name _____

Date _____



Air Conditioning Operation and Diagnosis Course Map

▪ Refrigerant Cycle

▪ Airflow Management

▪ Automatic Temperature Control

U-01
Identifying A/C
Components

U-05
Evacuating a R-134a
System

U-09
Heater, Vent and A/C
Mode Performance

U-10
Automatic Temperature
Control System Check

U-02
Locating A/C Protection
Devices

U-06
Applying Vacuum to a
R-134a System

U-11
Output Device
Performance Check

U-03
A/C Performance Check

U-07
Recharging a R-134a
System

U-04
Inspecting the Robinair
34700

U-08
Leak Testing Using an
Electronic Leak Detector

SAFETY PROCEDURES

A/C service and repair is potentially dangerous. You will be dealing with refrigerant and coolant at high pressure and temperatures, and you will be working with the engine running. In addition, the chemical properties of refrigerant make it potentially hazardous if not handled properly.

For these reasons, you must observe the following safety rules whenever you work on an A/C system.

1. Always wear eye protection. If refrigerant gets in your eyes, you could be blinded. Keep a supply of sterile mineral oil and a weak solution of boric acid handy to wash

INTRODUCTION

The A/C system has always been a system that many people can repair successfully yet few can explain the mystery of how the air becomes cool. Now that the majority of cars sold today are equipped with A/C it is important to understand the principles and functions of the system. Understanding how to diagnose the system quickly will allow you to perform repairs accurately which will improve Fix-It-Right-The-First-Time, and increase your income and potential for the future.

OBJECTIVES

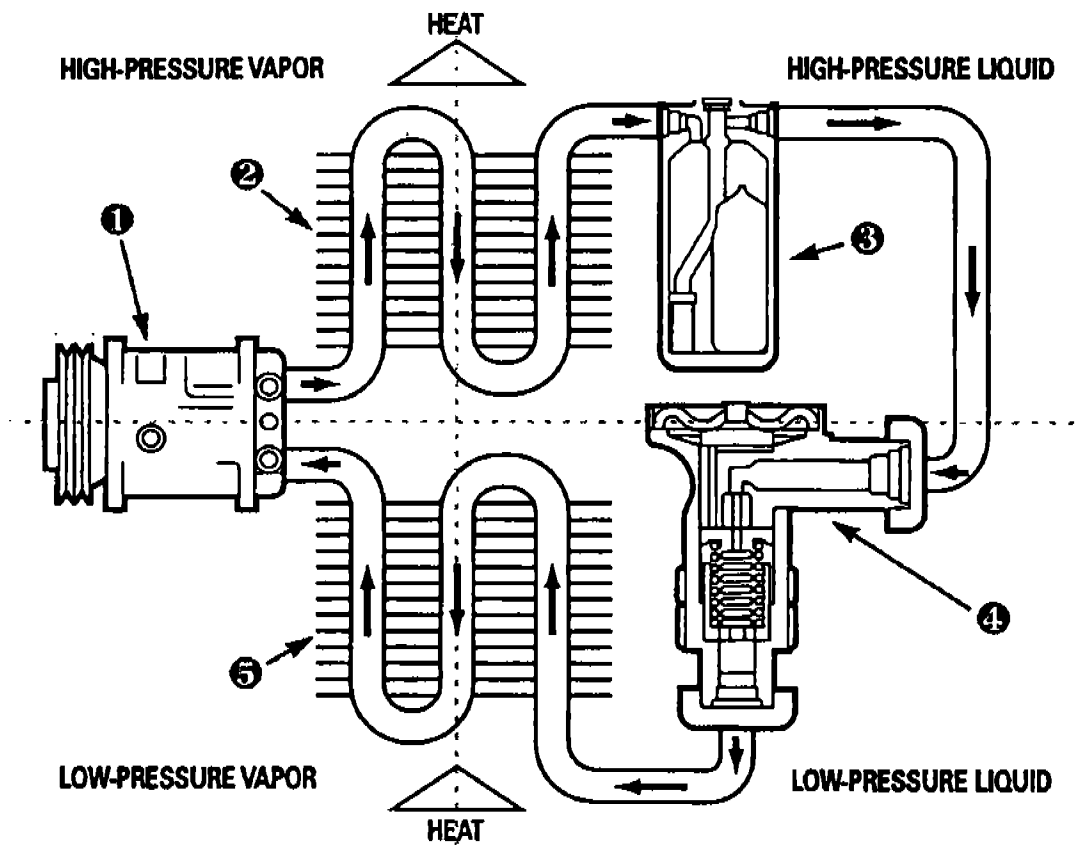
After completing this section, you will be able to:

- Describe a refrigeration cycle and what part the components play in the cooling process
- Identify major components of a manual A/C system

Activities in this section:

Activity #	Description	Location
U-01	Identifying A/C Components	Shop
U-02	Locating A/C Protection Devices	Shop
U-03	A/C Performance Check	Shop
U-04	Inspecting the Robinair 34700	Shop
U-05	Evacuating a R-134a System	Shop
U-06	Applying Vacuum to a R-134a System	Shop
U-07	Recharging a R-134a System	Shop
U-08	Leak Testing Using an Electronic Leak Detector	Shop

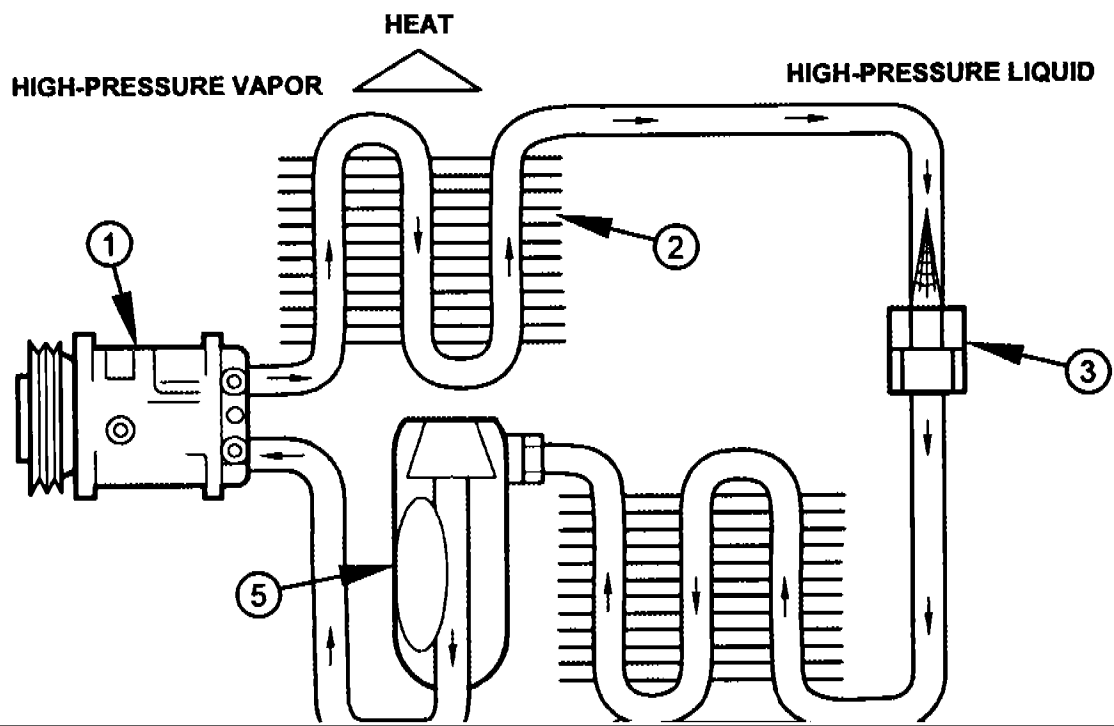
REFRIGERATION CYCLE (Expansion Valve)



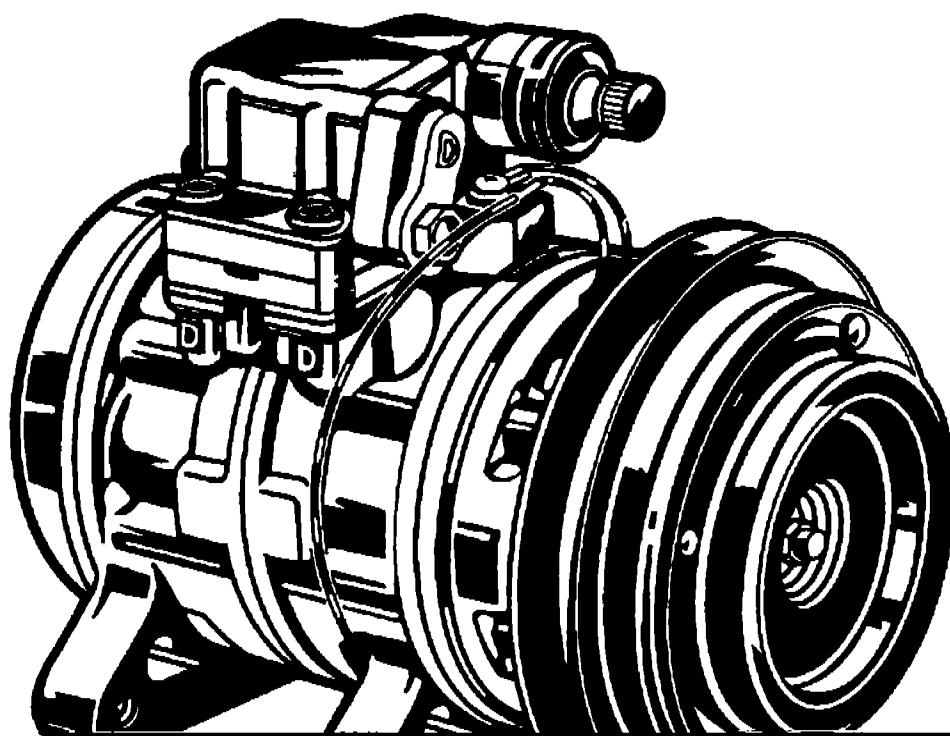
- One refrigeration cycle is made up of two pressure changes
- Compressor changes low pressure to high pressure
- Expansion valve changes high pressure to low pressure

Notes: _____

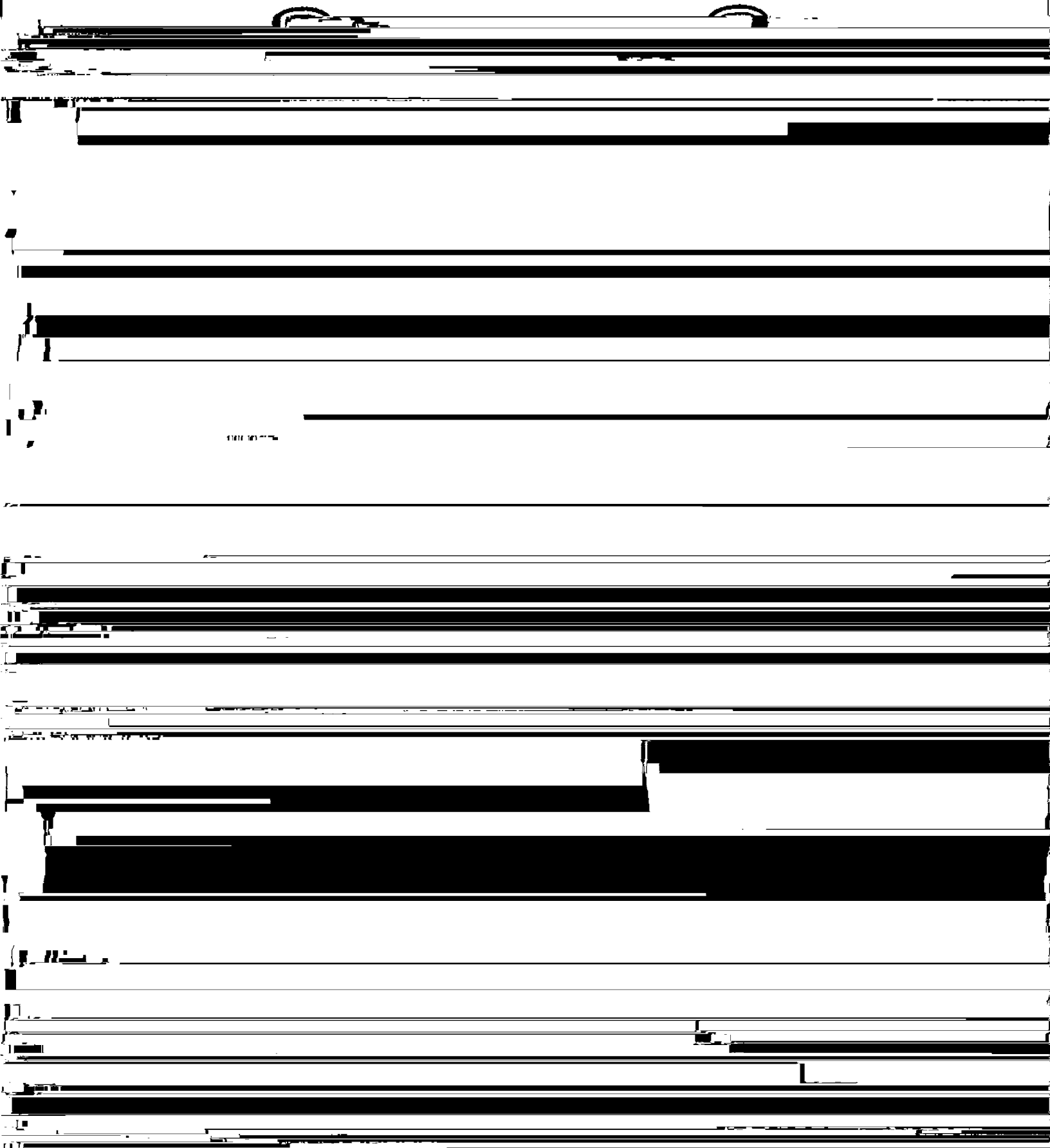
REFRIGERATION CYCLE (Orifice Tube)



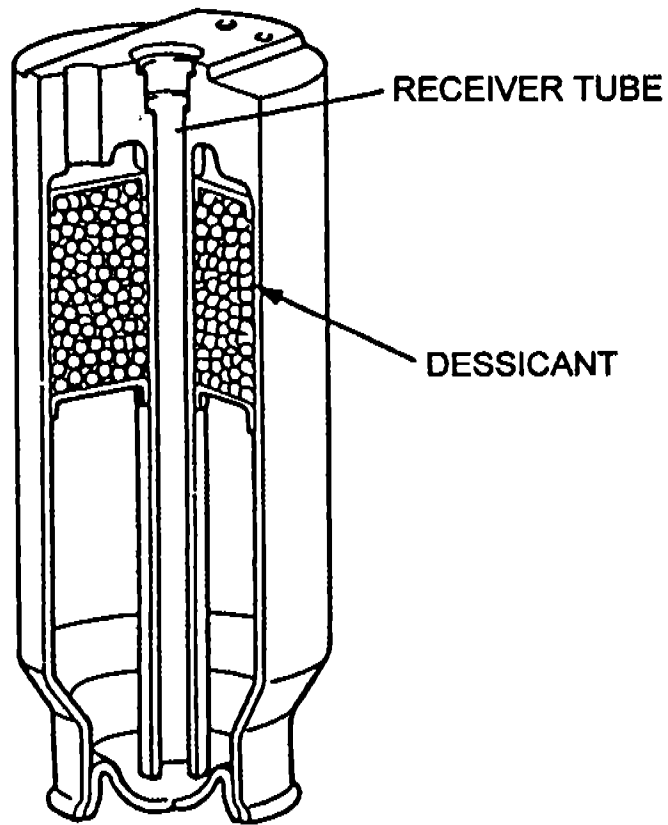
Compressor



Condenser



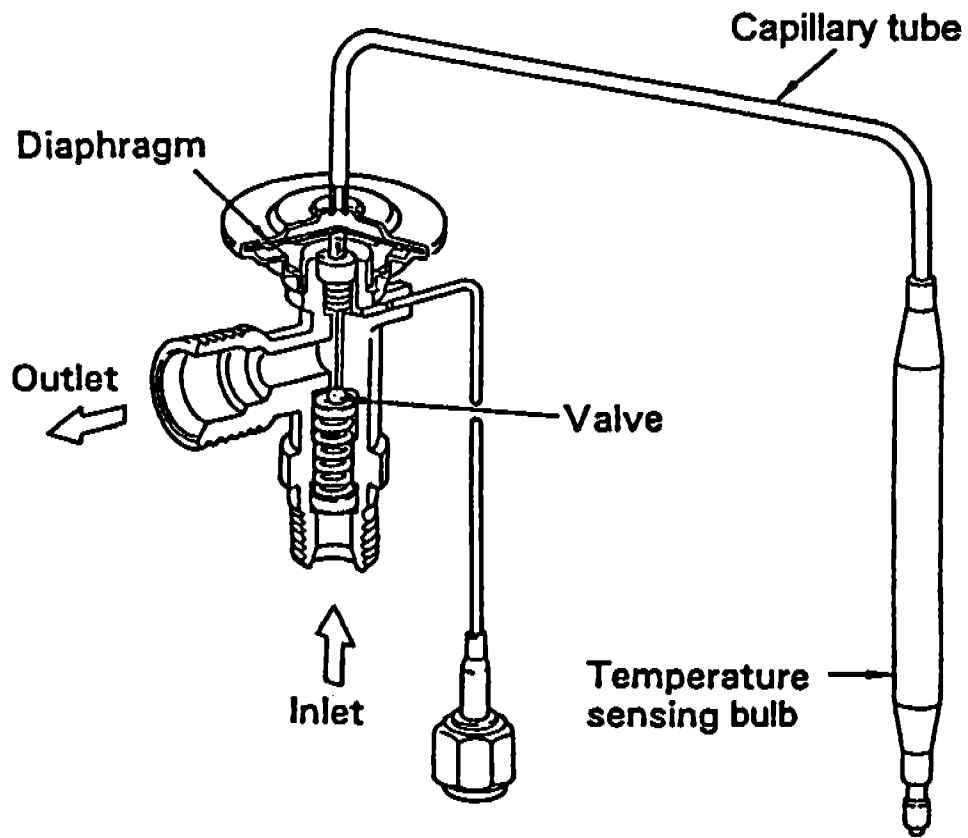
Receiver-Drier



- Desiccant must match the refrigerant
- Filters out moisture and foreign matter
- Stores liquid refrigerant
- Cooling will stop if moisture freeze within the expansion valve

Notes: _____

Expansion Valve



- Sensing bulb controls the valve position which regulates refrigerant flow
- Evaporator pressure is regulated to approximately 30 psi
- Valve position is constantly changing with evaporator pressure
- Valves are matched to specific refrigerants

Notes: _____

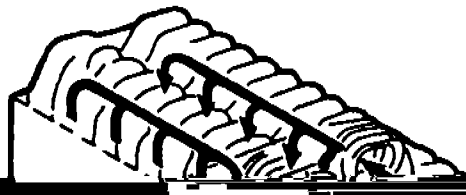
Orifice Tube



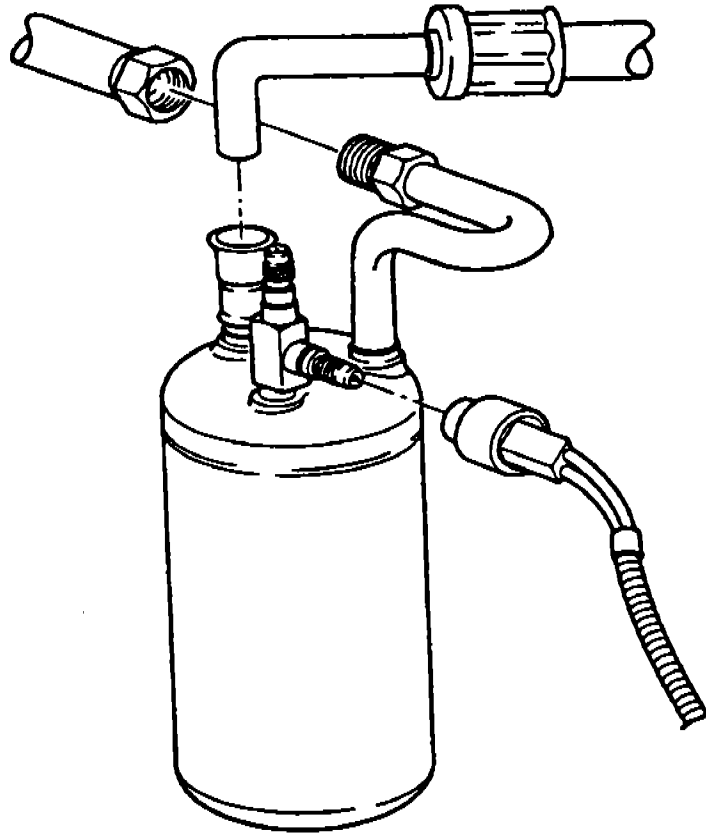
- Fixed opening controls refrigerant flow
- Orifice tube divides the high- and low-pressure side of the system
- Cycling the compressor clutch controls refrigerant flow

Notes: _____

Evaporator



Accumulator



- Stores, filters and dries refrigerant
- Prevents liquid refrigerant from damaging the compressor
- Located on the low-pressure side of the A/C system

Notes: _____

Technician Name _____

IDENTIFYING A/C COMPONENTS

Purpose: In this activity, you will identify major A/C components.

What you will need to complete this activity:

- Current model vehicle
- Workshop Manual or Body Electrical Trouble Shooting Manual

Component Identification

Identify the numbered A/C components on the vehicle and record in the spaces below. If you need help, refer to the Service Highlights or Workshop Manual.

1. _____

6. _____

2. _____

7. _____

3. _____

8. _____

4. _____

9. _____

5. _____

10. _____

Visual Inspection

1. Do the condenser and radiator have any obstructions to airflow? ☐ Yes ☐ No

NOTE:

Perform the following checks with engine off and key out of ignition.

2. If equipped with electric cooling fans, do they turn easily with engine and power off?
☐ Yes ☐ No
3. If equipped with fluid clutch fan, is there suitable resistance when turned by hand?
☐ Yes ☐ No
4. Does the radiator recovery bottle have proper fluid level? ☐ Yes ☐ No

Low coolant may cause the engine to run hot.

5. What is the general appearance of the refrigeration system components? _____

KEY POINT:

A leak can look like an oily residue. The oily residue will often show up at hose connections and seal locations.

6. Is the compressor drive belt in good condition and adjusted to specification?
☐ Yes ☐ No

IMPORTANT:

If the answer to any of the questions was no, fix the problem before continuing the inspection. Visual and component inspection help isolate the concern to a specific system.

Instructor Sign-Off:

Now that you have completed this activity, you should be able to:

- Identify A/C components

This skill will help you service an A/C system.

Instructor's initials:

Technician Name _____

LOCATING A/C PROTECTION DEVICES

Purpose: In this activity, you will locate A/C protection devices and explain how they operate.

What you will need to complete this activity:

- Millenia
- Millenia Workshop Manual
- Millenia Service Highlights
- Drop Light
- Fender Covers

Protection Devices react to abnormally high or low pressures and excessively high temperatures which would damage the system.

Refrigerant Pressure Switch

1. Where is the pressure switch located? _____
2. How does it protect a system that has a leak in the condenser? _____

3. How does it protect a system that has inoperative condenser fans? _____

4. Is the refrigerant that contacts the switch a liquid or vapor? _____

Thermal Protector (Thermal Switch)

1. Where is this device located? _____

2. This component senses the temperature of liquid or vapor refrigerant? _____

3. In what way does the thermal protector safeguard the system? _____

4. If this component fails due to an open circuit, what will the customer notice? _____

NOTE:

In the Millenia W/M, the Thermal Protector is called "Thermo Protector" and "Thermoswitch." When ordering parts, use the term "Thermo Protector Kit".

Pressure Relief Valve

1. Where is this device located? _____

2. At what pressure will you expect the pressure relief valve to discharge refrigerant to the atmosphere? _____

Instructor Sign-Off:

Now that you have completed this activity, you should be able to:

- locate A/C system protection devices
- explain the function of protection devices

These skills will help you evaluate protection devices for correct operation.

Instructor's initials:

Technician Name _____

CONDUCTING A PERFORMANCE CHECK

Purpose: In this activity, you will diagnose a vehicle's air conditioning system.

A Performance Check is the basis of air conditioning diagnosis. All diagnostic routines should begin and end with this test to determine if the system is performing to specifications. It is thorough and easy to perform.

What you will need to complete this activity:

- Current Model Vehicle
- Workshop Manual
- Thermometer
- R-134a Refrigerant Pressure Gauge Set
- Safety Glasses

NOTE:

Humidity and temperature have an effect on the outcome of this test.

Function Check

NOTE:

During the following tests, monitor instrument panel gauges and warning lights for out of specification readings.

1. Set hand brake and place gear selector in Park (ATX) or Neutral (MTX).
2. Keep hood open throughout the test to maximize airflow through the radiator and condenser.
3. With engine running, select all the blower fan speeds.
Does the fan speed change? ☐ Yes ☐ No

Are all speeds available? ☐ Yes ☐ No

(If no, repair according to workshop manual directions.)

4. Operate mode control to all positions and confirm that sufficient airflow is at each position. Does the airflow change according to the position of the mode control indication on the dash? ☐ Yes ☐ No

(If no, repair according to workshop manual directions)

5. Operate temperature select control throughout its range and confirm that the airflow temperature matches the setting. Start with the control in the coolest setting and slowly increase temperature to highest setting, then back to original setting. Does the temperature match the control setting? ☐ Yes ☐ No

(If no, repair according to workshop manual directions)

6. Turn off engine.

INFORMATION POINT:

A small temperature difference between the setting and the actual duct temperature is normal. The duct temperature will usually be cooler than the interior temperature. This is because the air from the evaporator is concentrated in the small area of the duct very close to the evaporator.

Performance Check

1. Place a thermometer in a center vent.
2. Close all doors and windows.
3. Set A/C controls for maximum cooling with:
 - a. temperature to full cold
 - b. airflow to face/vent
 - c. fresh/recirculate control to Recirc
 - d. activate compressor with fan speed on high

4. Install R-134a manifold gauges or hoses from charging station according to the workshop

5. Start engine and hold at 1500 rpm. When the pressures stabilize, record the high and low side pressures and center duct outlet temperature in the right column of the chart on page 4.

INFORMATION POINT:

Stabilized refrigerant pressures occur when maximum high side pressures remain the same each time the compressor cycles off. This pressure should not vary with the cycles.

The following charts represent average regional temperatures for the summer months.

Which chart best describes your zone? _____ Zone

1. **TEMPERATE ZONES** Average Humidity of 30%-70%.

TEMPERATE ZONE			
AMBIENT TEMP.	LOW GAUGE	HIGH GAUGE	OUTLET TEMP.
68° F	15 - 20 psi	150 - 180 psi	40 - 42° F
77° F	18 - 23 psi	185 - 210 psi	40 - 42° F
86° F	20 - 26 psi	210 - 240 psi	41 - 43° F

2. **HOT/DRY ZONES** Average Humidity of 20%-40%.

HOT/DRY ZONE			
AMBIENT TEMP.	LOW GAUGE	HIGH GAUGE	OUTLET TEMP.
86° F	16 - 23 psi	205 - 215 psi	40 - 42° F
95° F	18 - 26 psi	230 - 245 psi	43 - 44° F
104° F	20 - 27 psi	240 - 270 psi	46 - 50° F

3. **HOT/HUMID ZONES** Average humidity of 80%-99%.

HOT/HUMID ZONE			
AMBIENT TEMP.	LOW GAUGE	HIGH GAUGE	OUTLET TEMP.
86° F	16 - 29 psi	230 - 260 psi	50° F
95°F	18 - 31 psi	265 - 280 psi	55° F
104° F	20 - 32 psi	270 - 300 psi	70° F

NOTE:

It is acceptable for outlet temperatures to be cooler than the guidelines. If you perform the test in an air-conditioned shop, your readings will not match the temperature/humidity zone charts.

NOTE:

During this part of the test, monitor instrument panel gauges and warning lights for out of specification readings. Allow approximately ten minutes for A/C to cool interior of the vehicle and achieve stabilized pressures. In some hot/humid conditions, system pressures may become excessive. In this case, an assistant can spray water on the condenser to help

6. Record your findings in the left column of the chart below.

	YOUR FINDINGS	YOUR ZONE
Ambient Air Temp	° F	° F
Low Side Pressure	psi	psi
High Side Pressure	psi	psi

KEY POINT:

Because of individual comfort zones, customer perception of air conditioning performance varies. The customer may not understand the effect of humidity, solar gain, vehicle color, and glass area on vehicle cooling.

Use this performance check to confirm that a customer's A/C system is operating to manufacturer's specifications. This check also helps guide you towards the problem during diagnosis.

Instructor Sign-Off:

Now that you have completed this activity, you should be able to:

- conduct A/C performance checks

These skills will help you accurately diagnose an A/C system.

Instructors initials:

Technician Name _____

INSPECTING THE ROBINAIR 34700 BEFORE USING

INFORMATION POINT:

You must obtain certification before repairing or servicing A/C systems.

Purpose: In this activity, you will inspect the Robinair 34700. For this equipment to work properly, it must be undamaged and have the appropriate tank on the scale. Inspecting the charging station before using it helps ensure safe operation.

What you will need to complete this activity:

- Current Model Vehicle
- Workshop Manual or Body Electrical Trouble Shooting Manual
- Operation Manual for the Robinair 34700
- Safety Glasses

CAUTION:

You are working with a pressurized liquid that has a high potential for personal injury. Use care when connecting or disconnecting the service lines.

NOTE:

The following instructions apply to equipment that has already been set up and is in service. However, the more people using the machine, the more important it is to inspect it before using.

Preparation

Before attaching the recharging equipment to the vehicle, become familiar with the information in the Heater and Air Conditioner Systems section of the Workshop Manual or Body Electrical Troubleshooting Manual. Pay special attention to the Service Warnings.

Charging Station Inspection

1. Inspect for damage or missing components.
2. Check refrigerant tank is squarely positioned on scale. The unit's ability to accurately measure the weight of the tank is critical.
3. Inspect the hose connections at the tank and unit side for proper position and security.
 - A. Yellow hose to yellow port.
 - B. Blue hose to blue port. (First port below oil drain.)
 - C. Red hose to red port.
 - D. Red High Side service hose to high port.
 - E. Blue Low Side service hose to low port.
4. Inspect power cord. Is there any damage? Yes ☐ No ☐
5. Is there fresh oil in the oil injection bottle?
Yes ☐ No ☐
6. Open the oil drain valve slowly to remove any oil remaining in the equipment from the last service and dispose of properly.

NOTE:

The oil recovery port must be emptied after every service. If it is not emptied the amount of oil recovered during the next service will not be measured correctly.

7. Confirm that oil drain valve is fully closed.
8. Check for oil from the last service in the drain bottle, dispose of properly, and return oil drain bottle to its original position.
9. At control panel:
 - A. Main Switch "Off."
 - B. Low and High side valves closed.
10. Connect power cord and turn on main power switch on control panel. No warm up is needed.

Weighing the Refrigerant Tank

NOTE:

Before evacuation and recharging, make sure there is enough refrigerant in the tank to complete the job without causing delays for you or the customer.

1. Simultaneously press SHIFT/RESET and ENTER buttons on control panel to enter the diagnostic mode.
2. Press number pad 6 and read the total weight of the tank and its refrigerant. **The display must read at least 36 pounds.** This is the minimum weight for a complete A/C charge. Record weight from display: _____ lbs.
3. Depress SHIFT/RESET to return to original display.

Instructor Sign-Off:

Now that you have completed this activity, you should be able to:

- Inspect the Robinair 34700

This skill will help you safely use the charging station.

Instructor's initials:

NOW GO ON TO USING THE ROBINAIR 34700 TO EVACUATE AN R-134A SYSTEM.

Technician Name _____

USING THE ROBINAIR 34700 TO EVACUATE A R-134a SYSTEM

What you will need to complete this activity:

- Current Model Vehicle
- Applicable Workshop Manual or Body Electrical Troubleshooting Manual
- Temperature gauge
- Operation Manual for Robinair model 34700
- Safety glasses
- Hand tools

Evacuation of A/C System

1. Confirm that the coupler valve is in the closed position before attaching the hose to the service port. Remove cap from high-pressure service port and carefully support high-pressure line during coupling.

CAUTION:

On B-Series trucks, the high-pressure line is not supported and can be easily damaged if excessive force is used when attaching the valve.

2. After confirming that the connection is secure, open service line valve. Do the same with the blue low-pressure line.

WARNING:

Keep refrigerant recharging hoses away from fans and belts.

3. The main switch should be in the "ON" position to continue.
4. Open the red and blue valves on the control panel.
5. Open the red and blue valves on the refrigerant tank at the back of the machine.

6. Press the "Recover" button on the control panel. A 'click' can be heard and the letters "CL-L" appear on the display. (CL-L = low side clearing routine in progress). After several seconds, the display will change to the amount of refrigerant being recovered. As the display weight increases, the pressure on the gauges decreases.

INFORMATION POINT:

During recovery, monitor the color of the Moisture Indicator. If it is green, the recovered refrigerant is dry and normal. If it turns yellow, the refrigerant contains high levels of moisture.

7. The display will change to CPL and the pump stops. (CPL = complete; recovery process is finished). Now you must monitor the gauges for a pressure increase. Generally, after the first try pressure will rise to about 25-35 lbs. This indicates all the refrigerant has not been removed from the system.

To continue evacuation, press HOLD/CONTINUE and watch the display change to CH-P (system has less than 25 psi). When this happens, press HOLD/CONT to start second cycle of evacuation. Repeat until pressure remains around zero.

CAUTION:

If the system is free of refrigerant, there is no benefit to continue evacuation. It is possible that the pump could be damaged.

How much refrigerant was removed from the system? _____ lbs.

8. Depress SHIFT/RESET after recording weight of recovered refrigerant.

At this point, the system may be opened for service or repairs. If a component is to be removed, cover and/or cap all open lines to minimize the amount of moisture that could get in the system.

Instructor Sign-Off:

Now that you have completed this activity, you should be able to:

- Evacuate an R-134a A/C system

This skill will help you service R-134a systems.

Instructor's initials:

NOW GO ON TO APPLYING A VACUUM TO AN R-134A SYSTEM.

Technician Name _____

APPLYING A VACUUM TO AN R-134A SYSTEM

Purpose: After completing this activity you will be able to use the recharging station to apply a vacuum to the AC system. Applying a vacuum is important because it removes moisture and is a preliminary leak test.

What you will need to complete this activity:

- Current Model Vehicle
 - Applicable Workshop Manual or Body Electrical Troubleshooting Manual
 - Temperature gauge
 - Operation Manual for Robinair model 34700
 - Safety glasses
 - Hand tools
1. Turn on main switch or return to main menu. The display should read a preset time of approximately 15:00, indicating a vacuum time of fifteen minutes. To accept the default time, press "Recover."

INFORMATION POINT:

The Robinair 34700 provides a default pull-down (vacuum) time of 15:00 minutes. Depending on individual circumstances, you may need to extend this time.

To **change** pull-down time:

Press ENTER. After display (15:00) blinks, depress number pads until the desired time is displayed. For example: Press 3 then 000 (30:00), then press ENTER. The display will flash. The program is now ready to pull-down for thirty minutes.

2. If the displayed time is correct, activate the vacuum sequence by pressing "VACUUM." You will hear the pump start and the timer will start counting down. The pump will stop automatically at the end of the time selected. The display will now read "CPL" and a "beep" will be heard.
3. When the countdown sequence is completed, close both valves below the gauges on the control panel and wait for five minutes to see if the system vacuum will hold. If the system does not hold a vacuum, the system must be leak tested before adding refrigerant. If no leaks are present, go on to *A/C System (System Under Vacuum)*.

Instructor Sign-Off:

Now that you have completed this activity, you should be able to:

- Apply a vacuum to an R-134a A/C system

This skill will help you service R-134a systems.

Instructor's initials:

Technician Name _____

RECHARGING A/C SYSTEM (SYSTEM UNDER VACUUM)

Purpose: After completing this activity you will be able to add a refrigerant charge to the A/C system and confirm proper cooling.

What you will need to complete this activity:

- Current Model Vehicle
- Workshop Manual or Body Electrical Trouble Shooting Manual
- Thermometer
- Operation Manual for the Robinair Model 43700
- Safety Glasses

There are two main sources to find the amount and type of refrigerant for a particular vehicle.

1. Workshop Manual
2. Label on the evaporator case or hood (note unit of measure).

Replacing Refrigeration Oil

1. Check again to see that the waste oil drain bottle is empty and in proper position.
2. Open the oil drain at the rear of the unit **very slowly** until all the waste oil is removed. **If valve is opened too far, oil will splash out of the waste oil bottle.**
3. Measure the amount of drained oil and roll the O-ring around the fresh oil bottle as a stop reference.
4. Using the ring as a reference, open valve until oil level matches the ring. The oil supply has now been replenished.

CAUTION:

The oil that was separated from the refrigerant must be disposed of according to local regulations. Contaminated oil can not be reused.

Recharging

1. To recharge the system, enter the Program Mode. To do this, press the pad marked 'CHG.' Determine the amount of refrigerant charge. Enter the refrigerant amount using the keypads on the control panel.

NOTE:

The display reads in pounds, tenths, and hundredths of pounds. Therefore, conversion is necessary to service the correct amount. For example: The label states that the charge should be 1 lb. 8 oz. You would enter 1.50 because 8 oz. equals .5 pounds (16 oz. = 1 pound, 8 oz. = 0.5 pounds).

2. When the display reads the desired amount, press ENTER. The recharging program is now ready for activation.
3. Follow the manufacturer's recommendation on recharging through the low side or through low and high sides. Open proper valve on control panel below the gauges.
4. Press CHG to begin charging. The display will count down to zero then change to CPL. A 'beep' will signal the end of the charging program.
5. Close the low side valve on the control panel. Confirm that both the low and high side valves are now closed.

CAUTION:

The vehicle's A/C system must not be operated unless the low side and high side valves on the control panel are in the closed position.

6. With everything clear of all belts and fans, start engine and turn A/C on to full cold and high fan. When the cycling pressures are constant, charging is complete. Compare actual readings with the Workshop Manual.

WARNING:

When disconnecting the service hoses from the vehicle, use **extreme caution!** Both hoses may contain liquid refrigerant under pressure. Keep all hoses clear of drive belts and fans.

7. Complete all system pressure checks. While the A/C system is still operating, close the High Side coupler valve. Now remove that coupler valve and stow it at the brass fitting at the rear of the unit. A small release of pressure may be heard during separation.

8. At the control panel, open both the red high side, and the blue low side valves. This causes the refrigerant in both lines to be drawn into the vehicle's A/C system through the low side circuit.
9. Close the low side coupler valve and separate the low side line from the vehicle. Stow the low side service hose in the same manner as the high side hose.
10. Confirm that all valves are closed. Remove all tools and rags from under the hood.

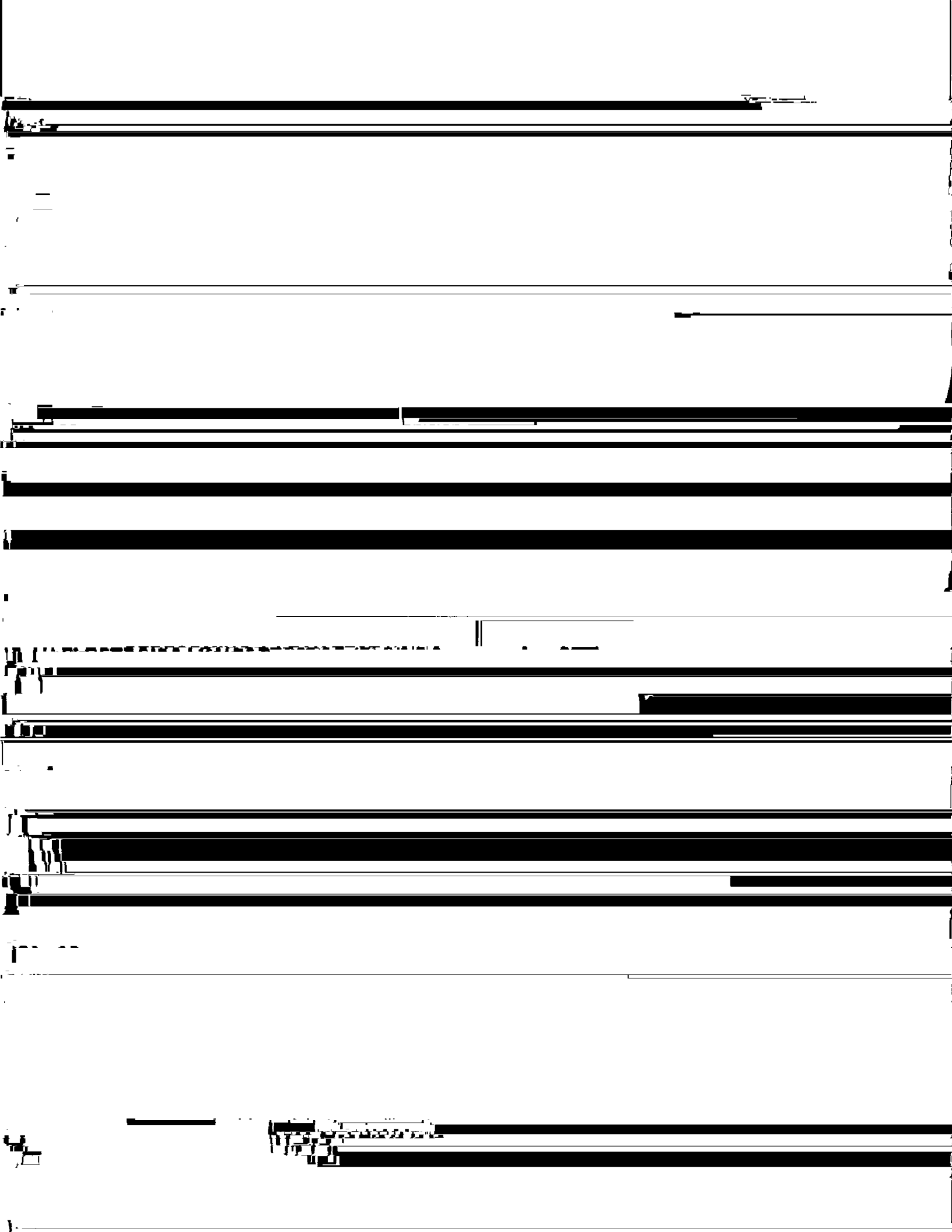
Instructor Sign-Off:

Now that you have completed this activity, you should be able to:

- Recharge an R-134a system

This skill will help you service R-134a systems.

Instructor's initials:



- d. Confirm unit's sensitivity at fuel filler. Notice the slight delay after the probe is placed in the filler neck.
- e. Be sure the engine is off and not started during test.

Inspection Tips

- The tester samples air by drawing in small amounts as the probe moves along a surface.
- The probe must be within ¼ inch of the area being tested. Remember that R-134a is heavier than air, so check at the lower side of a suspected component, line, or connection.
- A large leak will mask a small leak. Recheck the system after the first repair.
- Locating a very small leak requires patience. The following are a few suggestions:
 - a. Divide the system into sections that can be isolated and tested separately.
 - b. Isolate suspected areas and adjust the leak detector to the highest sensitivity. Move the probe very slowly.
 - c. Place the ELD probe at the evaporator drain hose and in the face and floor vents to check the evaporator and components within the case.
- When you begin the search, always begin at the same place regardless of the vehicle. Performing tests like this requires consistency for predictable results.

NOTE:

A very small leak is difficult to find because the refrigerant will easily dilute into the air.

Instructor Sign-Off:

Now that you have completed this activity, you should be able to:

- Use an electronic leak detector to locate a refrigerant leak.

This skill will help you service R-134a systems.

Instructor's initials:

OBJECTIVES

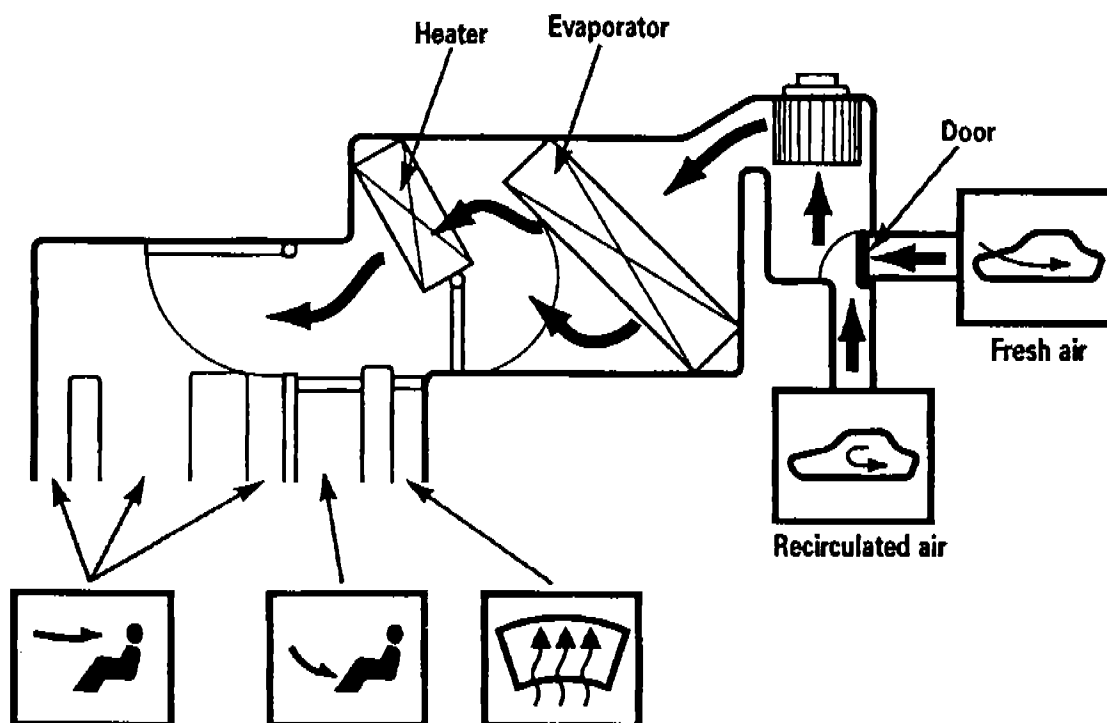
After completing this section, you will be able to:

- Describe passenger compartment airflow management and it's effect on the cooling process
- Explain the various airflow modes and their purpose

Activities in this section:

Activity #	Description	Location
U-09	Heater, Vent and A/C Mode Performance	Shop

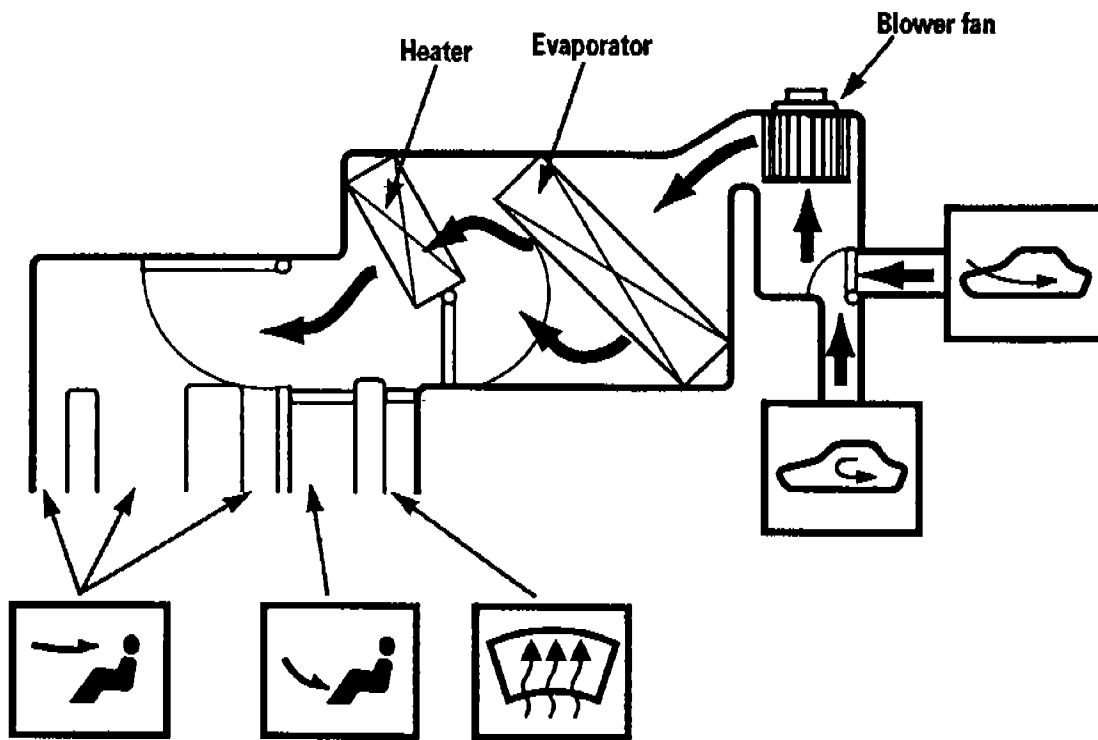
Fresh Air/Recirculated Air Door



- Adjust to allow outside air entry
- Adjust to recirculate interior air
- Produces maximum A/C efficiency by recirculating cool dehumidified air
- **MAX COOL** automatically adjusts door to recirculate

Notes: _____

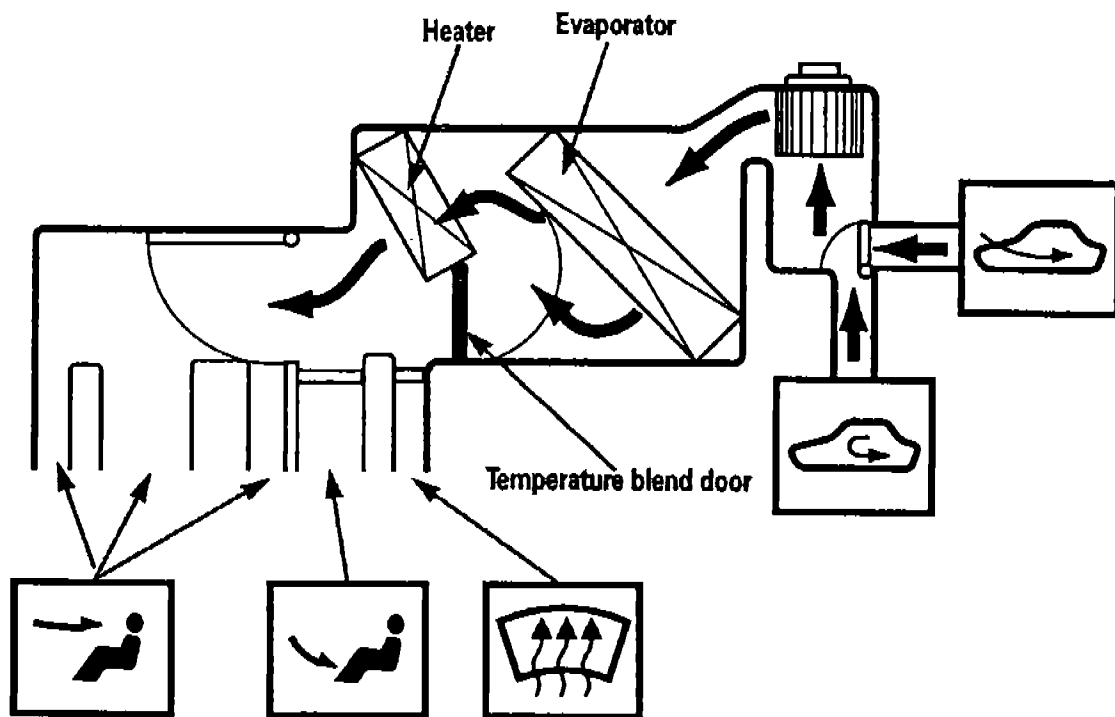
Blower Fan



- Mechanically forces airflow through the system
- Variable speeds allow adjustments to suite needs

Notes: _____

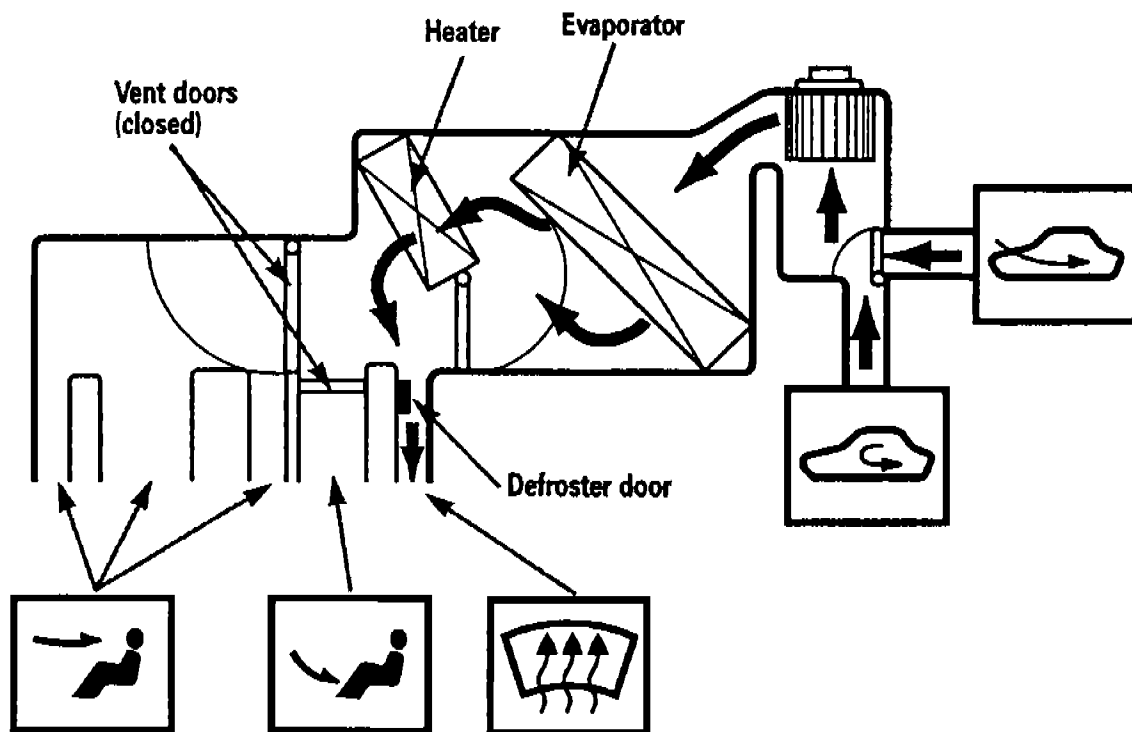
Temperature Blend Door



- Allows airflow through the heater core
- Variable positioning of door "blends" hot and cool air to a comfortable level
- Proper adjustment of the door is important to system performance

Notes: _____

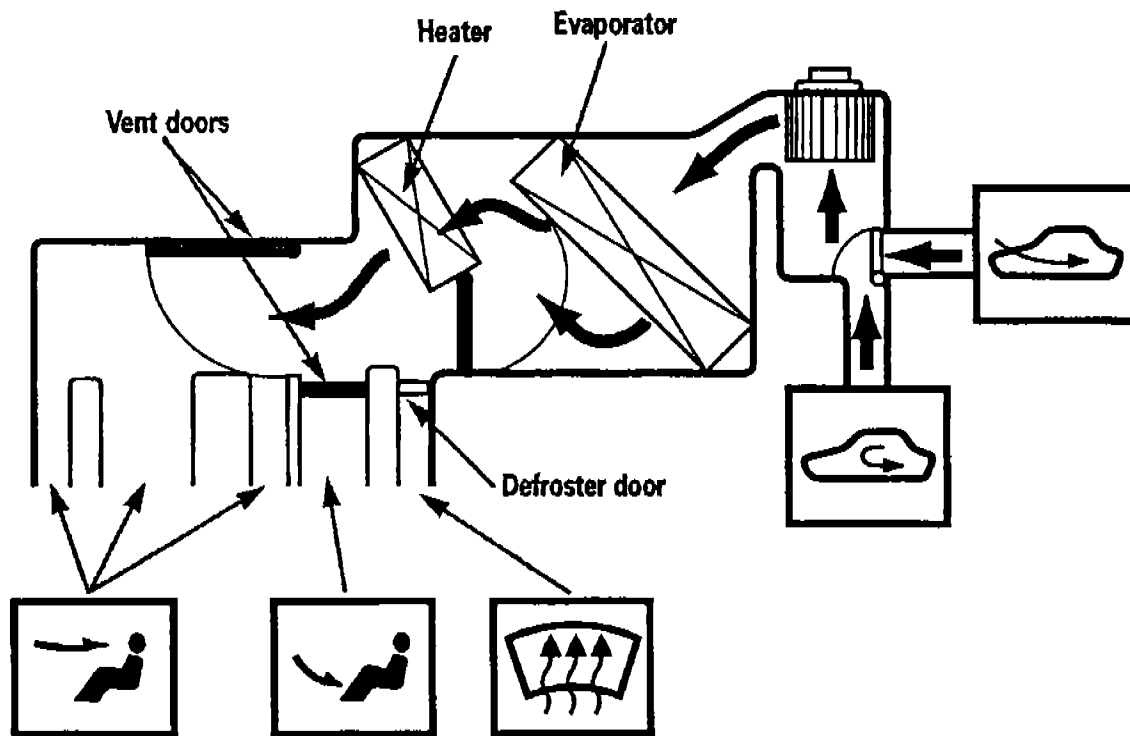
Defroster Door



- In defrost mode maximum air flow is directed at the windshield
- On newer systems, defrost mode is the default if a failure occurs
- In defrost mode, the floor and upper vents close

Notes: _____

Vent/Face and Heater Doors



- Controls airflow to the upper (face) and floor vents
- BI-Level mode directs airflow to face and floor vents at the same time

Notes: _____



Technician Name _____

HEATER, VENT AND A/C (HVAC) MODE PERFORMANCE

Purpose: In this activity, you will observe normal HVAC performance. Understanding exactly what to expect will eliminate unnecessary diagnostic time.

What you will need to complete this activity:

- Current Model Vehicle
- A/C Vent Thermometer
- Wall Thermometer/Humidity Gauge
- Owner Manual

Place a thermometer in the center discharge duct. Record output temperatures in different modes and fill in the information below.

1. The temperature in the shop is _____ °F

2. The relative humidity in the shop is _____ %

Vehicle being tested: _____

At normal operating temperature and engine at idle, place the fan switch to second speed, and air intake lever to 'Fresh.' Adjust temperature level to about 10-15 degrees above shop temperature. As a precaution, position floor fan in front of the radiator to simulate air being forced through the condenser and radiator.

Operate the A/C following the Owner's Manual instructions. While adjusting only the "Mode" lever, answer the following questions.

3. The operating sound level is higher when the lever is set to Fresh or Recirculate?

4. If the mode selector is set to the Floor position, is there any air going to another position?
☐ Yes ☐ No

If yes, where? _____

5. Does the A/C compressor automatically come on with the heat lever in the Hot position, while in the Defrost mode?

☐ Yes ☐ No

6. In very cold weather, what is the preferred method for defogging the inside windows?

Instructor Sign-Off:

Now that you have completed this activity, you should be able to:

- Understand and operate heater, vent and AC modes

This skill will help you explain normal operation to customers.

Instructor's initials:

Automatic Temperature Control

OBJECTIVES

After completing this section, you will be able to:

- Explain the function of Automatic Temperature Control (ATC) systems
- Describe the major components of an ATC system
- Explain ATC self-diagnostics function

Activities in this section:

Activity #	Description	Location
U-10	Automatic Temperature Control System Check	Shop
U-11	Output Device Performance Check	Shop

AUTOMATIC TEMPERATURE CONTROL

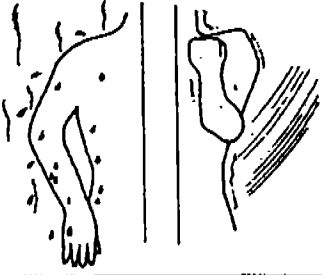
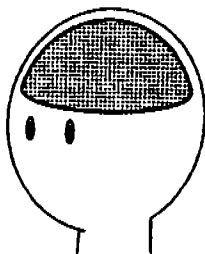
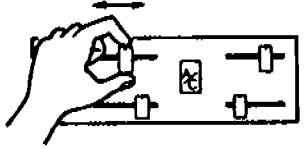
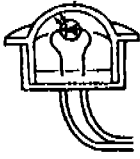
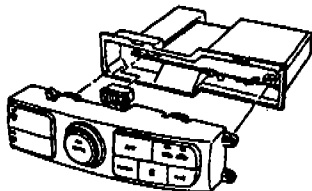

The automatic climate control system maintains a pre-selected temperature, despite outside or internal influences, without driver intervention.

The only Mazda currently equipped with Automatic Temperature Control (ATC) is the Millenia.

For the most efficient diagnosis, separate the refrigeration system from the control system.

Notes: _____

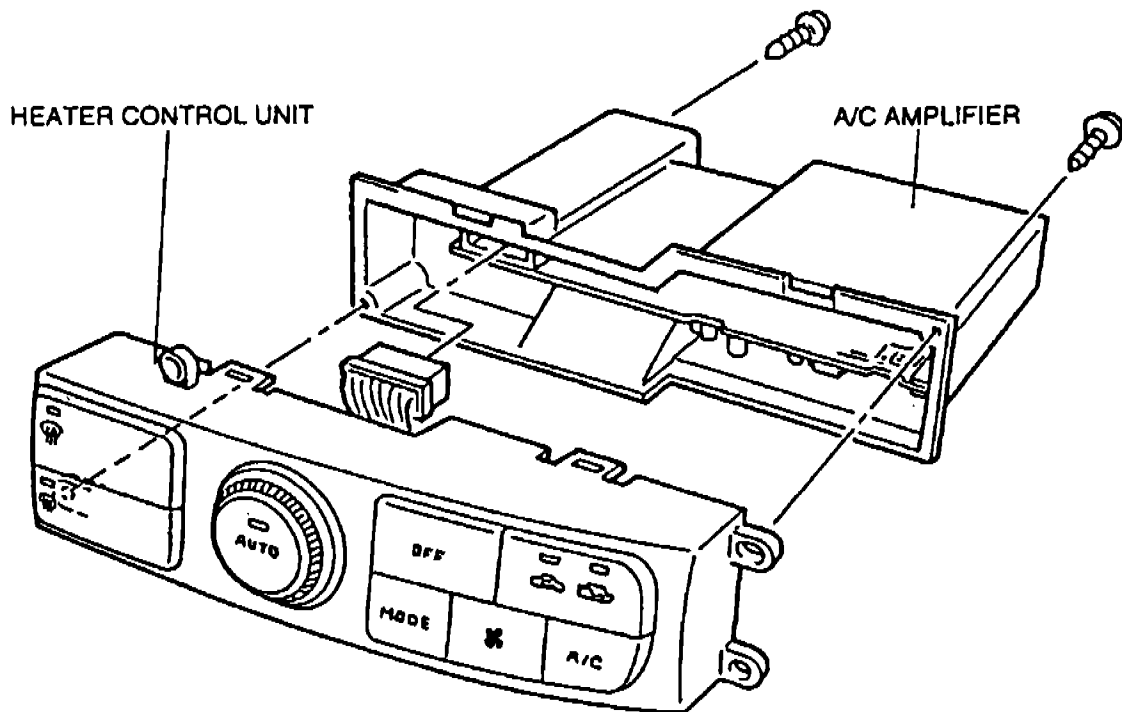
AUTOMATIC TEMPERATURE CONTROL

TYPE	INPUT	CONTROL	OUTPUT
MANUAL AIR CONDITIONER	BODY TEMPERATURE 	BRAIN 	HAND 
AUTO AIR CONDITIONER	SENSOR 	A/C AMPLIFIER 	ACTUATOR etc. 

- Compare the operation and control of manual and automatic systems
- Input and output devices are the key components of a Automatic Temperature Control system

Notes: _____

A/C Amplifier

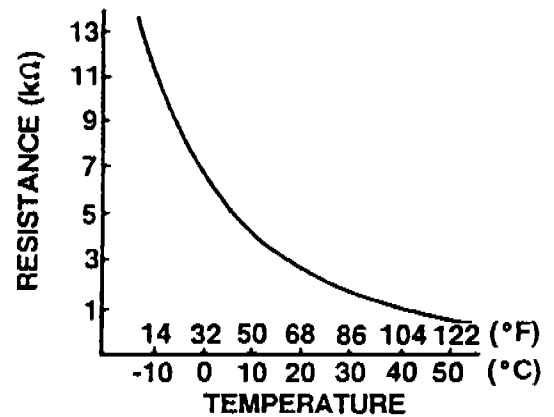
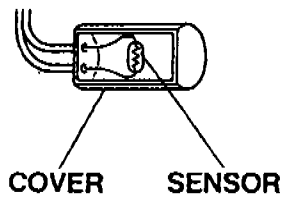
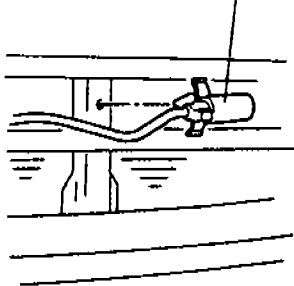


- The A/C amplifier receives information from the inputs and adjusts the outputs to control interior comfort
- The A/C amplifier monitors the system and stores diagnostic trouble codes

Notes: _____

Ambient Temperature Sensor (Input)

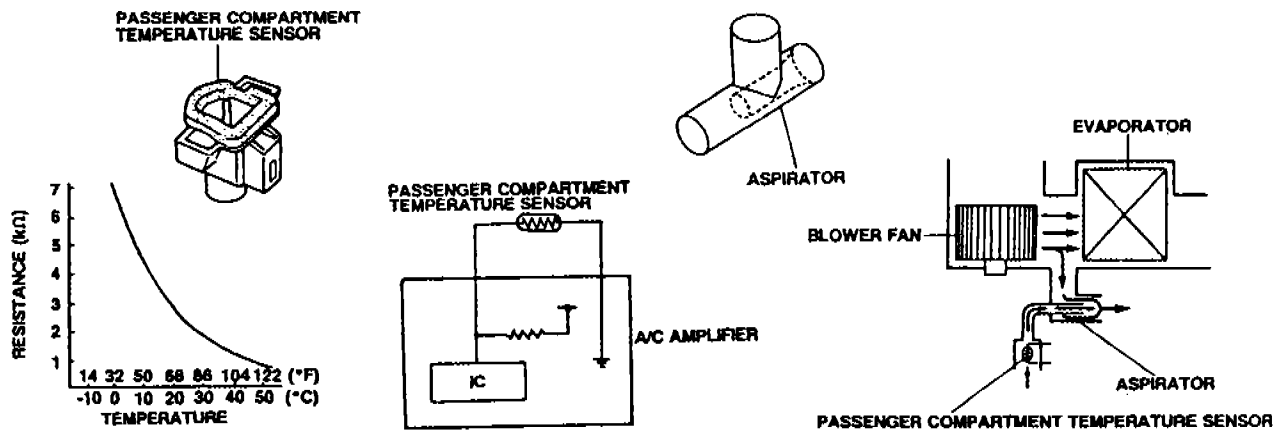
AMBIENT TEMPERATURE SENSOR



- As temperature increases, resistance decreases
- The A/C amplifier calculates ambient temperature based on the voltage drop across the resistance.

Notes: _____

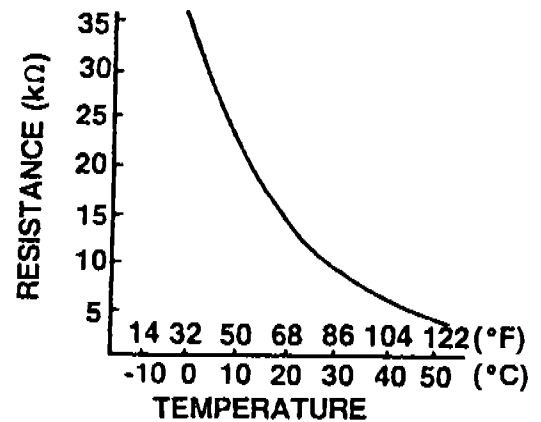
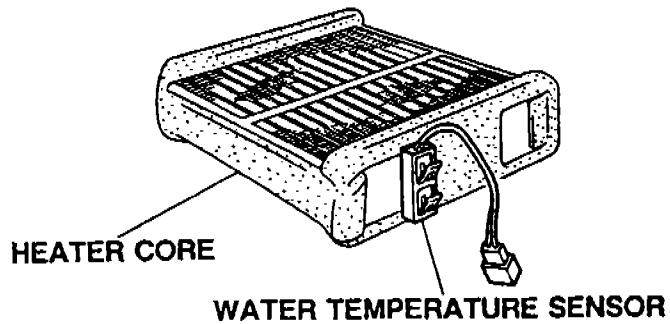
Passenger Compartment Temperature Sensor (Input)



- Communicates passenger compartment temperature to the A/C amplifier
- If the preset temperature is different from the actual temperature, the amplifier adjusts the air mix door

Notes: _____

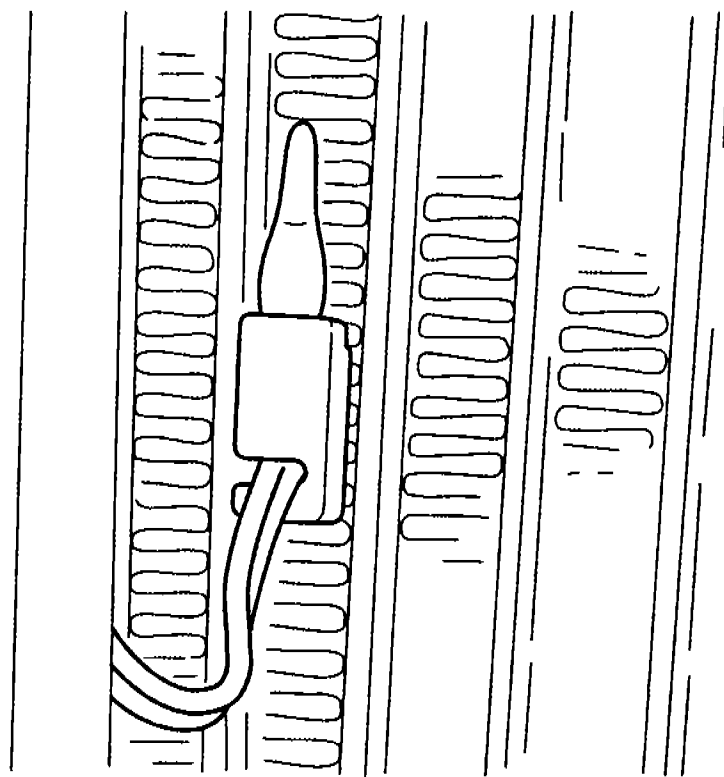
Water Temperature Sensor (Input)



- Communicates heater core temperature to the amplifier to prevent the blower fan from coming on when the coolant temperature is below a comfortable temperature

Notes: _____

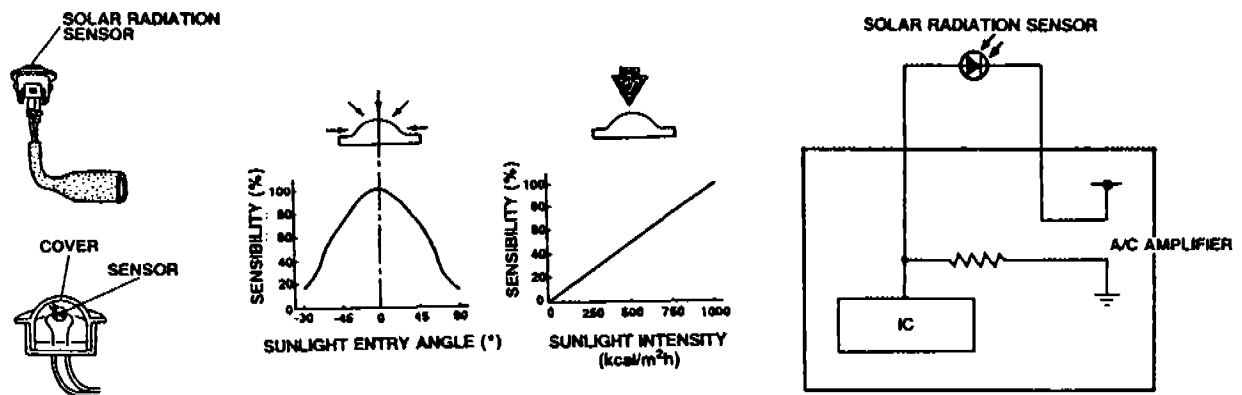
Evaporator Temperature Sensor (Input)



- Measures the temperature of the air passing through the evaporator core
- Prevents evaporator freeze-up by signaling the A/C amplifier to turn off the compressor

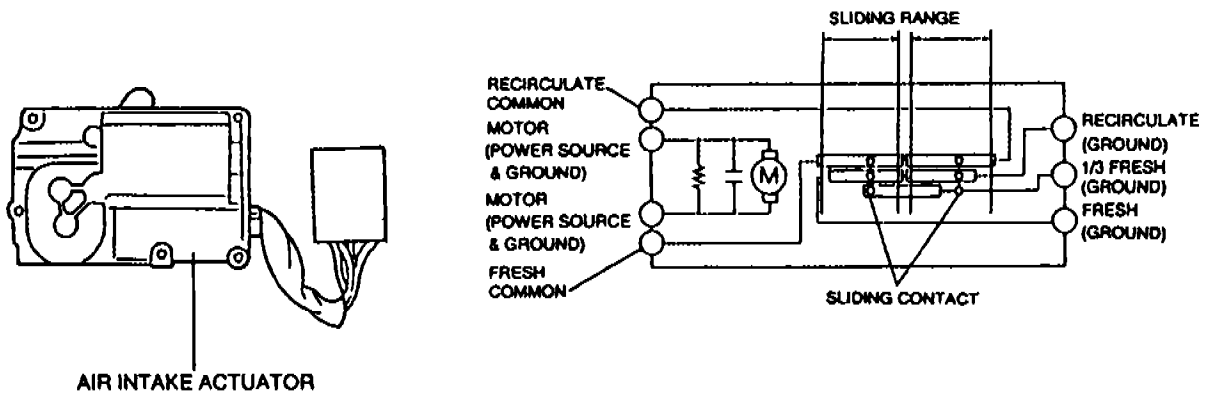
Notes: _____

Solar Radiation Sensor (Input)



- A photo diode creates a signal related to the sun's intensity and sends it to the amplifier.
- If the sensor is covered, there will be a noticeable drop in performance

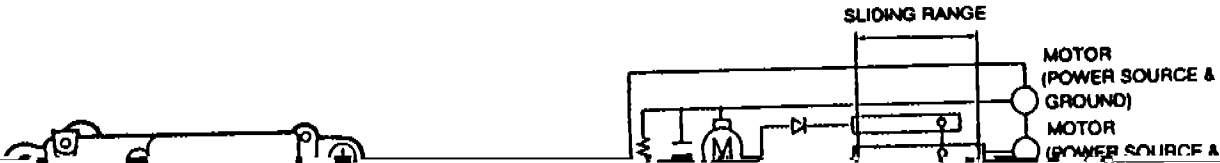
Air Intake Actuator (Output)



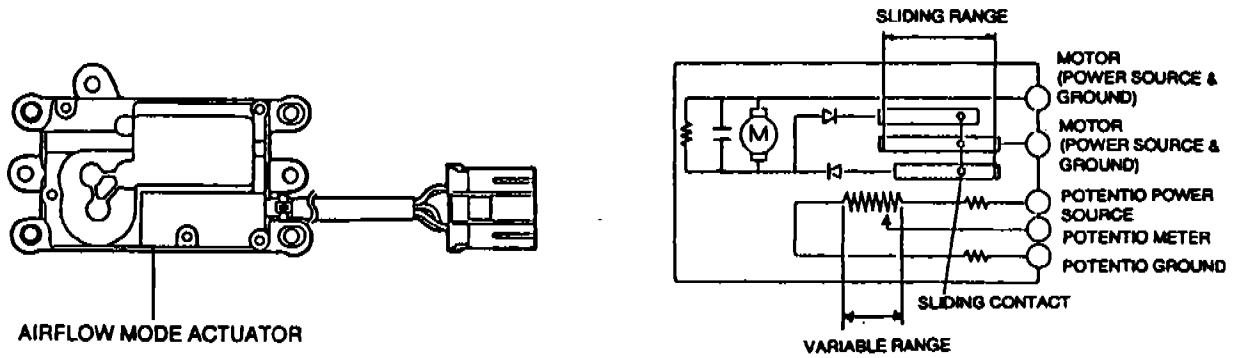
- Electronic version of the Fresh/Recirc lever
- Sliding electrical contacts control motor position
- Motor Positions: Fresh, 1/3 Fresh, Recirculate

Notes: _____

Air Mix Actuator (Output)



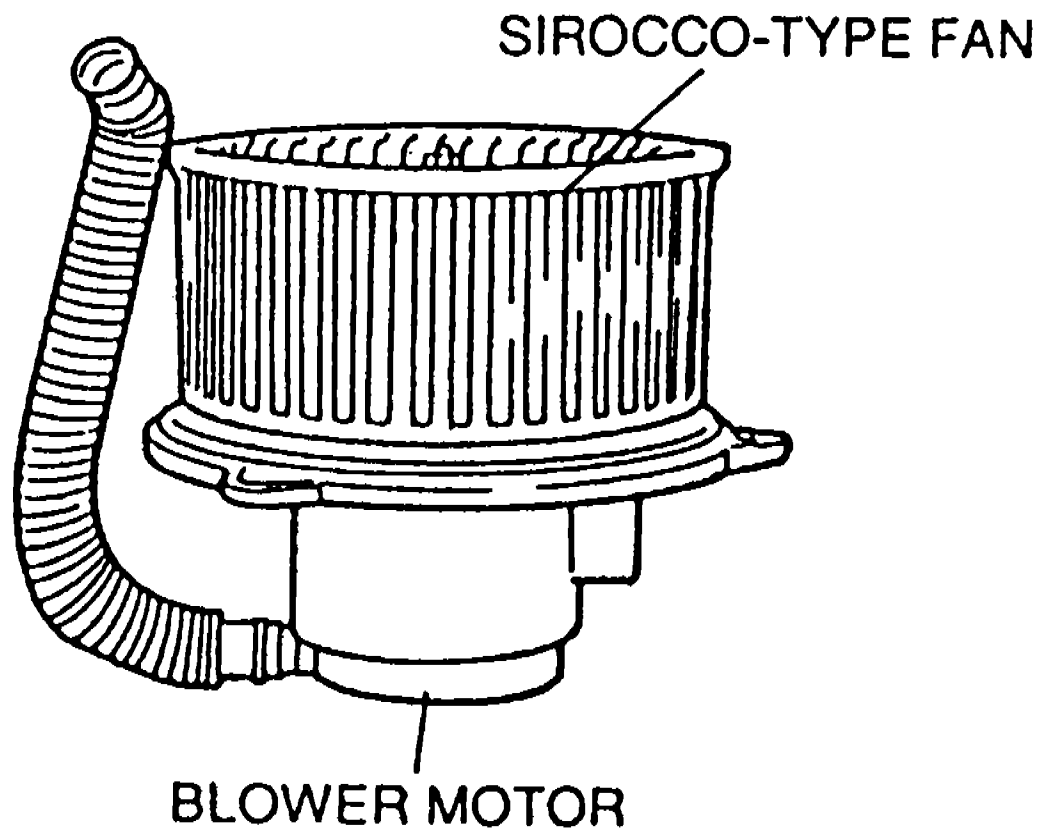
Airflow Mode Actuator (Output)



- The mix and mode actuators are activated similarly
- Total door position angle is 90 degrees of rotation

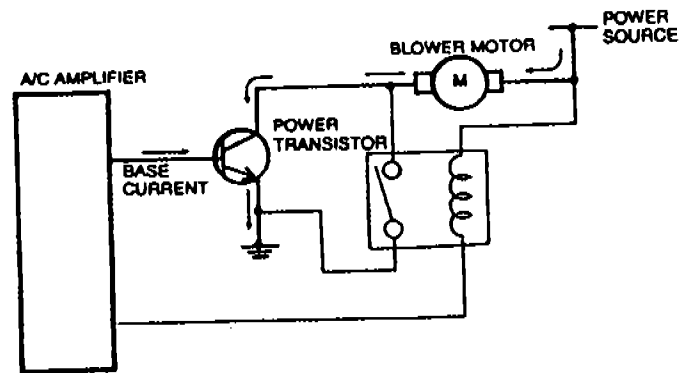
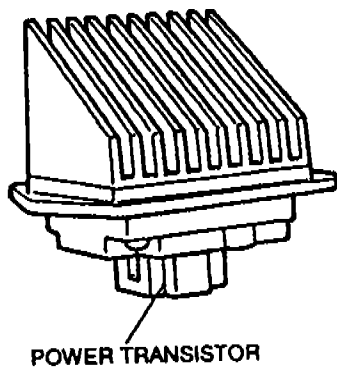
Notes: _____

Blower Motor (Output)



The Sirocco type fan rotates at required speed in response to the amount of power

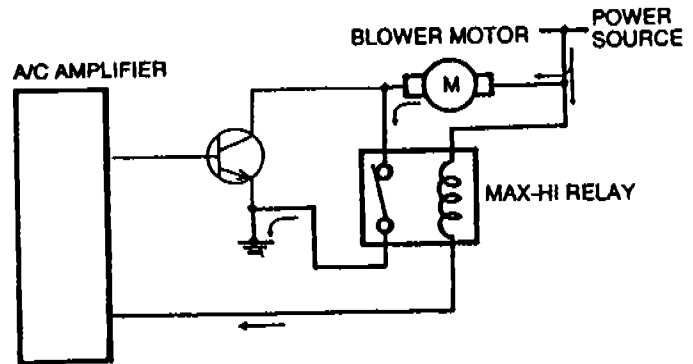
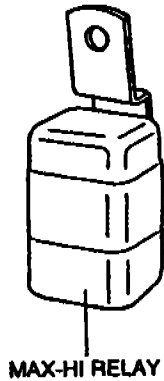
Power Transistor (Output)



- Amplifier sets fan speed by regulating base current to the power transistor
- In AUTO mode, 32 fan speeds are possible

Notes: _____

Max-High Relay (Output)



- Amperage at maximum fan speed can damage the power transistor
- The relay bypasses the power transistor to give maximum fan speed

Notes: _____

ON-BOARD DIAGNOSTICS (Output)

- Because of the complexity of the control strategy an on-board diagnostic function has been programmed into the A/C amplifier. This allows easy diagnosis of defective circuits and components.
- The New Generation Star (NGS) tester is used to diagnose the automatic temperature control system.
- To diagnose the air-conditioner module, the NGS tester with MECS adapter is connected to the underhood data link connector (DLC1).

Notes: _____

Technician Name: _____

Performing an Automatic Temperature Control (ATC) System Check

Purpose: In this activity you will use a NGS tester to retrieve A/C system diagnostic trouble codes.

What you will need to complete this activity:

- Mazda Millenia
- Workshop Manual
- Wiring Diagram
- New Generation Star (NGS) tester (49 T088 0A0) with Super MECS adapter (49 T088 003) and cable adapter (49 T088 05)

Checking for present Diagnostic Trouble Codes (DTC)

1. Bring the vehicle to operating temperature.
2. Connect the NGS tester to the underhood data link connector and the battery.
3. Set the Super MECS Adapter to AUX1.
4. Select "Vehicle & Engine Selections" on the NGS display and then select the vehicle model, engine type, and model year.
5. Select "Diagnostic Data Link" on the NGS display.
6. Select "A/C-Air Conditioner Module" on the display.
7. Select "Diagnostic Test Mode" on the NGS display.
8. Start the on-board diagnostic function by pressing the "start" button on the display.
9. Press Trigger when the NGS displays "set the super MECS adapter to the AUX 1 position, warm up the engine"

Note:

To prevent a false code 2 from being set, the solar radiation sensor must be lit by sunlight or infrared lamp.

1. What trouble code did the NGS tester display? _____
2. What is the trouble code definition? _____

Refer to the "Diagnostic trouble code table" in the workshop manual.

3. What flowchart number should be followed to diagnose the system? _____
4. What electrical check are you performing in step one of the flowchart? _____

5. When the "diagnostic test mode" was entered, what happen to the heater control display?

6. What settings always return to the heater control panel after exiting the "diagnostic test mode"?

Checking for past Diagnostic Trouble Codes

The AC amplifier can store information on past failures such as intermittent opens or shorts. The past DTC are checked by pressing the A/C button during the NGS diagnostic mode. To access the past codes perform the following:

Checking Procedure:

1. Bring the vehicle to operating temperature.
2. Connect the NGS tester to the underhood data link connector and the battery.
3. Set the Super MECS Adapter to AUX1.
4. Select "Vehicle & Engine Selections" on the NGS display and then select the vehicle model, engine type, and model year.
5. Select "Diagnostic Data Link" on the NGS display.
6. Select "A/C-Air Conditioner Module" on the display.
7. Select "Diagnostic Test Mode" on the NGS display.
8. Start the on-board diagnostic function by pressing the "start" button on the display.
9. Press Trigger when the NGS displays "set the super MECS adapter to the aux 1 position, warm up the engine"
10. Press the "A/C" button on the heater control unit.
11. Record any DTC that are displayed.

Were any DTCs stored in memory? _____

12. Press the "A/C" button again to exit the past DTC retrieval.

Note:

Exiting past code retrieval returns diagnostics to present mode.

13. Press the NGS "cancel" button to exit diagnosis completely.

Clearing Diagnostic Trouble Codes.

After repairing the vehicle make sure diagnostic trouble codes are cleared. If they are not cleared, incorrect diagnosis could occur in the future.

1. Bring the vehicle to operating temperature.
2. Connect the NGS tester to the underhood data link connector and the battery.
3. Set the Super MECS Adapter to AUX1.
4. Select "Vehicle & Engine Selections" on the NGS display and then select the vehicle model, engine type, and model year.
5. Select "Diagnostic Data Link" on the NGS display.
6. Select "A/C-Air Conditioner Module" on the display.
7. Select "Diagnostic Test Mode" on the NGS display.
8. Start the on-board diagnostic function by pressing the "start" button on the display.
9. Press Trigger when the NGS displays "set the super MECS adapter to the aux 1 position, warm up the engine"
10. Press the "A/C" button on the heater control unit.
11. Press the "Auto" and "Rec/Fresh" switch on the heater control unit at the same time.
12. The codes are now cleared and a "1" will appear on the NGS display.

Instructor Sign-off:

Now that you have completed this activity, you should be able to:

- Retrieve present Automatic Temperature Control (ATC) trouble codes.
- Retrieve past ATC diagnostic trouble codes.
- Perform ATC system repairs.
- Clear diagnostic trouble codes.

These skills will help you accurately diagnose an Automatic Temperature Control system.

Instructor's initials:



Technician Name: _____

Output Device Operation Performance Check

Purpose: In this activity you will use a NGS tester and the on-board diagnostic functions to check the Automatic Temperature Control (ATC) system output devices.

What you will need to complete this activity:

- Mazda Millenia
- Workshop Manual
- New Generation Star (NGS) tester (49 T088 0A0) with Super MECS adapter (49 T008 003) and cable adapter (49 T088 05)

Checking Output Device Operation

1. Bring the vehicle to operating temperature.
2. Connect the NGS with Super MECS Adapter to the underhood data link connector and the battery.
3. Set the Super MECS adapter to AUX1.
4. Select "Vehicle & Engine Selections" on the NGS display and then select the vehicle, model, engine type, and model year.
5. Select "Diagnostic Data Link" on the NGS display.
6. Select "A/C Air Conditioner Module" on the display.
7. Select "Diagnostic Test Mode" on the NGS display.
8. Start the on-board diagnostic function by pressing the "start" button on the display.
9. Press Trigger when the NGS displays "set the super MECS adapter to the AUX 1 position, warm up the engine"
10. With the NGS in diagnostic test mode press the "AUTO" button on the heater control unit.

What did the heater control unit lights do when the "AUTO" button was pressed?

What is the purpose of this test?

11. Press "AUTO" and "REC/FRESH" at the same time to switch to the next output mode test.

What output test device is operating?

12. Press "AUTO" and "REC/FRESH" at the same time to switch to the next output test mode.

What output test device is operating?

13. Press "AUTO" and "REC/FRESH" at the same time to switch to the next output test mode.

What output test device is operating?

14. Press "AUTO" and "REC/FRESH" at the same time to switch to the next output test mode.

What 3 output test devices are operating?

Instructor Sign-off:

Now that you have completed this activity, you should be able to:

- Use the NGS and on-board diagnostics to activate the Automatic Temperature Control self test.
- Verify normal system operation.
- Locate diagnostic charts within the workshop manual.

These skills will help you accurately diagnose an Automatic Temperature Control system.

Instructor's initials: