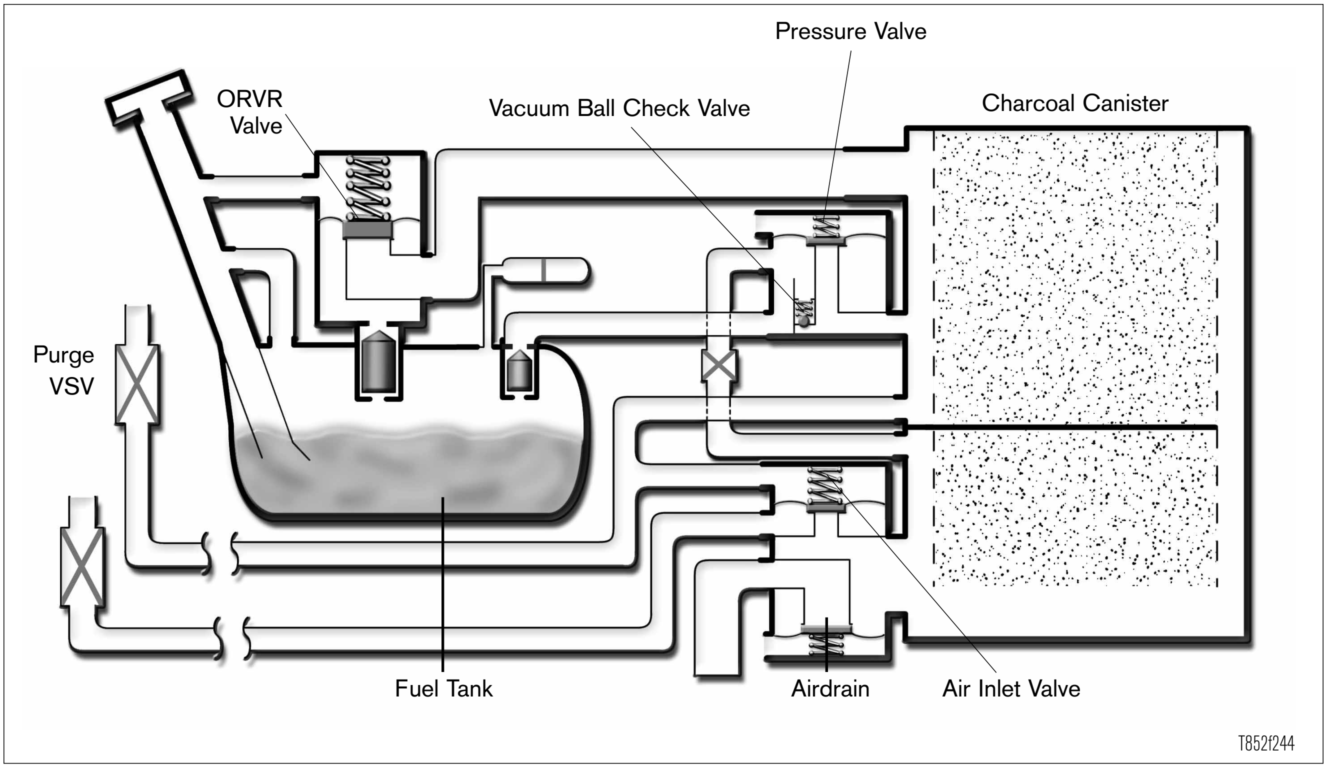
Evaporative Emission Control Systems



Lesson Objectives

1. Determine the condition of the EVAP system operation based on engine data
2. Determine the condition of the EGR system based on engine data
3. Determine the root cause of a failure(s) in the EGR system using appropriate diagnostic procedures

Notes

EMISSION SYSTEMS

Evaporative Emissions Control Systems

Approximately 20% of all hydrocarbon (HC) emissions from the automobile originate from evaporative sources. The Evaporative Emission Control (EVAP) system is designed to store and dispose of fuel vapors normally created in the fuel system and prevent their escape to the atmosphere.

The EVAP system is a fully closed system designed to maintain stable fuel tank pressures without allowing fuel vapors to escape to the atmosphere. Fuel vapor is normally created as fuel temperature rises. It is then transferred to the EVAP system charcoal canister as tank vapor increases. When the engine can tolerate additional enrichment, these stored fuel vapors are purged into the intake manifold and added to the incoming air/fuel mixture.

There are two basic types of evaporative emission control systems: **Non-ECM controlled EVAP systems** use solely mechanical control devices to collect and purge stored fuel vapors. Typically, these systems use a ported vacuum purge port and a Thermo Vacuum Valve (TVV) to prohibit cold engine operation.

ECM controlled EVAP systems use a manifold vacuum purge source in conjunction with a duty cycled Vacuum Switching Valve (VSV). This type of EVAP system has the ability to provide more precise control of purge flow volume and inhibit operation. This is the only type on current models.

Non-ECM Controlled EVAP System

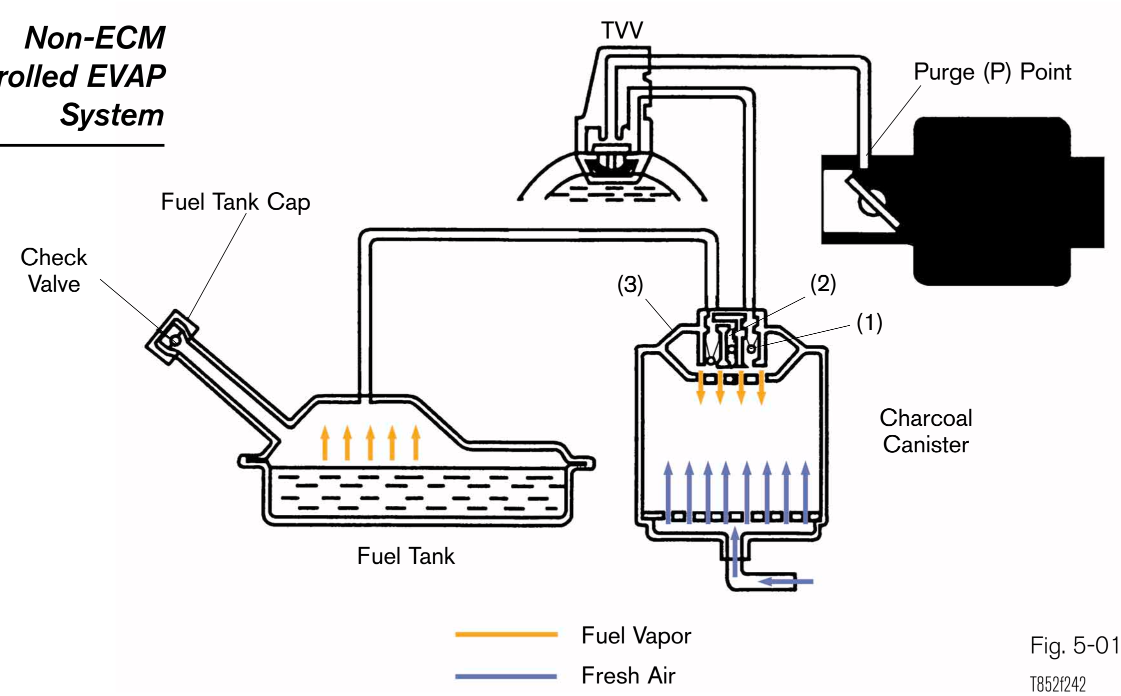


Fig. 5-01

T852f242

Non-ECM Controlled EVAP Systems

Non-ECM controlled EVAP systems typically use the following components:

- Fuel tank.
- Fuel tank cap (with vacuum check valve).
- Charcoal canister (with vacuum & pressure check valves).
- Thermo Vacuum Valve (TVV).
- Ported vacuum purge port (port P; on throttle body).

Under some conditions, the fuel tank operates under a slight pressure to reduce the possibility of pump cavitation due to fuel vaporization. Pressure is created by unused fuel returning to the tank and is maintained by check valve No. 2 in the charcoal canister and the check valve in the fuel tank cap.

Under other conditions; as fuel is drawn from the tank, a vacuum can be created in the tank causing it to collapse. This is prevented by allowing atmospheric pressure to enter the tank through check valve No. 3 in the charcoal canister or the fuel tank cap check valve. The EVAP system is designed to limit maximum vacuum and pressure in the fuel tank in this manner.

When the engine is running, stored fuel vapors are purged from the canister whenever the throttle has opened past the purge port (port P) and coolant temperature is above a certain point (usually around 54°C (129°F)). Fuel vapors flow from the high pressure area in the canister, past check valve No.1 in the canister, through the Thermo Vacuum Valve (TVV), to the low pressure area in the throttle body. Atmospheric pressure is allowed into the canister through a filter located on the bottom of the canister. This ensures that purge flow is constantly maintained whenever purge vacuum is applied to the canister. When coolant temperature falls below a certain point–usually around 35°C (95°F), the TVV prevents purge from taking place by blocking the vacuum signal to check valve No.1.

ECM Controlled EVAP System

The Purge VSV is duty ratio controlled by the ECM.

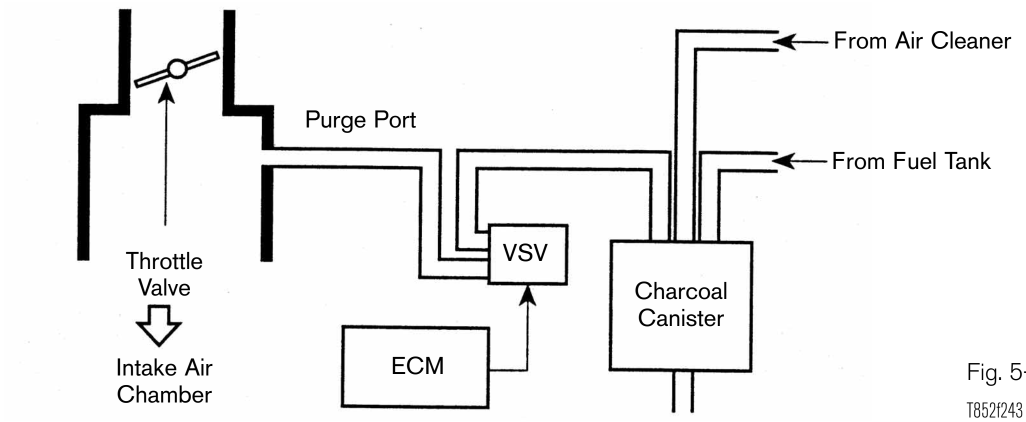


Fig. 5-02
T852f243

ECM Controlled EVAP Systems

ECM controlled EVAP systems were introduced to provide a more precise control and maintain driveability. The ECM will adjust the fuel injection duration based on oxygen sensor or air/fuel ratio sensor signal.

ECM controlled EVAP systems typically use the following components:

- Fuel tank.
- Fuel tank cap (with vacuum check valve).
- Charcoal canister (with vacuum & pressure check valves).
- Purge VSV (manifold vacuum purge port).
- Early ECM EVAP systems used a ported vacuum purge port with in-line check valve (port A; on throttle body).

When the engine has reached predetermined parameters (closed loop, engine temp. above 52°C (125°F), stored fuel vapors are purged from the canister whenever the purge VSV is opened by the ECM. At the appropriate time, the ECM will turn on the purge VSV. This will allow the low pressure in the intake manifold to draw the fuel vapors out of the charcoal canister. The vapors will then be burned in the combustion chamber.

The ECM will change the duty ratio cycle of the purge VSV thus controlling purge flow volume. Purge flow volume is determined by manifold pressure and the duty ratio cycle of the purge VSV. Atmospheric pressure is allowed into the canister to ensure that purge flow is constantly maintained whenever purge vacuum is applied to the canister.

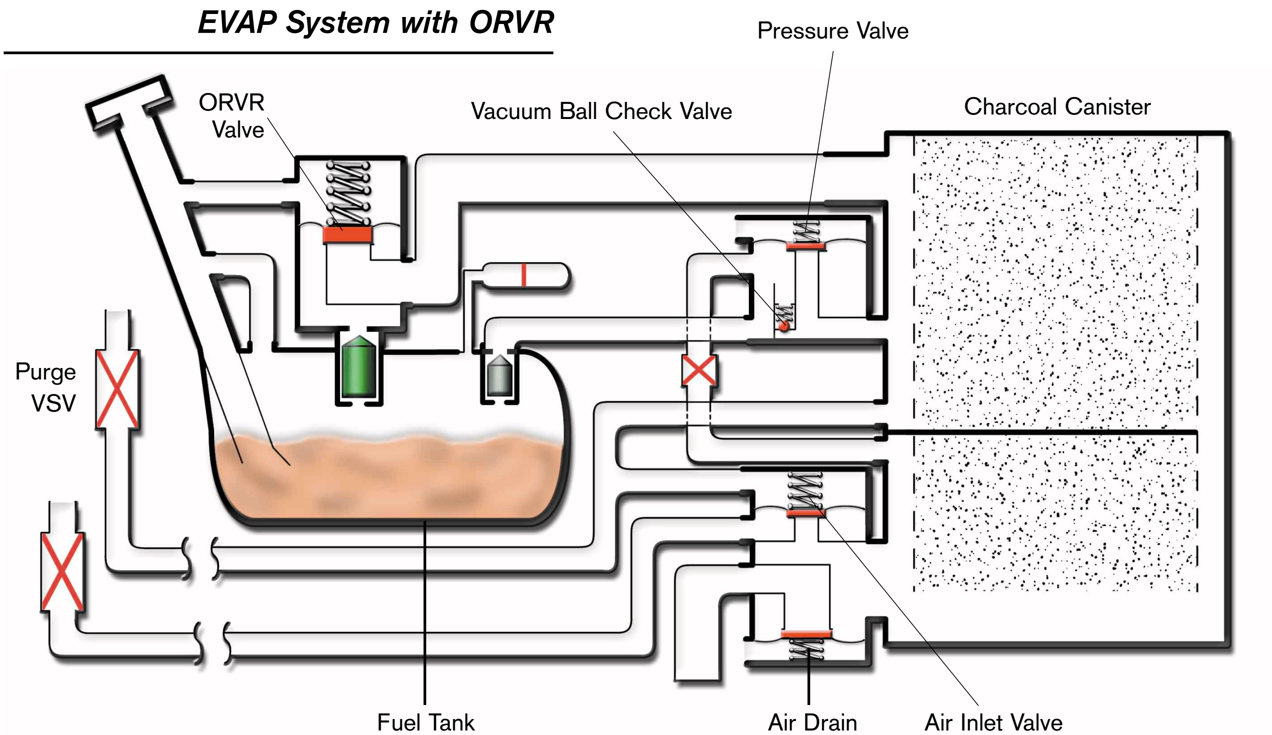


Fig. 5-03

T852f244

Condition	Purge Port	Air Inlet Valve	Tank Vacuum Ball Check	Tank Pressure Port	Fill Check Valve	Air Drain
VSV Purge Valve On	OPEN (V)	OPEN (V)	CLOSED	CLOSED	CLOSED	CLOSED
VSV Purge Valve Off	CLOSED (NV)	CLOSED (NV)	CLOSED	CLOSED	CLOSED	CLOSED
Pressure In Tank	CLOSED	CLOSED	CLOSED	OPEN	CLOSED	CLOSED
Vacuum In Tank			OPEN	CLOSED	CLOSED	CLOSED
Refill			CLOSED	CLOSED	OPEN	OPEN

Charcoal Canister The charcoal canister is filled with activated charcoal. This charcoal has the ability to absorb gasoline vapors and release these vapors when fresh air passes through the canister. Mounted on the charcoal canister are check valves to control vapor flow. The table on the previous page shows the action of each valve according to engine operation and fuel tank conditions.

Pressure in Fuel Tank

Fuel vapor pressure is vented into the charcoal canister when vapor pressure forces the tank pressure control valve open.

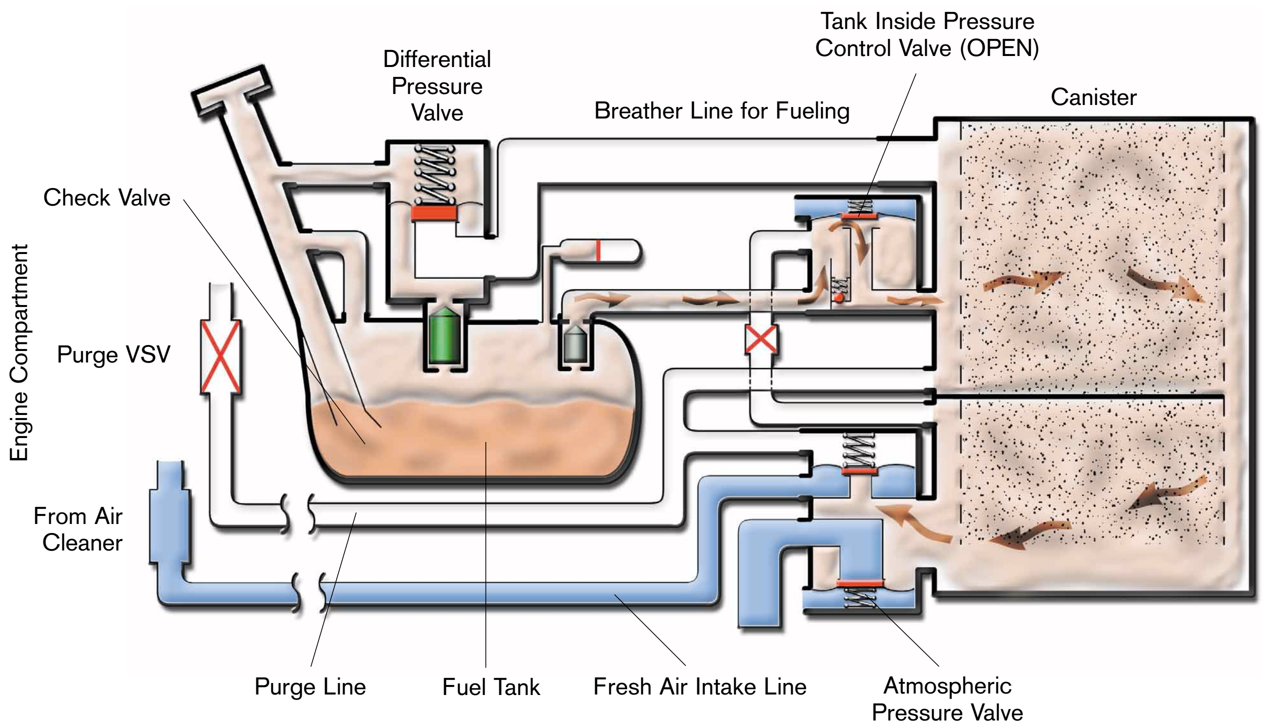
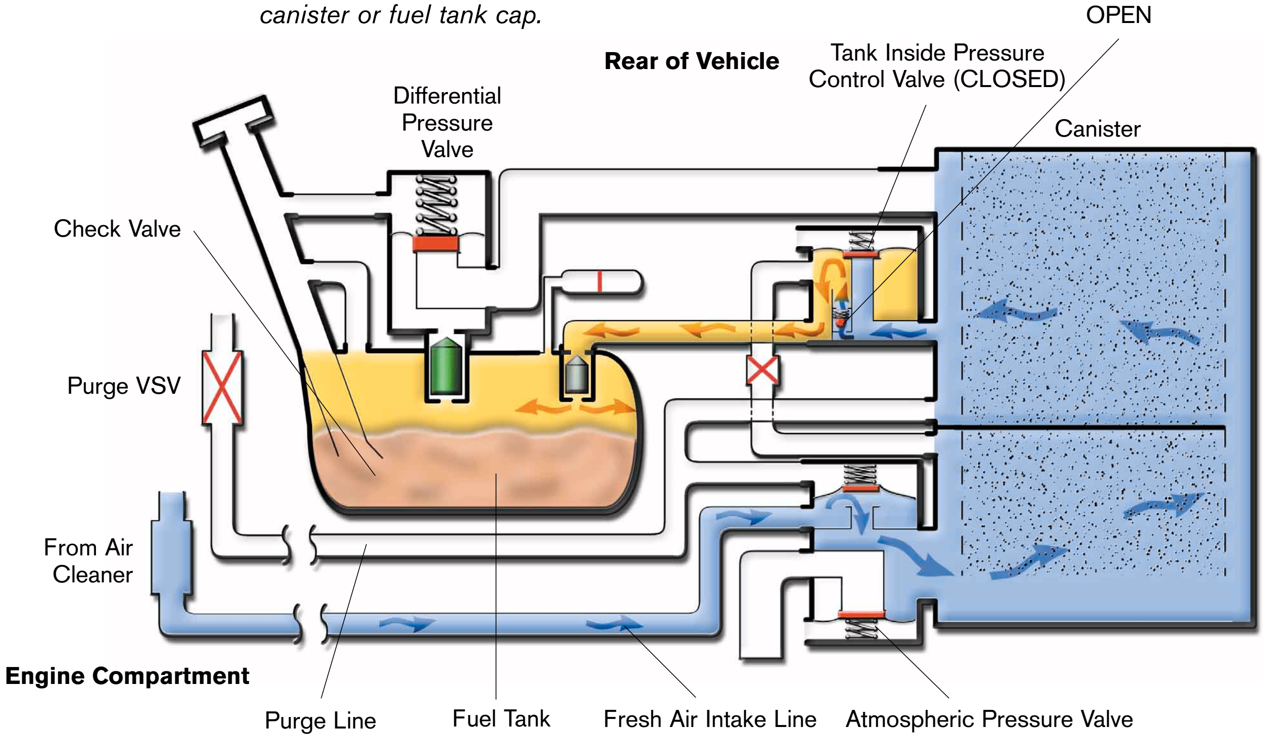


Fig. 5-04

T852f245

Vacuum in Fuel Tank

Vacuum in the tank can be relieved by allowing air to enter through the charcoal canister or fuel tank cap.



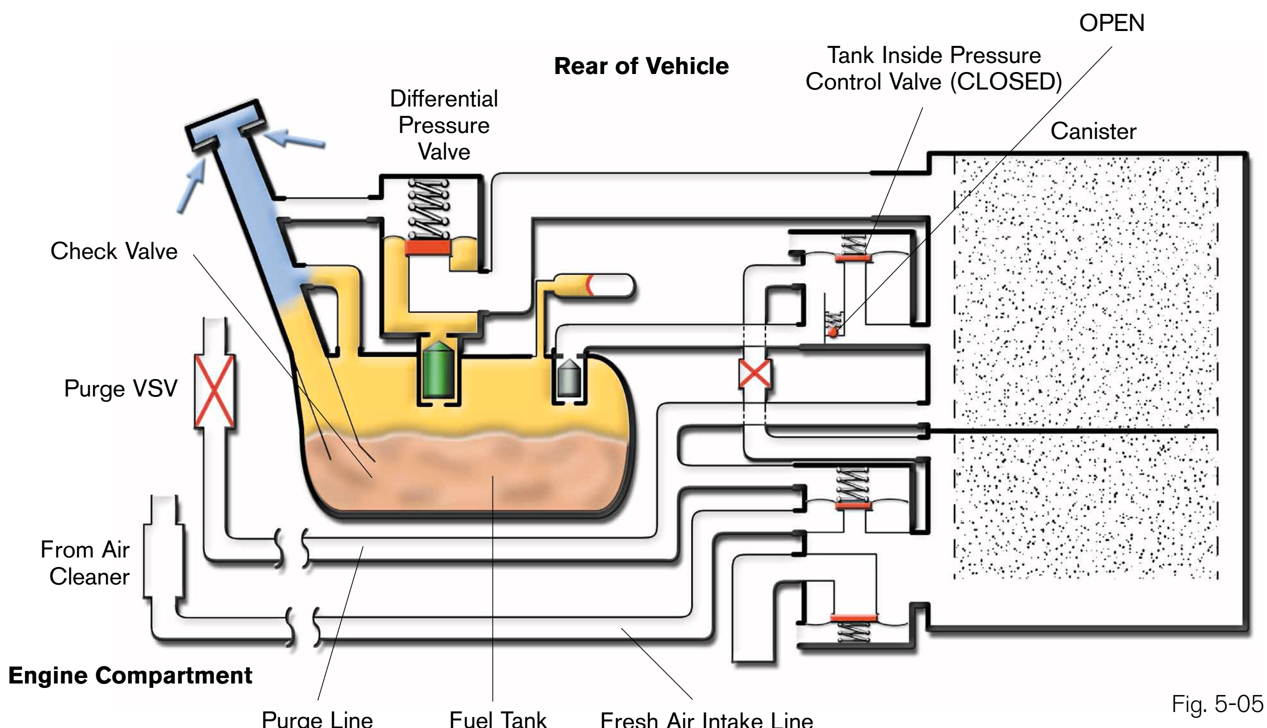


Fig. 5-05

T852f246/T852f334

Purge Mode

During purge, vapors are drawn out of canister and burned in the engine.

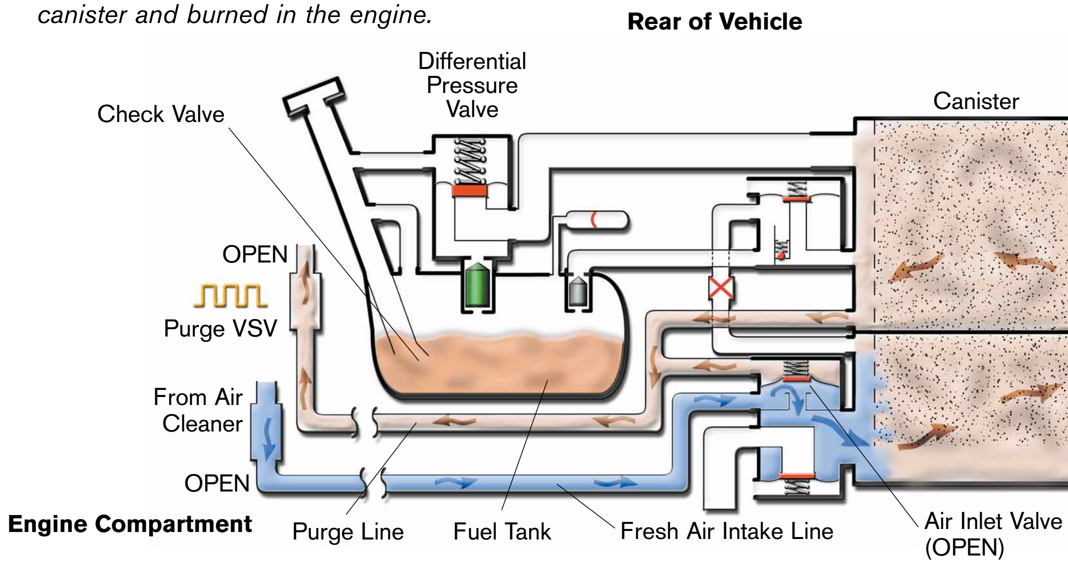


Fig. 5-06
T852f247

Refueling Mode

During refueling, the differential pressure valve and air drain valve are open. Fuel vapors are absorbed by the charcoal canister and excess air is vented to the atmosphere.

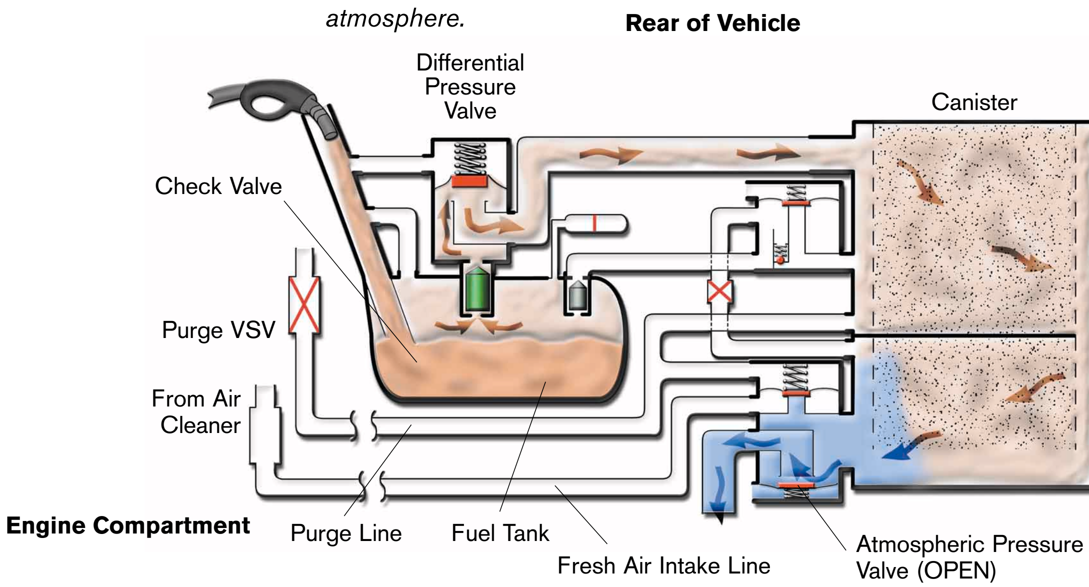


Fig. 5-07
T852f248

EVAP System Service

There is no routine maintenance for the EVAP system. It is critical that the proper diameter hoses and parts are used. Failure to do so can result in driveability problems. There are diagnostic procedures for checking the valves listed in the Repair Manual.

Exhaust Gas Recirculation System

The Exhaust Gas Recirculation (EGR) system is used for reducing oxides of nitrogen and for engine knock control. By recirculating a controlled amount of exhaust gases into the intake air-fuel mixture, combustion temperature is lowered. This, in turn, reduces the amount of NO_X emission.

Basic EGR System

Exhaust gases are directed to the intake manifold to lower oxides of nitrogen emissions.

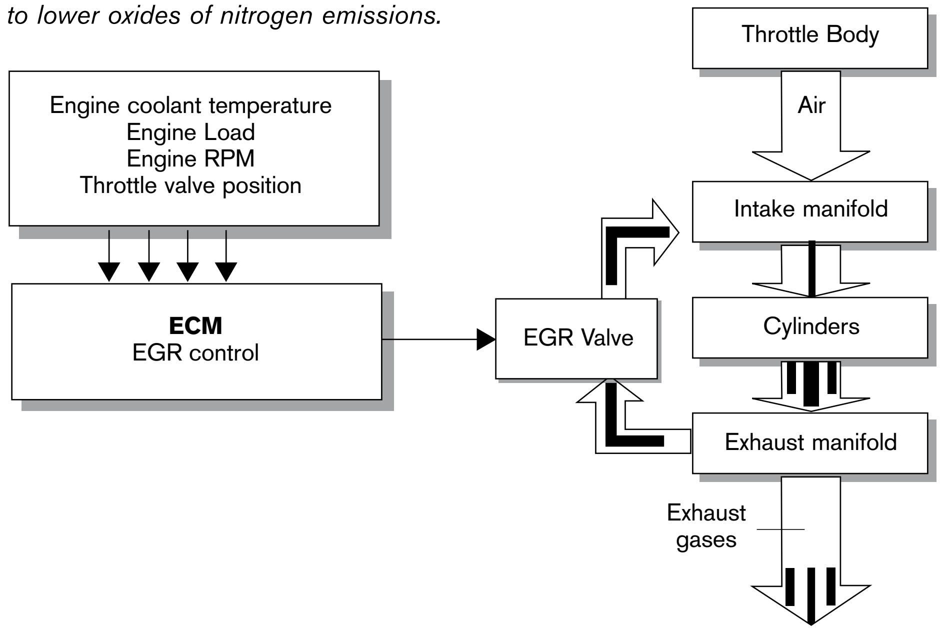


Fig. 5-08

T852f249

EGR Valve

When the EGR valve opens, exhaust gasses enter the intake manifold.

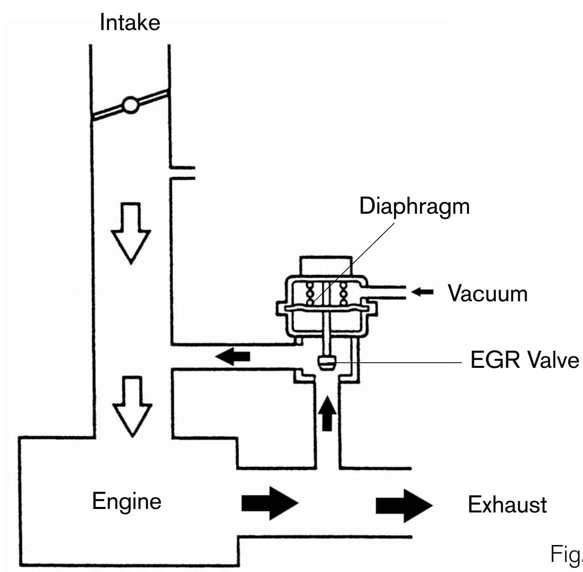


Fig. 5-09

T852f250

EGR Valve

Also, the exhaust gases help prevent engine knock and allow for more advanced ignition timing.

The EGR valve opens and closes the passage between the exhaust manifold and intake manifold. Vacuum is used to move the EGR valves.

Inside the vacuum actuated EGR valve is a valve, diaphragm, and spring. When vacuum is applied to the diaphragm the diaphragm lifts the valve off its seat allowing exhaust gases into the intake air stream. When vacuum is removed the spring forces the diaphragm and valve downward closing the exhaust passage.

For proper engine operation, the EGR valve must open to the proper height, and when closed seal the intake manifold from exhaust gases.

CAUTION The EGR valve can get very hot. Handle with care.

Cut-Off Control EGR System

EGR Operating (VSV OFF)

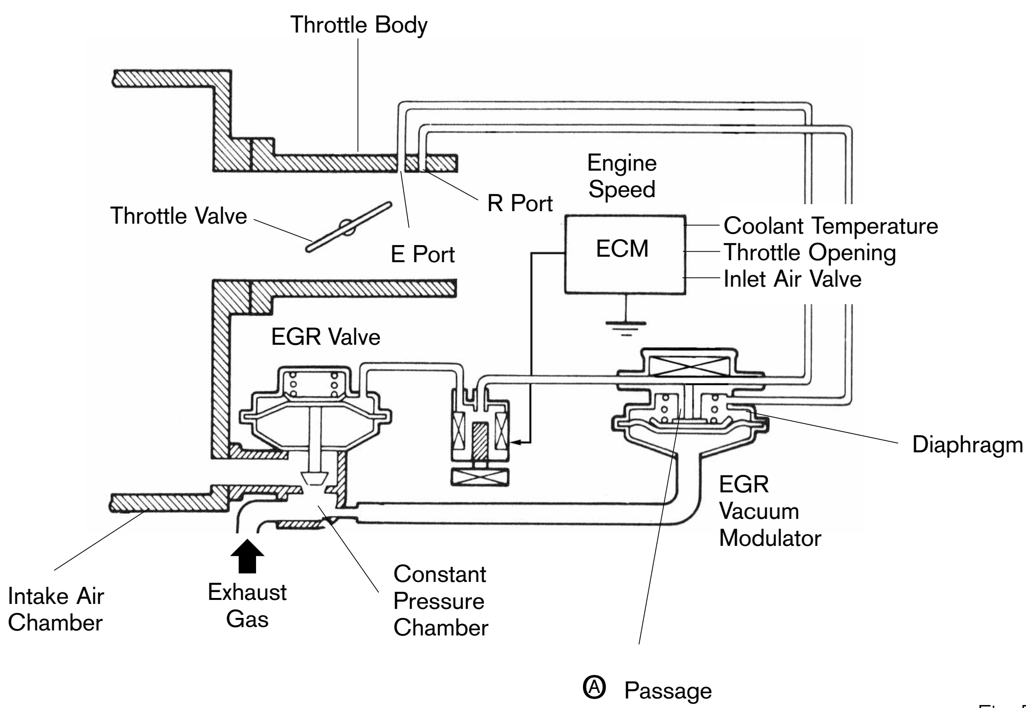


Fig. 5-10

T852f251

Cut-Off Control EGR System Operation

Some EGR valve's are water cooled and this is done to cool the exhaust gases. Cooling the exhaust gases increases the exhaust gases effectiveness in reducing NO_X and engine knock.

In the Cutoff Control EGR system, the amount of exhaust gas to be recirculated is controlled by the EGR vacuum modulator. The EGR modulator is needed because of the changes in engine vacuum and exhaust backpressure. The vacuum available at ports E and R changes with throttle opening. As the throttle valve opens and intake air volume/speed increases, the vacuum signals from ports E and R increases. As engine load increases the amount of exhaust backpressure increases.

For the above reasons, an EGR vacuum modulator controls the amount of vacuum reaching the EGR valve lifting the EGR valve to the correct height.

As determined by the ECM, the EGR VSV is closed to atmospheric pressure allowing the modulated vacuum to reach the EGR valve.

EGR Signal Logic Table

Port	Throttle Valve Opening	Vacuum Signal
E	Position Less than E Port	No Vacuum Present
E	Position More than E Port	Near Manifold Vacuum
R	Position Less than R Port	No Vacuum Present
R	Position More than R Port	Near Manifold Vacuum

Fig. 5-11

EGR Cut-Off

When the EGR VSV is on, the vacuum line is open to atmosphere, preventing the EGR from opening.

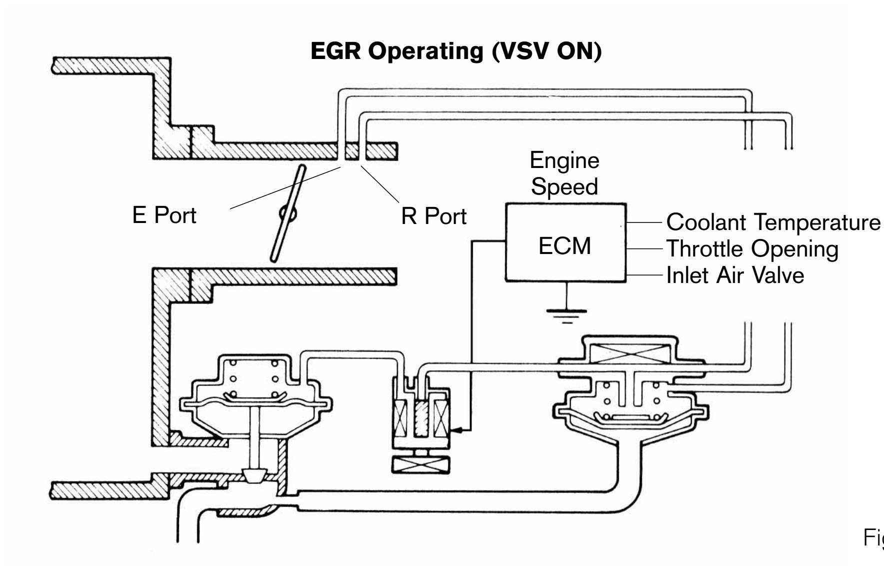


Fig. 5-12

T852f252

EGR Cut-Off Operation

To close the EGR valve, the VSV is turned on by a signal from the ECM. This opens the vacuum line to atmospheric pressure closing the EGR valve and shutting off the exhaust gas flow. This is done when EGR is not needed and to maintain driveability. This operation (EGR cut-off) is implemented when the following conditions exist:

- Coolant temperature below 57°C (134°F).
- During deceleration (throttle valve closed).
- Light engine load (amount of intake air very small).
- Engine speed approximately 4000 RPM or more.
- Engine racing (neutral start switch turned on).

EGR Gas Flow

Variations in exhaust pressure.

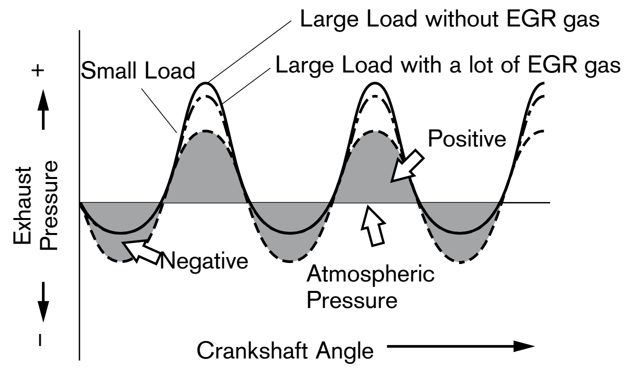


Fig. 5-13
T852f253

EGR Vacuum Modulator

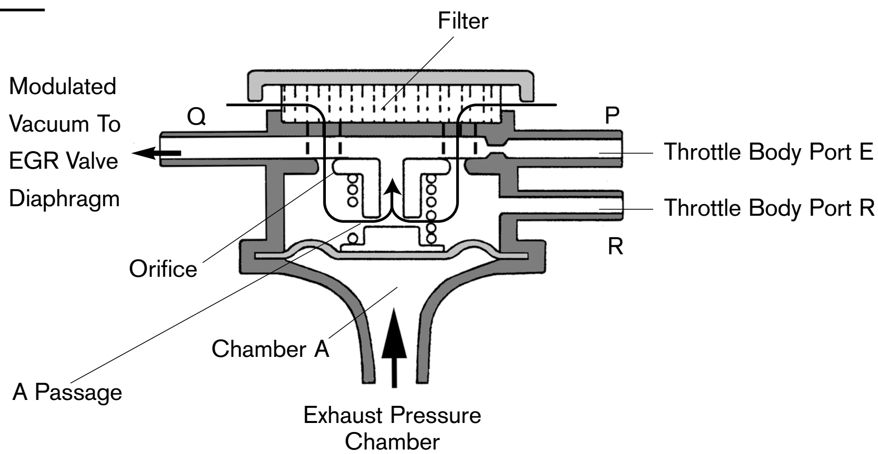


Fig. 5-14
T852f254

EGR Vacuum Modulator

The exhaust gas pressure increases in proportion to the amount of intake air. As the throttle valve opens and the amount of intake air volume increases, a higher exhaust gas pressure is applied to the constant pressure chamber of the EGR vacuum modulator. It pushes the diaphragm of the EGR vacuum modulator upward to narrow the "A" passage. Since vacuum acts then on the E and R ports of the throttle body, the vacuum is modulated by the size of the "A" passage. This modulated vacuum causes the EGR valve to open, which, in turn, allows exhaust gas into the intake manifold. This also causes the gas pressure inside the exhaust pressure chamber to go down, which in turn, lowers the EGR vacuum modulator diaphragm.

The EGR valve is now under less vacuum and the valve moves until the vacuum balances with the spring tension and the amount of EGR gas is regulated. Therefore, the amount of EGR is regulated according to the exhaust gas pressure and the vacuum signal strength.

Constant Vacuum System

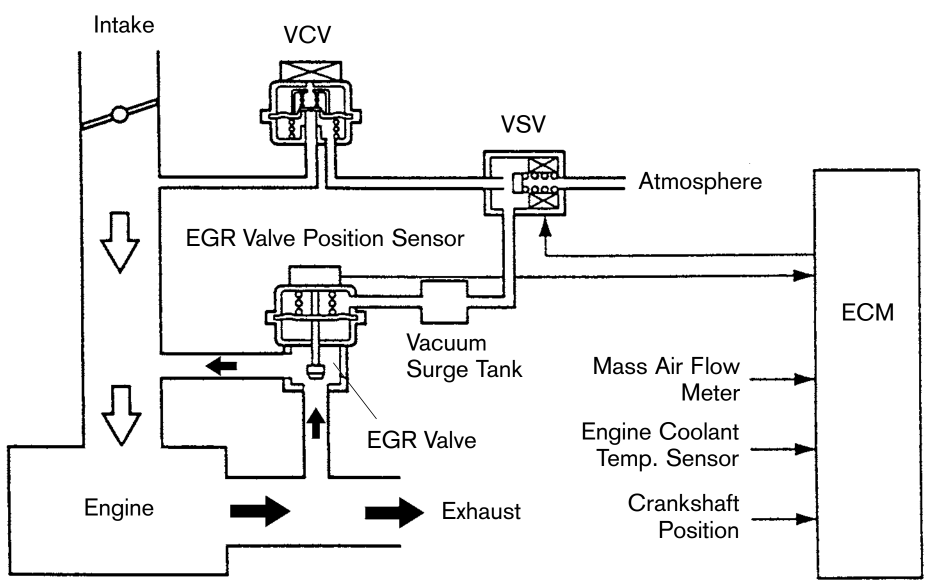


Fig. 5-15
T852f255

Constant Vacuum System Operation

This type of ECM EGR controlled system uses a Vacuum Control Valve (VCV), an EGR VSV, and an EGR valve position sensor to regulate exhaust gas flow.

Vacuum Control Valve (VCV)

When diagnosing the VCV, remember that the vacuum output is very low. An accurate vacuum gauge is needed.

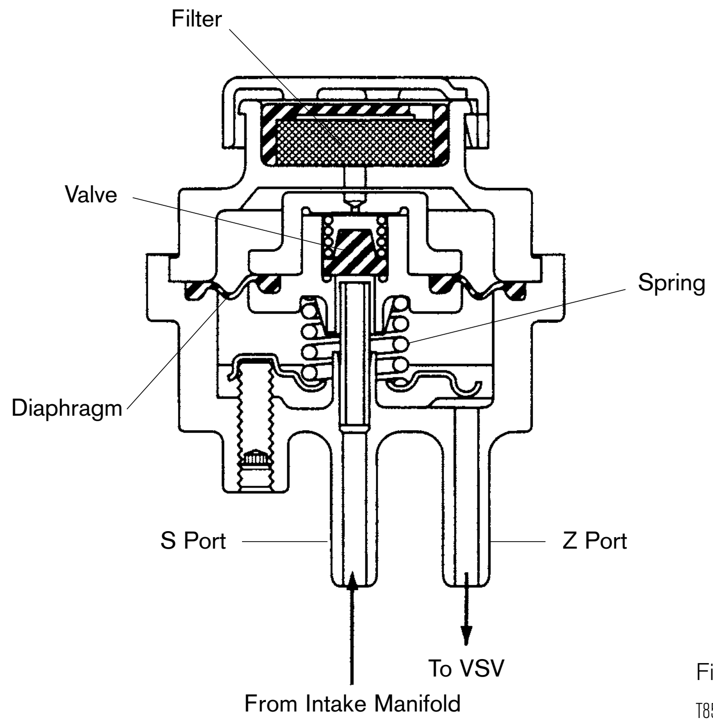


Fig. 5-16

Vacuum Control Valve (VCV)

The VCV is a valve that regulates the intake manifold vacuum applied to the VSV to a constant level (-17 kPa, -l30 mmHg, -5 inHg).

The intake manifold vacuum that is supplied through the S port is applied to the diaphragm. If this force becomes greater than the spring force, the diaphragm moves downward allowing the valve to close the S port and the atmosphere supplied through the filter.

Conversely, if the vacuum that is applied to the diaphragm becomes weaker, the diaphragm moves upward causing the valve to open and to shut off the atmosphere and supply the intake manifold vacuum. This process is repeated to regulate the vacuum in the Z port to a constant level.

EGR Valve Position Sensor

This sensor measures EGR valve height.

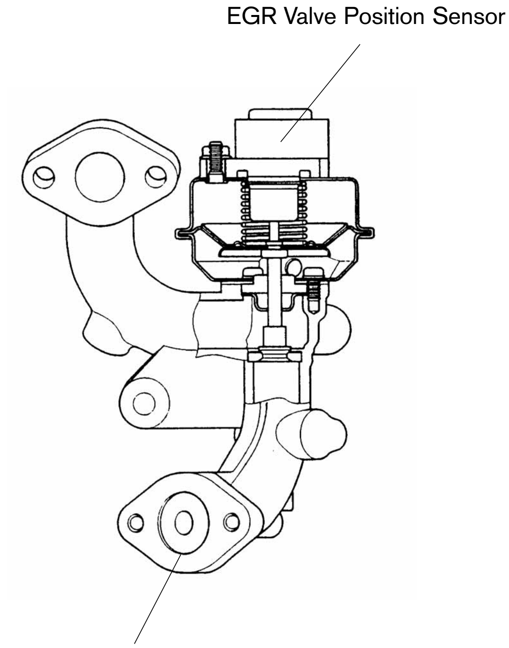


Fig. 5-17

T852f056

EGR Valve Position Sensor

The EGR valve position sensor is a potentiometer sensor mounted on the EGR valve. The EGR valve and signal arm in the position sensor move together. As the EGR valve opens, the voltage signal of the EGR valve position sensor increases.

EGR VSV

The EGR VSV is a three way VSV. When the VSV is off, atmospheric pressure is applied to the EGR valve keeping the valve closed. When the engine has reached the appropriate conditions, the ECM will turn on the EGR VSV applying vacuum to the EGR valve.

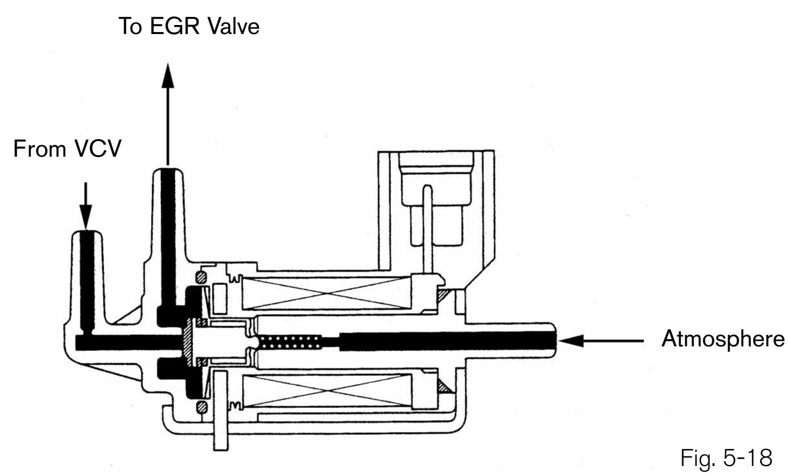


Fig. 5-18

T852f257

Operation

The ECM uses the EGR valve position sensor signal to control EGR valve position height and to detect excessive EGR flow. EGR valve height is controlled by the strength of the vacuum signal and the ECM controls vacuum signal strength by varying the pulsewidth signal sent to the EGR VSV. If greater EGR flow is needed, the ECM increases the pulsewidth signal to the EGR VSV. This applies more vacuum to the EGR valve.

Under the following conditions the ECM turns off the VSV and closes the EGR valve:

- Coolant temperature below 57°C (134°F).
- During deceleration (throttle valve closed).
- Light engine load (amount of intake air very small).
- Engine speed approximately ≈ 4000 rpm or more.
- Engine idling.

WORKSHEET 5–1
EVAP Systems

Vehicle	Year/Prod. Date	Engine	Transmission

Technician Objectives

With this worksheet, you will learn to test EVAP systems using the required tools and equipment, retrieve and apply the needed service information, retrieve and interpret service data information.

Tools and Equipment

- Vehicle Repair Manual & Vehicle EWD
- Diagnostic Tester
- Hand Tool Set
- Vacuum Gauge

Section 1

EVAP Identification

Use the Repair Manual and Technician Handbook to answer the following questions on the vehicle you are working on.

1. Is the EVAP system the Intrusive or Non-Intrusive type?

2. Is the EVAP system equipped with the ORVR system?

3. Identify on the canister the tank valve assembly.
4. Identify on the canister the air inlet valve assembly.
5. If equipped, identify the ORVR vent line.

Section 2

Purge VSV Operation

1. Select ACTIVE TEST.
2. Set to EVAP VSV and turn the VSV ON using the left and right arrow keys.
3. Disconnect the purge hose from the canister side of the purge VSV and listen for a duty cycle pulsing sound from the VSV.

4. If a pulsing sound is heard, will vacuum be present at the purge hose?

____

5. Turn the purge VSV OFF using the left and right arrow keys. Check for vacuum on the VSV with a vacuum gauge. If vacuum is present, the purge VSV is

____

Note: If a purge valve were stuck, open or closed, the following steps are recommended:

1. If the valve is stuck open or closed, this could be the result of active charcoal contamination or metal flakes from manufacturing inside the purge VSV.
2. If charcoal is found in the purge lines, all hoses must be cleaned of charcoal and the canister and purge VSV must be replaced.
3. If metal is found in the purge VSV, blow the metal lines out between canister and engine and replace the VSV.

Section 3

Vapor Pressure Sensor

1. Refer to SF section in the Repair Manual on vapor pressure sensor inspection.
2. Turn the ignition switch ON.
3. Disconnect the vacuum hose (the one connected to EVAP pressure).
4. Connect a voltmeter to terminals PTNK and E2. According to the RM, measure the voltage under specified conditions.

Condition	Applied Pressure	PTNK Voltage
Below Atmospheric Pressure		
Atmospheric Pressure		
Above Atmospheric Pressure		

As pressure increase, voltage increases. __________

5. Predict the PTNK signal voltage if the PTNK wire were to become disconnected. Voltage will

____

6. Disconnect the vps electrical connector.
7. Record the voltage between PTNK and E2 terminals at the ECM: __________
8. Why did this happen?

____

____

EVAP Systems

Name ______________________________ Date ______________

Review this sheet as you are doing the worksheet. Check each category after completing the worksheet and instructor presentation. Ask the instructor if you have questions. The comments section is for you to write where to find the information, questions, etc.

Topic	I have questions	I know I can	Comment
Locate components in the EVAP system using the EWD and RM			
Find wire colors, pin numbers in the EVAP electrical circuits using the EWD and RM			
Visually inspect tank, fuel cap, lines, canister			
Activate purge VSV with Active Test			
Test purge VSV and compare to specifications to determine condition			
Check and retrieve relevant DTCs			
Locate in the RM three sections related to EVAP system concerns			
Test vapor pressure sensor			

Notes

WORKSHEET 5–2
EGR Cutoff Control System

Vehicle	Year/Prod. Date	Engine	Transmission

Technician Objectives

With this worksheet, you will learn to test the EGR cutoff control system using the required tools and equipment, retrieve and apply the needed service information, retrieve and interpret service data information.

Tools and Equipment

- Vehicle Repair Manual
- Vehicle EWD
- Diagnostic Tester
- Hand Tool Set
- Vacuum pump with gauge

Section 1

Component Tests

VSV Component Check

1. Connect a DVOM to the EGR VSV terminal at the ECM.
2. According to the Repair Manual, perform the Inspect VSV operation test procedure. Test procedure and specifications are found in what section?

   ____

3. When the engine is cold, does the EGR valve have vacuum applied to it?

Circle the correct words in the following statements.

4. When cold, the EGR VSV is **ON/OFF** and **OPEN/CLOSED** to atmosphere.
5. When the EGR valve is open, the EGR VSV is **ON/OFF** and **OPEN/CLOSED** to atmosphere.

EGR Vacuum Modulator

1. Check the EGR Vacuum Modulator according to the Repair Manual.
2. With the engine OFF and Ports P and R blocked, should air pass freely from Port Q to atmosphere?

   Why? ____

3. With the engine ON and Ports P and R blocked, should air pass freely from Port Q to atmosphere?

   Why? ____

4. If the atmospheric port were blocked, what would be the engine symptoms?

____

EGR Valve

1. With the engine idling and warm, slowly apply vacuum to the EGR valve, so that the engine runs rough. What happened to EGR temperature?

____

2. On MAP sensor equipped engines, what happens to intake manifold pressure when the EGR valve is opened?

____

____

EGR Cutoff Control System

Name ______________________________ Date ______________________

Review this sheet as you are doing the worksheet. Check each category after completing the worksheet and instructor presentation. Ask the instructor if you have questions. The comments section is for you to write where to find the information, questions, etc.

Topic	I have questions	I know I can	Comment
Locate components in the EGR system using the EWD and RM			
Find wire colors, pin numbers in the EGR electrical circuits using the EWD and RM			
Visually inspect EGR valve, modulator, hoses			
Activate EGR VSV with Active Test			
Test EGR VSV and compare to specifications to determine condition			
Test vacuum modulator and compare to specifications to determine condition			
Check and retrieve relevant DTCs			
Locate in the RM three sections related to EGR system concerns			

Notes

WORKSHEET 5–3
EGR Constant Vacuum System

Vehicle	Year/Prod. Date	Engine	Transmission

Technician Objectives

With this worksheet, you will learn to test the EGR constant vacuum system using the required tools and equipment, retrieve and apply the needed service information, retrieve and interpret service data information.

Tools and Equipment

- Vehicle Repair Manual
- Vehicle EWD
- Diagnostic Tester
- Hand Tool Set
- Vacuum pump with gauge

Section 1

Component Tests:

VCV Component Check

1. According to the Repair Manual, perform the VCV test procedure for operation.

   ____

2. What port has vacuum applied to it? Did it match the Repair Manual?

   ____

3. A good VCV puts out:

   ____

EGR Valve Position Sensor

1. Using the vacuum pump, apply the vacuum specified and record EGR valve position sensor voltage.

0 inHG	2 inHG	4 inHG

2. From the voltage readings, is the EGR valve position sensor voltage signal normal?

EGR VSV

1. Connect the positive (+) lead of the DVOM to EGR VSV, terminal.
2. Connect the negative (-) lead to ground.

3. Start the engine and record voltage.

____

Is the EGR VSV open to atmosphere pressure with the EGR valve off?

____

Section 3

EGR Operation

1. With the DT, go to Active Test and select EGR. In User Data select EGR Temp, EGR valve position sensor.
2. Connect the positive (+) lead of the DVOM to EGR VSV connector/terminal.
3. Connect - lead to ground.
4. Record the following.

Engine RPM	EGR Temperature	EGR Valve Position	VSV Voltage	EGR Gas Flow (Y/N)

5. Activate the EGR system and record the following.

Engine RPM	EGR Temperature	EGR Valve Position	VSV Voltage

6. Increase engine RPM and record the following.

Engine RPM	EGR Temperature	EGR Valve Position	VSV Voltage

7. What happened to EGR temperature?

____

8. What happened to EGR valve position sensor voltage?

____

9. What happened to EGR VSV voltage as the EGR valve height increased?

____

10. If the EGR VSV were disconnected, what would be common engine symptoms, and what DTC would set?

____

EGR Constant Vacuum System

Name ______________________________ Date ________________

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Topic	I have questions	I know I can	Comment
Locate components in the EGR system using the EWD and RM			
Find wire colors, pin numbers in the EGR electrical circuits using the EWD and RM			
Visually inspect EGR valve, modulator, hoses			
Activate EGR VSV with Active Test			
Test EGR VSV and compare to specifications to determine condition			
Test VCV and compare to specifications to determine condition			
Test EGR valve position sensor and compare to specifications to determine condition			
Test EGR temperature sensor and compare to specifications to determine condition			
Check and retrieve relevant DTCs			
Locate in the RM three sections related to EGR system concerns			