

# Evaporative Emissions System Theory

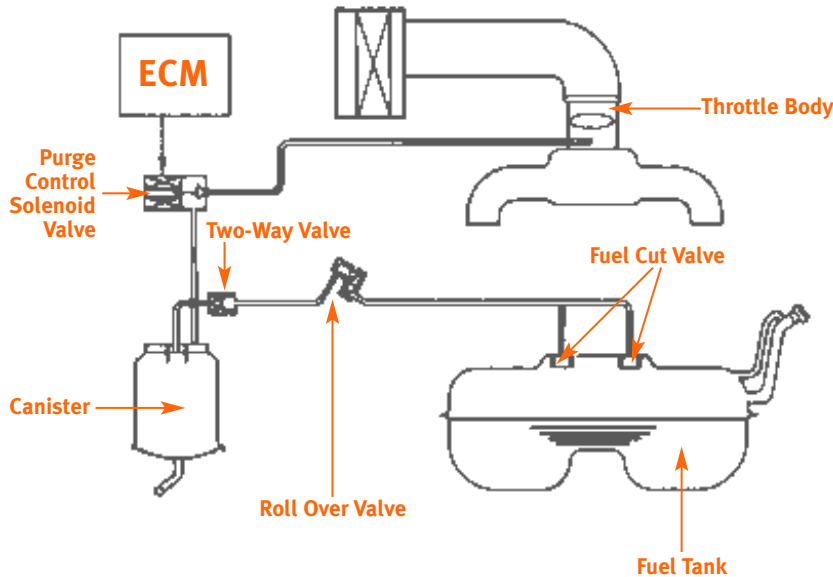


**S**ubaru vehicles are equipped with either a Conventional or Enhanced Evaporative Emissions Control System. Both systems function to prevent unburned Hydrocarbons from escaping to the atmosphere.

## **Conventional Evaporative components include the following:**

1. Fuel Cap – Construction incorporates a relief valve that allows air to enter the tank in the event a vacuum develops.
2. Canister – Temporarily stores evaporative gas from the fuel tank.
3. Purge Control Solenoid Valve – Controls the flow of stored evaporative gas from the canister to the intake manifold.
4. Two Way Valve – Controls air flow to the fuel tank. High tank pressure opens the valve allowing the pressure and evaporative gas to the canister. Low tank pressure closes the valve allowing atmosphere to the fuel tank through a pinhole in the valve.
5. Fuel Cut Valve – Used on AWD models. Prevents liquid fuel from entering the evaporative line.

### Conventional Evaporative System



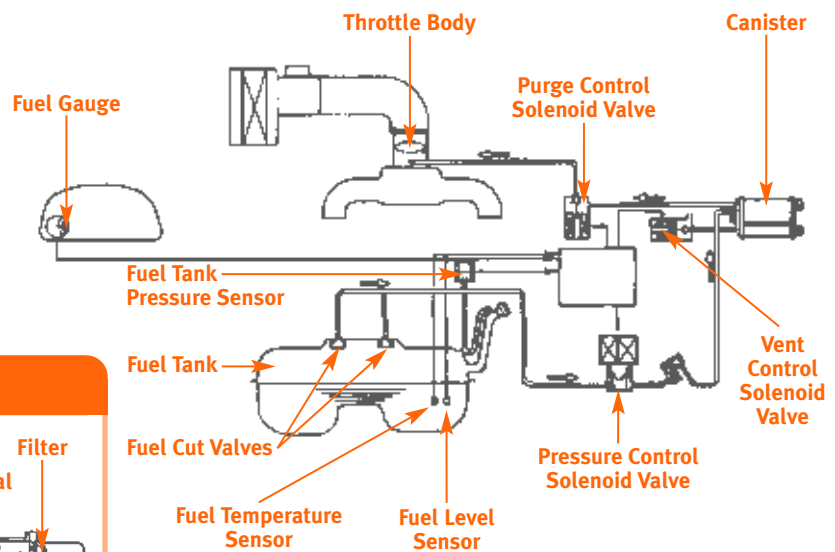
The fuel separator allows fuel vapor to condense and return to the tank as liquid. Some models use a plastic tank mounted in the trunk or cargo areas. Other models use an air space designed into the fuel tank to condense fuel vapors.

**System Operation** – The ECM grounds the purge control solenoid, turning it on. Ported vacuum then removes the stored evaporative gas from the canister. System activation is controlled based upon coolant temperature, engine load and vehicle speed inputs.

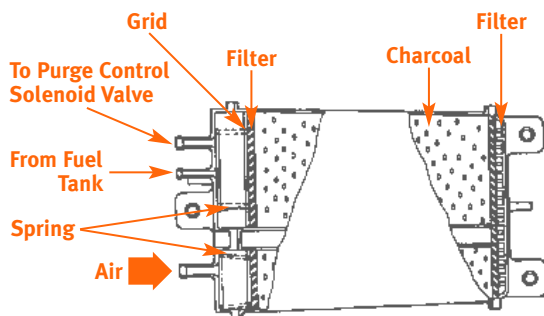
### Enhanced Evaporative System

#### Enhanced Evaporative components include:

1. Canister – Function is unchanged, however the shape is more boxy and is located under the right rear of the vehicle.



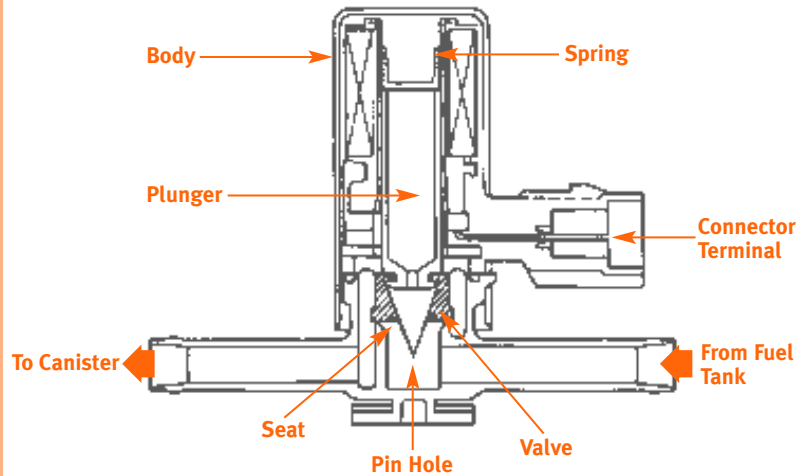
#### Canister



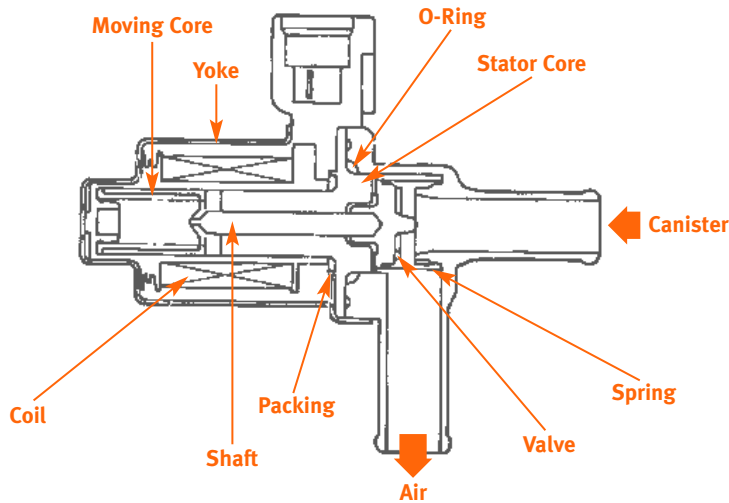
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2. **Pressure Control Duty Solenoid** – Adjusts the pressure inside the fuel tank from a signal from the ECM. It also controls the flow of evaporative gas from the fuel tank to the canister.
3. **Vent Control Solenoid Valve** – Controls the flow of atmospheric pressure to the canister. During normal operation the valve is open allowing atmospheric pressure to the canister. During the time the ECM is checking the integrity of the evaporative system the valve is closed to isolate the system from atmosphere.

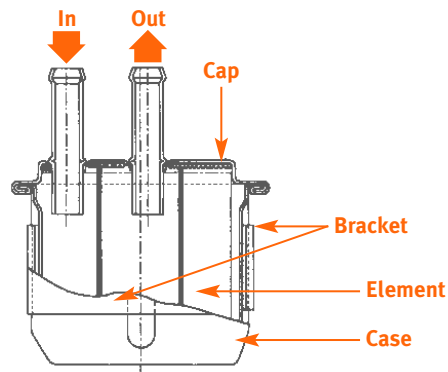
### Pressure Control Duty Solenoid



### Vent Control Solenoid Valve



### Air Filter



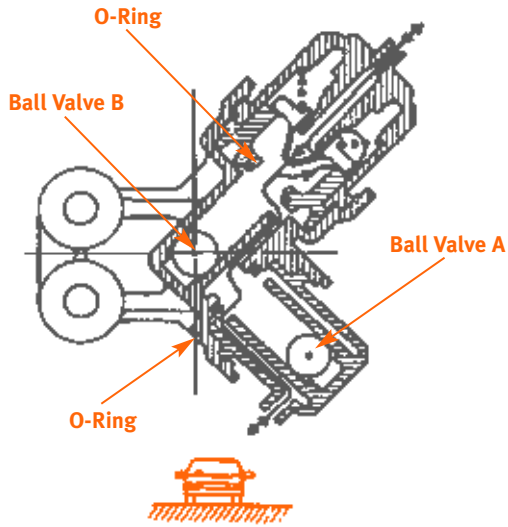
4. **Air Filter** – Filters air as it enters the vent control solenoid valve.
5. **Fuel Tank Pressure Sensor** – Monitors fuel tank pressure and sends an input signal to the ECM.

**System Operation** – Optimum purge control is programmed in the ECM and is influenced by engine load, coolant temperature and vehicle speed.

When fuel tank pressure is low, the pressure control solenoid valve is closed. The vent control solenoid is open and the purge control duty solenoid is active. When fuel tank pressure is high, the pressure control solenoid valve is open.

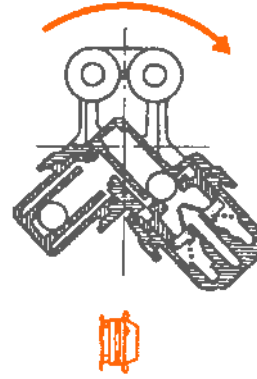
The fuel caps of both systems have a vacuum relief valve that allows atmospheric pressure to enter the fuel tank. This prevents vacuum from forming as the fuel is used, and acts as a back up for the two way valve.

### Roll Over Valve in Normal Vehicle Position

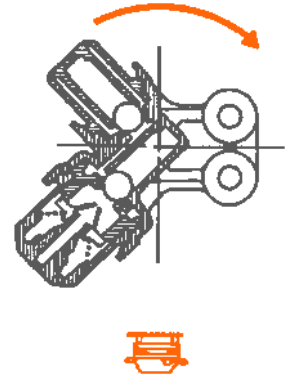


Both systems use a rollover valve located under the center rear of the vehicle. Rollover valve operation prevents fuel from flowing through the evaporative line in the event of a vehicle rollover. Valve operation is performed by gravity and the position of two Ball Valves.

### With Vehicle on its Side



### With Vehicle on its Roof



## Evaporative Emissions System Theory

### On Board Refueling Vapor Recovery

On Board Refueling Vapor Recovery (ORVR) controls the pressure inside the fuel tank and collects fuel vapors during all vehicle operating conditions and during the time the vehicle is being refueled.

#### ORVR Components include:

- Fuel Cut Valve (FCV) – Prevents liquid fuel from entering into the evaporative line.
- Valve Vent – Controls the flow of fuel vapors during the time the vehicle is being refueled.
- Pressure Difference Detecting Line – Directs atmospheric pressure to the back side of the valve vent diaphragm.
- Orifice Chamber – Drains fuel from the pressure difference detecting line into the tank.

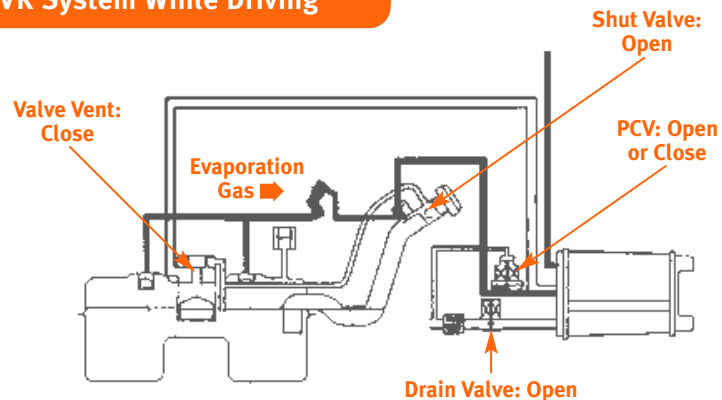
- Shut Valve – Closes the evaporation line when a filler gun is inserted into the filler neck. Prevents fuel vapors from escaping to atmosphere while refueling.
- Tank Pressure Sensor – Monitors fuel tank pressure for diagnosis.
- Vent Line – Directs fuel vapors from the valve vent to the canister during the time the vehicle is being refueled.
- Pressure Control Valve (PCV) – Controls the flow of fuel vapors from the tank to the canister, except during the time the vehicle is being refueled. Also controls the flow of atmospheric pressure to the tank when a negative pressure develops.
- Drain Valve – Provides a pathway to atmosphere for air after the fuel vapors have been removed by the charcoal element of the canister (only while the vehicle is being refueled).

### ORVR System Operation

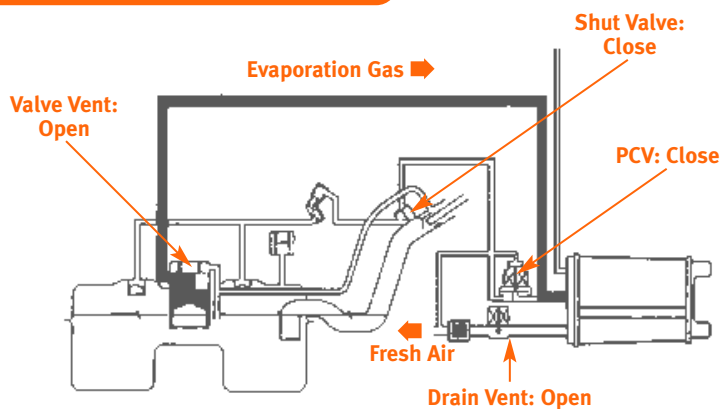
#### While Driving

While driving, the fuel tank pressure is applied to one side of a diaphragm inside the Pressure Control Valve. When the pressure is greater than atmospheric, a port inside the PCV opens. This allows fuel vapors to the canister. If negative pressure exists, the PCV opens allowing atmospheric pressure to the fuel tank.

#### ORVR System While Driving



#### ORVR System While Refueling



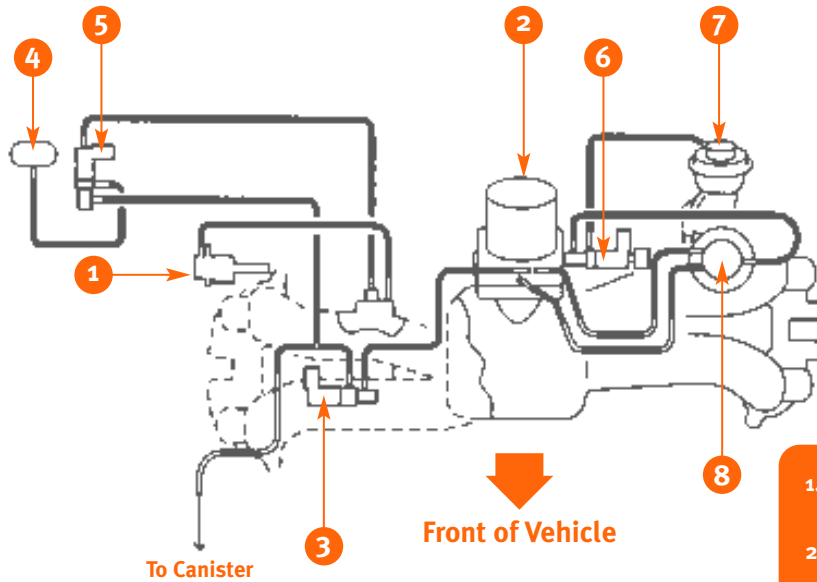
#### While Refueling

As fuel fills the tank during refueling, the air inside the tank is displaced carrying fuel vapors with it. This large increase in pressure opens the valve vent allowing the fuel vapors to the canister.

The continued filling of the tank pushes the remaining air and fuel vapors through the canister. The charcoal element of the canister absorbs the fuel vapors and directs fuel vapor-free air to the atmosphere through the drain valve and air filter.



The PCV is checked by the ECM for circuit malfunction. Drain valve checks include circuit and performance checks.

## 1995 and Newer Manifold



## Pressure Sources Switching Operation

A Pressure Sources Switching solenoid (PSSS) is used on 1995 and newer Subaru vehicles equipped with OBD II. The PSSS functions via an ECM ground signal and switches to allow atmospheric pressure to reach the pressure sensor during engine start, then every 30 minutes or 3.1 miles. The PSSS switches to allow manifold pressure to reach the pressure sensor when not switched to atmosphere.

- |  |  |
|--|--|
| 1. Fuel Pressure Regulator             | 6. EGR Solenoid  |
| 2. Throttle Body                       | 7. EGR Valve   |
| 3. Canister Purge                      | 8. Back Pressure Transducer  |
| 4. Pressure Sensor                     |  : Hose |
| 5. Pressure Sources Switching Solenoid |  : Pipe |



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The passageway to atmosphere on conventional evaporative systems accesses the atmosphere via the evaporative canister. Enhanced evaporative systems access the atmosphere via an extension of the PSSS.

The pressure sensor functions to monitor manifold and atmospheric pressure. PSSS position determines the pressure source. Changes in pressure (positive or negative) produce a changing reference voltage signal. Reference voltage signal changes are used by the ECM to determine optimum ignition timing and injection duration.

Canister purge flow is also monitored with the Pressure Sensor. The PSSS switches to atmosphere while the purge control solenoid is on.

### ORVR Component Changes

The fuel tank and ORVR components have been relocated on 2000 and later Legacy models. This makes necessary movement of key fuel system plumbing. One such movement involves a new hose, which is routed from the fuel neck to the vent control valve located on the driver's rear of the fuel tank. The routing carries the hose through the inner fender into the passenger compartment.



Figure 1: Hose Quick Connector



Figure 2: Fuel Pump and Sub Pump Unit Access



Figure 3: Resin Based Fuel Pump Assembly



Figure 4: Round Fuel Filter Housing

The hose is protected by a metal cover, which must be removed to gain access to the quick connector (**Figure 1**). The quick connector must be disconnected before the fuel tank is lowered.

Movement of the fuel tank is accompanied by a change in the fuel pump assembly design and location. The fuel pump assembly and sub pump pickup assembly are now accessed from under the rear seat (**Figure 2**). The pumps are located on the lower level of the fuel tank which makes it necessary to remove the fuel from the tank before removing the fuel pump or sub pump pickup assemblies. Failure to remove fuel from the tank will result in fuel being introduced into the passenger compartment.

A fuel drain is located on the passenger side, front of the fuel tank. Use of this drain will lower the fuel from the high



Figure 5: Static Charge Wiring

side of the tank and totally drain the passenger side of the saddle tank. The sub pump pickup side of the tank (the driver's side) will remain full. Consult the appropriate Subaru service manual on proper procedure for draining all fuel from the fuel tank.

The body of the new fuel pump assembly is resin based (**Figure 3**). The gasket for the assembly has two location prongs that must be pulled into the outer cover. The assembly includes a round housing (**Figure 4**) designed to accept a fuel filter. However, vehicles for the North American market do not have a filter located on the fuel pump.

The small wire connected to cap area of the fuel pump housing carries static charges away from the pump body to vehicle ground (**Figure 5**).

The low fuel level sensor operation has also been enhanced. The sensor itself works the same as before. However, the low level when sensed triggers a circuit located in the fuel gauge to maintain the low level indicator illumination until fuel is added to the tank.

