Evaporative Emission Systems

Overview

The Evaporative Emission (EVAP) system prevents fuel vapor build-up in the sealed fuel tank. Fuel vapors trapped in the sealed tank are vented through the vapor valve assembly on top of the tank. The vapors leave the valve assembly through a single vapor line and continue to the EVAP canister (located in the engine compartment, in the rear of vehicle near luggage compartment area or along the frame rail) for storage until the vapors are purged to the engine for burning.

There are four types of Evaporative Emission (EVAP) systems:

- The Evaporative Emission (EVAP) Purge Flow system.
- The Vapor Management Flow system.
- The Evaporative Emission (EVAP) Running Loss system.
- The On-Board Refueling Vapor Recovery (ORVR) Evaporative Emission (EVAP) system.

Evaporative Emission (EVAP) Purge Flow System

The (EVAP) Purge Flow system consists of a fuel tank, fuel filler cap, fuel vapor valve, EVAP canister, EVAP canister purge valve, purge flow (PF) sensor, intake manifold hose assembly, powertrain control module (PCM) and connecting wires and fuel vapor hoses. Operation of the system is as follows (Figure 89):

1. The EVAP Purge Flow system uses inputs from the engine coolant temperature (ECT) sensor, the intake air temperature (IAT) sensor, the throttle position (TP) sensor, the mass air flow (MAF) sensor and the vehicle speed sensor (VSS) to provide information about engine operating conditions to the PCM. The conditions necessary to activate the EVAP Purge Flow system is that the engine must be warm, stable, running at moderate load, and at open or part throttle position. The power relay provides vehicle power (VPWR) to the PCM, EVAP canister purge valve and PF sensor. The PCM deactivates the EVAP Purge Flow during idle, closed throttle or whenever a failure is detected in the EVAP canister purge valve, PF sensor or evaporative emission purge flow required input.
2. The PCM calculates the desired amount of purge vapor flow to the intake manifold for a given engine condition. The PCM can then output the proper duty cycle signal to the EVAP canister purge valve.
3. The EVAP canister purge valve is a normally closed valve (duty cycle at 0%), but receives a duty cycle signal (0% to 100%) from the PCM during various operating modes. The EVAP canister purge valve uses that signal from the PCM and responds by controlling the flow of vapors (purging) from the EVAP canister to the intake manifold.
4. The PF sensor is used to determine if fuel vapor is flowing to the intake manifold through the fuel vapor hose from the EVAP canister.

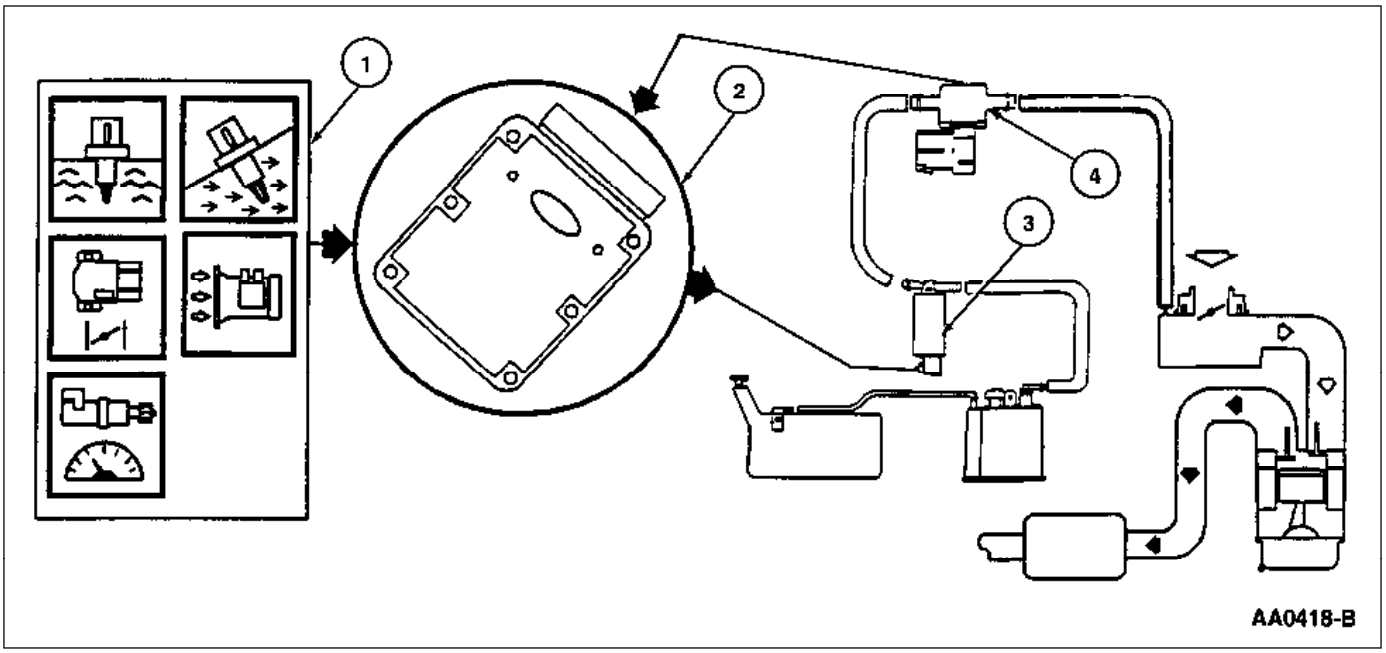

Figure 89: Evaporative Emission Purge Flow System Operation (Refer to the On-Board Diagnostics II System Overview for icon definitions.)

Hardware

Evaporative Emission (EVAP) Canister Purge Valve

The EVAP canister purge valve (Figure 90) is the part of the EVAP Purge Flow System that is controlled by the PCM. This valve controls the flow of vapors (purging) from the EVAP canister to the intake manifold during various engine operating modes. The EVAP canister purge valve is a normally closed valve.

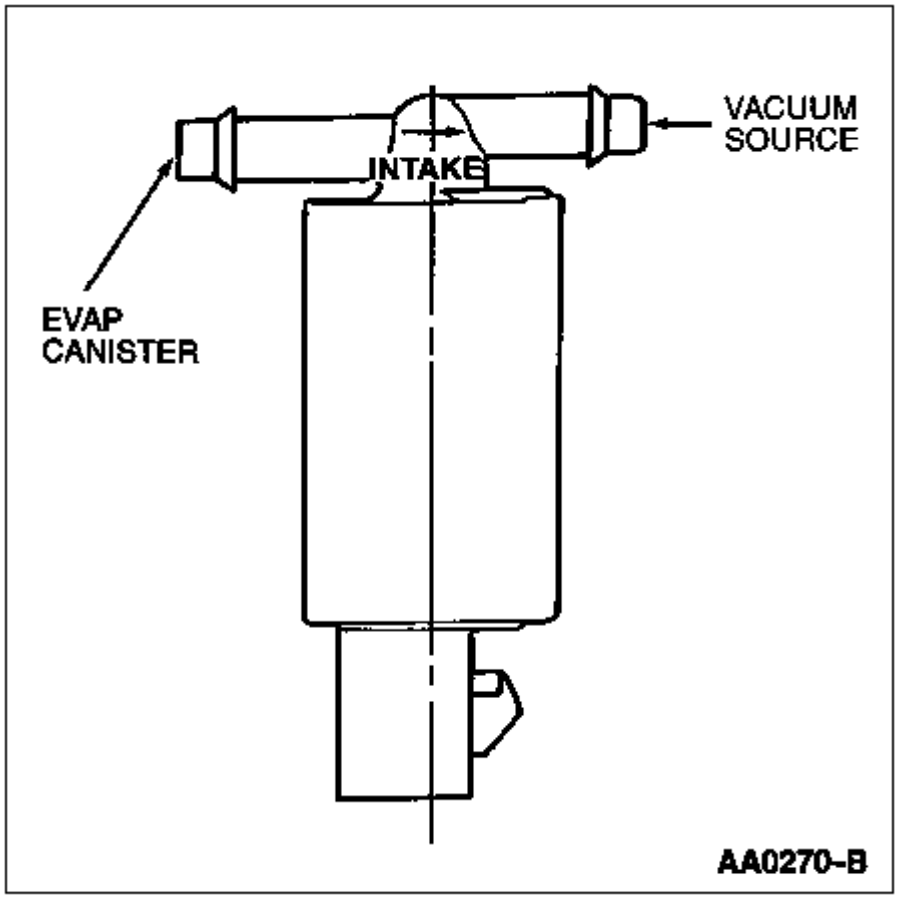

Figure 90: Evaporative Emission Canister Purge Valve

Purge Flow Sensor

The purge flow (PF) sensor (Figure 91) is used to monitor fuel vapor flow to the engine during the OBD II Evaporative Emission Test.

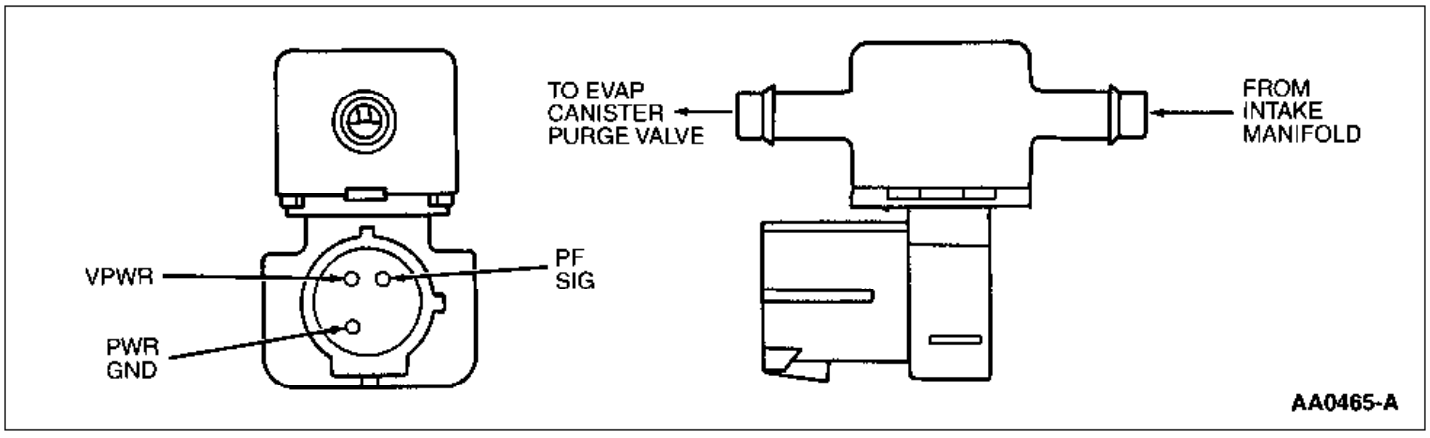

Figure 91: Purge Flow (PF) Sensor

Fuel Vapor Vent Valve Assembly

Fuel vapor in the fuel tank is vented to the EVAP canister through the fuel vapor vent valve assembly (Figure 92). The valve is mounted in a rubber grommet at a central location in the upper surface of the fuel tank. A vapor space between the fuel level and the upper surface of the tank is combined with a small orifice and float

shut-off (rollover) valve in the vapor valve assembly to prevent liquid fuel from passing to the EVAP canister. The vapor space also allows for thermal expansion of the fuel.

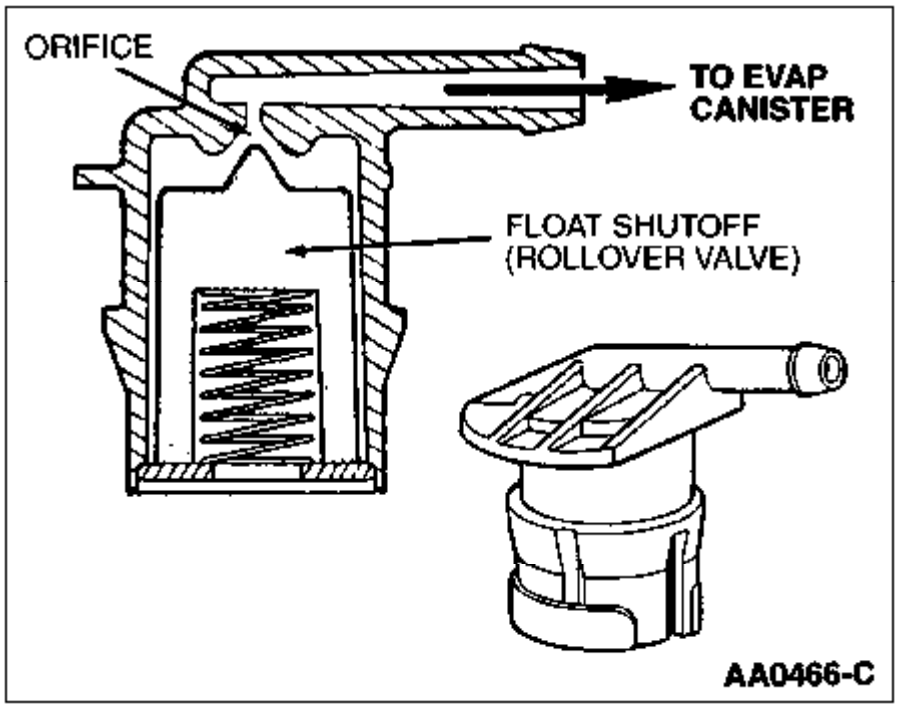

Figure 92: Fuel Vapor Vent Valve

Vapor Management Flow System

The Vapor Management Flow system consists of a fuel tank, fuel filler cap, fuel vapor valve, EVAP canister, EVAP canister purge valve, intake air tube assembly, powertrain control module (PCM) and connecting wires and fuel vapor hoses. Operation of the system is as follows: (Figure 93)

1. The Vapor Management Flow system uses inputs from upon the engine coolant temperature (ECT) sensor, the intake air temperature (IAT) sensor, the mass air flow (MAF) sensor and the vehicle speed sensor (VSS) to provide information about engine operating conditions to the PCM. The conditions necessary to activate the Vapor Management Flow system is that the engine must be warm, stable, running at a moderate load and rpm, at open or part throttle position, and in close loop fuel control. The PCM deactivates the fuel vapor management flow during idle or whenever a failure is detected in the EVAP canister purge valve or fuel vapor management flow required input.
2. The PCM calculates the difference between the idle speed air requested at a high purge flow and at a no purge flow. If the difference is below a calibrated threshold, flow is inferred not to be occurring properly, and the PCM indicates an evaporative emission system malfunction with a Diagnostic Trouble Code (DTC).
3. The PCM outputs a variable duty cycle signal (between 0% and 100%) to the solenoid on the EVAP canister purge valve.

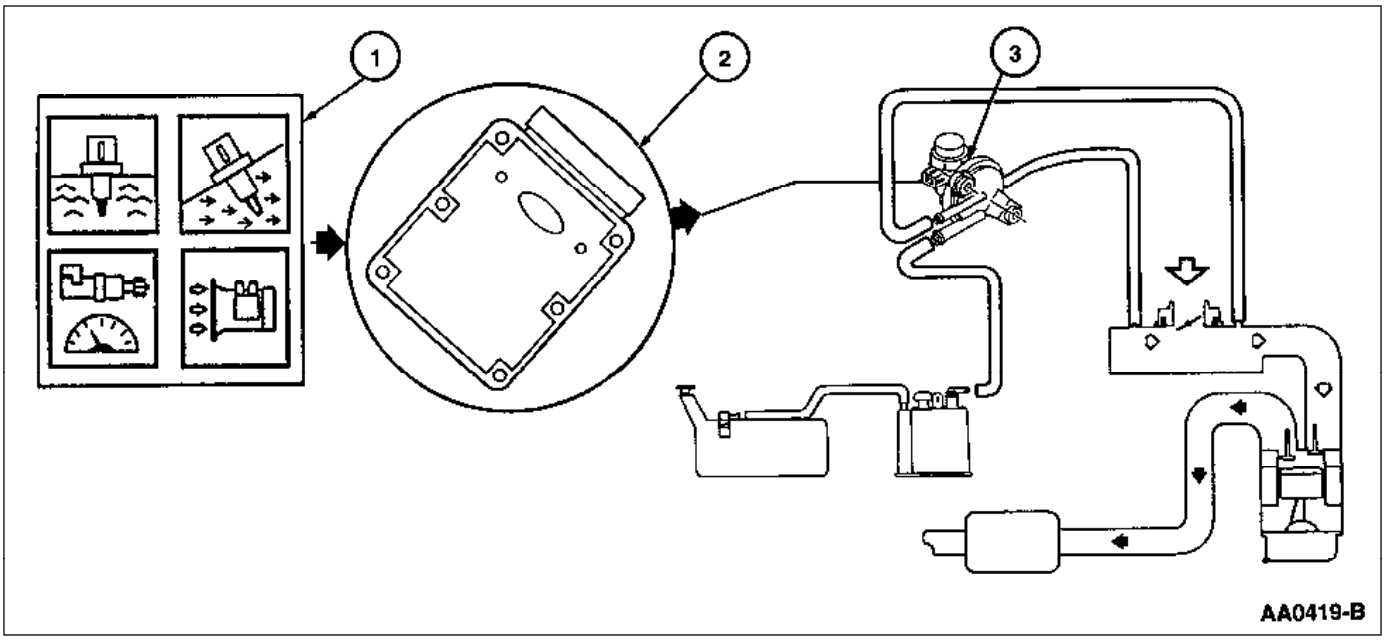

Figure 93: Vapor Management Flow System Operation (Refer to the On-Board Diagnostics II Overview System for icon definitions.)

Hardware

EVAP Canister Purge Valve

The EVAP canister purge valve (Figure 94) is the part of the vapor management flow and EVAP running loss systems that is controlled by the PCM. This valve controls the flow of vapors (purging) from the EVAP canister to the intake manifold during various engine operating modes. The EVAP canister purge valve is a normally closed valve.

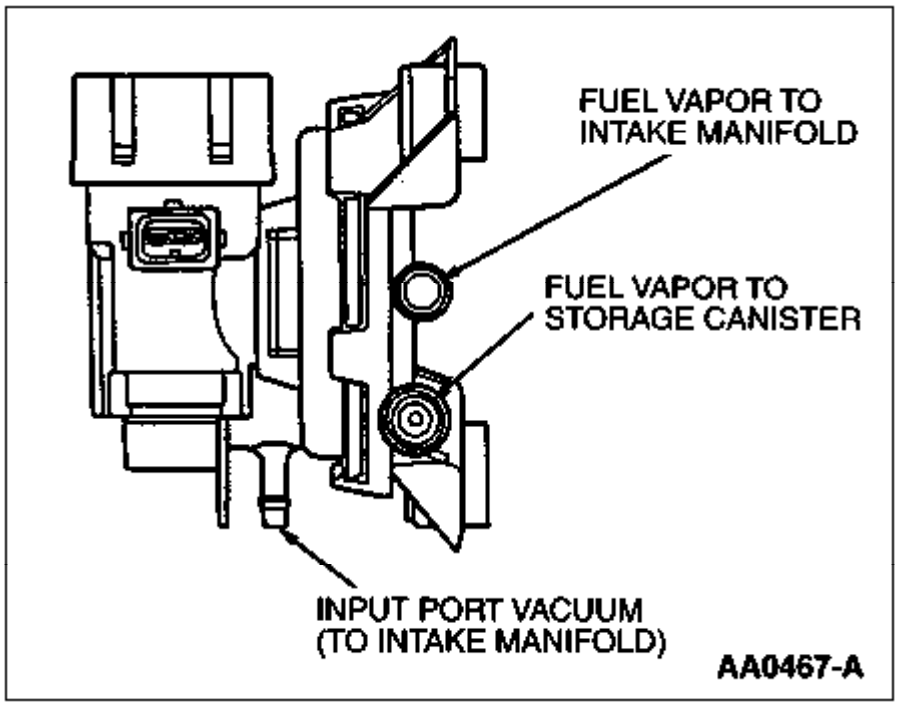

Figure 94: EVAP Canister Purge Valve

Fuel Vapor Vent Valve Assembly

The fuel vapor vent valve assembly (Figure 92) for the Vapor Management Flow system functions in the same manner as in the EVAP Purge Flow system.

Evaporative Emission (EVAP) Running Loss System

The EVAP Running Loss system (Figure 95) consists of a fuel tank, fuel filler cap, fuel tank mounted or in-line fuel vapor control valve, fuel vapor vent valve EVAP canister, fuel tank pressure (FTP) sensor, EVAP canister purge valve, intake manifold hose assembly, canister vent (CV) solenoid, powertrain control module (PCM) and connecting wires and fuel vapor hoses.

1. The EVAP Running Loss system uses inputs from the engine coolant temperature (ECT) sensor, the intake air temperature (IAT) sensor, the mass air flow (MAF) sensor, the vehicle speed sensor (VSS) and the fuel tank pressure (FTP) sensor to provide information about engine operating conditions to the PCM. The fuel level input (FLI) and FTP sensor signals to the PCM are used by the PCM to determine activation of the EVAP Monitor based on presence of vapor generation or fuel sloshing.
2. The PCM calculates a variable duty cycle based on the desired amount of purge vapor flow to the intake manifold for a given engine condition. The PCM can then output the duty cycle correct to the EVAP canister purge valve. The PCM uses the EVAP Running Loss system inputs to evacuate the system using the EVAP canister purge valve, seals the EVAP Running Loss system from atmosphere using the CV solenoid, and uses the FTP sensor to observe total vacuum lost for a period of time.
3. The canister vent (CV) solenoid seals the EVAP Running Loss system to atmosphere during the EVAP Running Loss Monitor.
4. The PCM outputs a variable duty cycle signal (between 0% and 100%) to the solenoid on the EVAP canister purge valve.
5. The fuel tank pressure (FTP) sensor monitors the fuel tank pressure during engine operation and continuously transmits an input signal to the PCM. During the EVAP monitor testing, the FTP sensor monitors the fuel tank pressure or vacuum build-up.
6. The fuel tank mounted fuel vapor vent valve assembly, fuel tank mounted fuel vapor control valve (or remote fuel vapor control valve) are used in the EVAP Running Loss system to control the flow of fuel vapor entering the engine. All of these valves also prevent fuel tank overfilling during refueling operation and prevent liquid fuel from entering the EVAP canister and the EVAP canister purge valve under any vehicle severe handling or rollover condition. The liquid/vapor fuel discriminator is part of the fuel vapor control valve assembly on Escort/Tracer (2V) applications.
7. The EVAP Running Loss system, including all the fuel vapor hoses, can be checked when a leak is detected by the PCM. This can be done by pressurizing the system using Rotunda Evaporative Emission Tester kit 134-00056 or equivalent and the leak frequency (ultra-sonic) detector included with the kit.

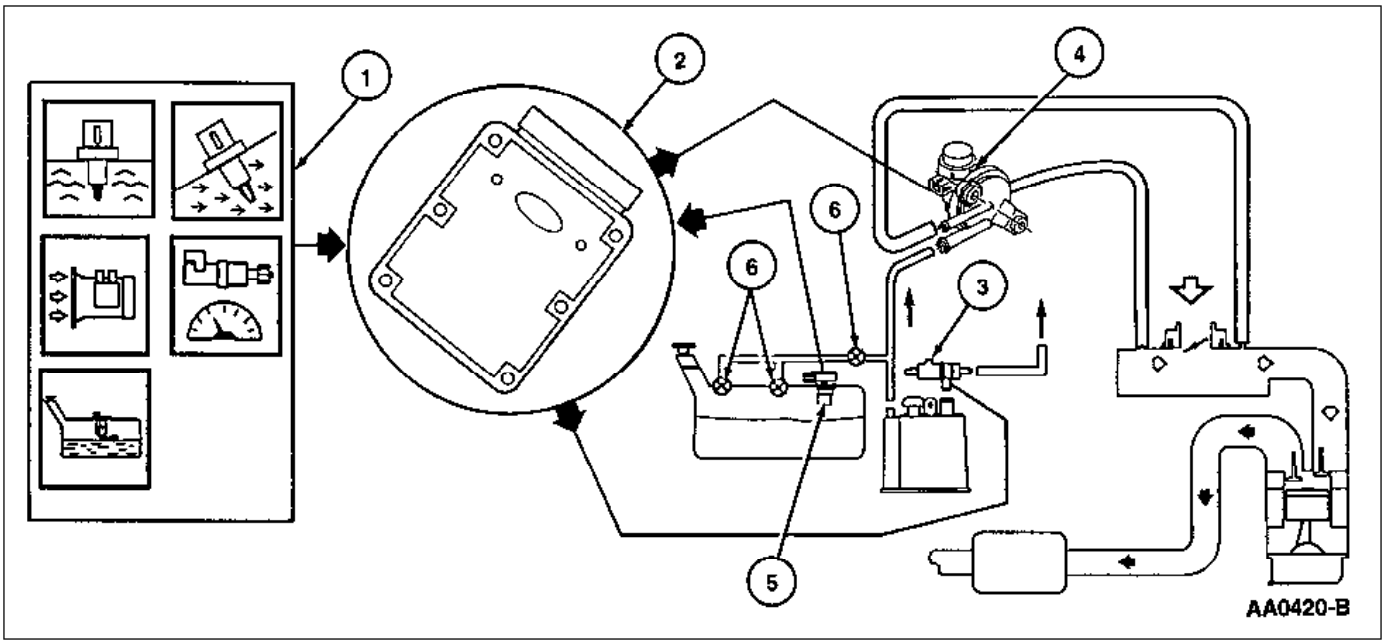

Figure 95: Evaporative Emission Running Loss System (Refer to the On-Board Diagnostics II System Overview for icon definitions.)

Hardware

Fuel Tank Pressure Sensor

The fuel tank pressure (FTP) sensor (Figure 96) is used to measure the fuel tank pressure during the EVAP monitor test on vehicles equipped with the Running Loss type system. Also, it is used to control excessive fuel tank pressure by forcing the system to purge.

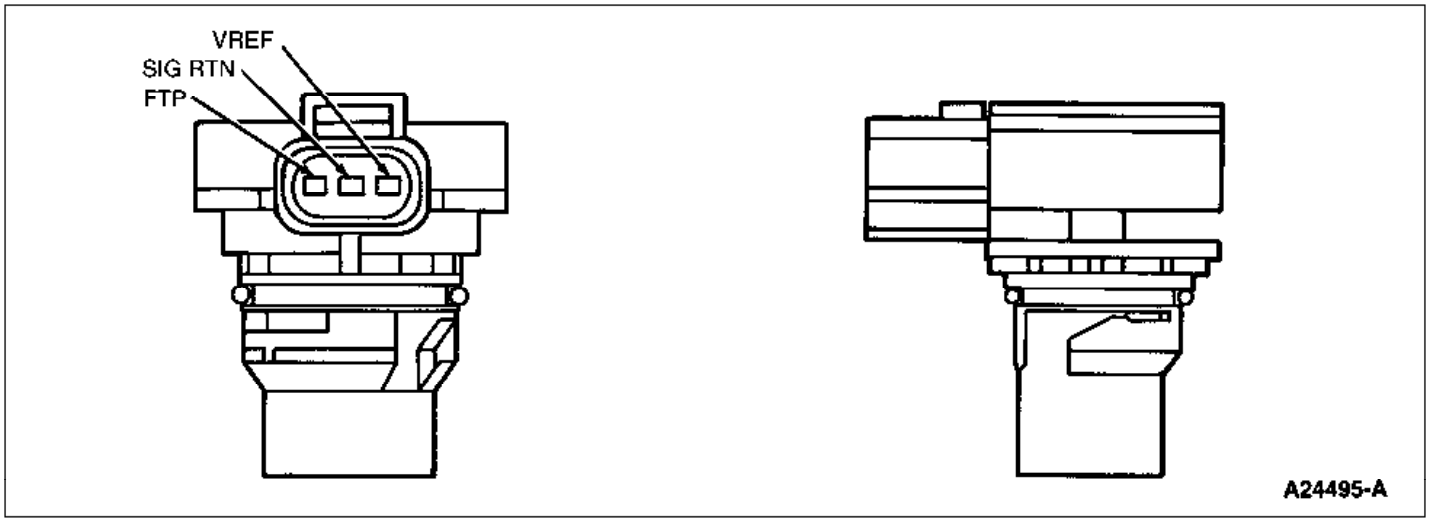

Figure 96: Fuel Tank Pressure (FTP) Sensor

Canister Vent Solenoid

During the EVAP Running Loss System monitor, the canister vent (CV) solenoid (Figure 97) seals the EVAP canister from atmospheric pressure. This allows the EVAP canister purge valve to obtain the target vacuum in the fuel tank.

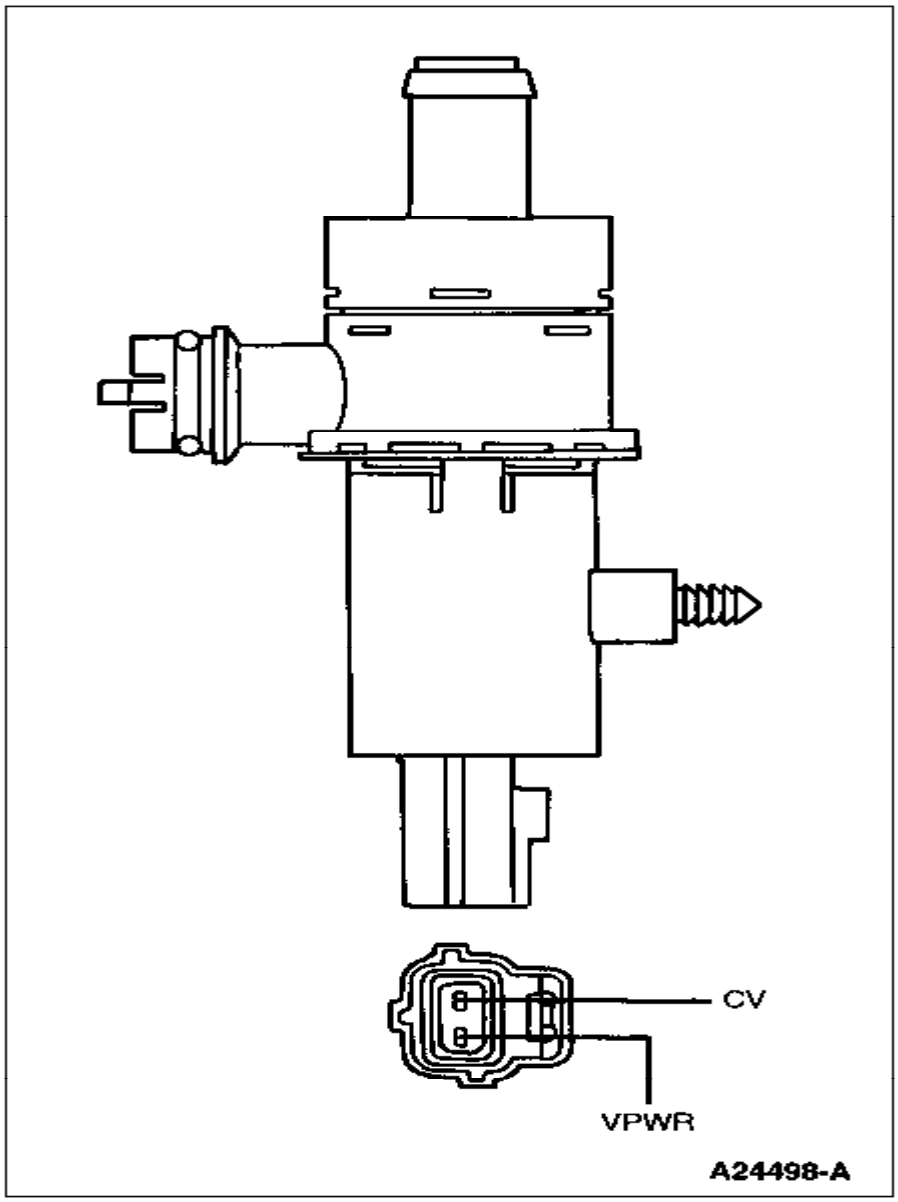

Figure 97: Typical Canister Vent (CV) Solenoid

EVAP Canister Purge Valve

The EVAP canister purge valve (Figure 94) for the EVAP Running Loss system functions in the same manner as in the Vapor Management Flow system.

Fuel Vapor Control Valve

The fuel vapor control valve (Figure 98) is in series with the fuel vapor vent valve and the EVAP canister. The function of this fuel vapor control valve is to close the flow of liquid fuel to the EVAP canister purge valve or EVAP canister during refueling and to prevent the collection of liquid fuel in the fuel vapor hoses by overfilling the fuel tank.

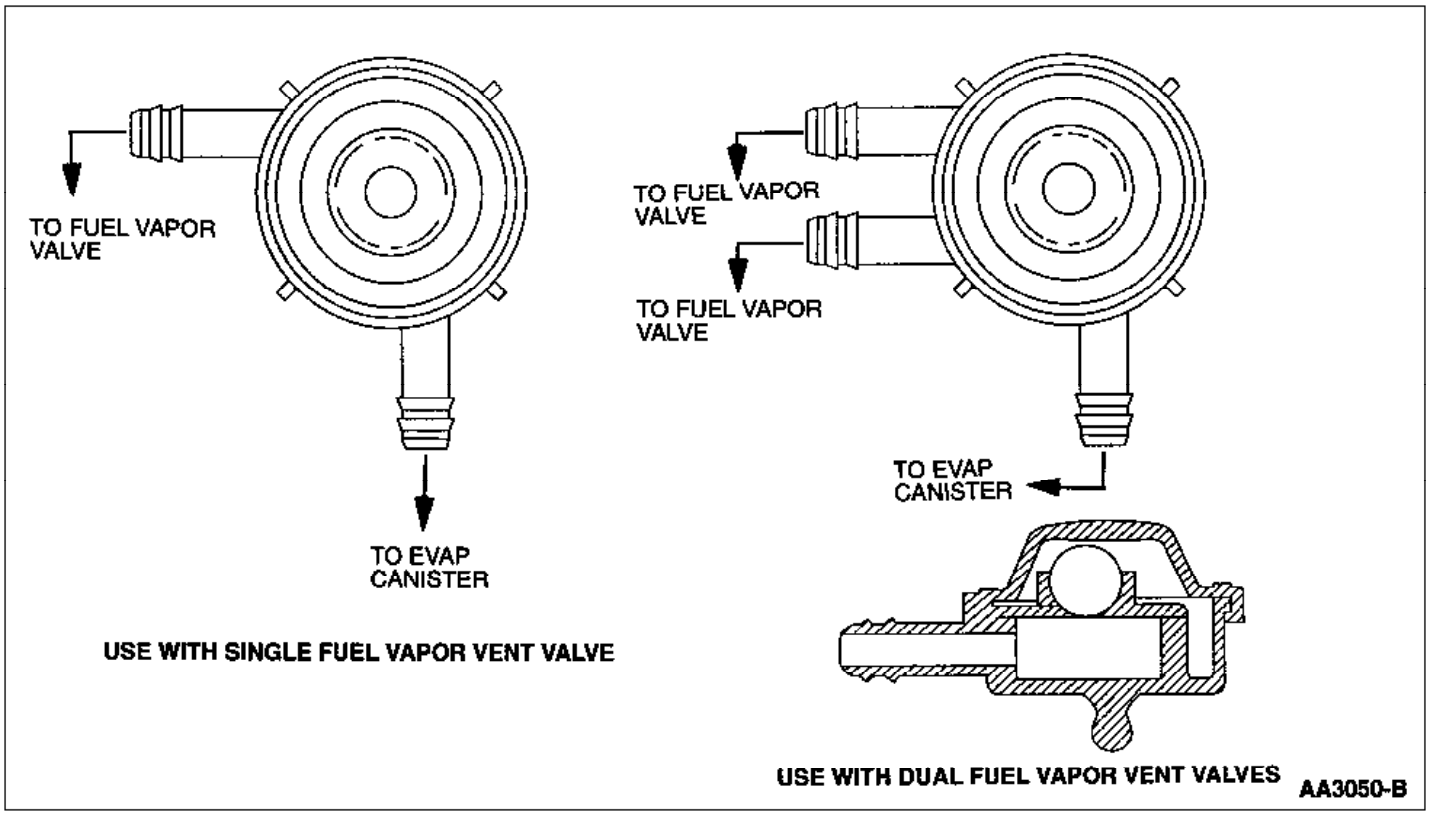

Figure 98: Fuel Vapor Control Valve (Remote)

Fuel Vapor Vent Valve Assembly

The fuel vapor vent valve assembly that is mounted on the top of the fuel tank is used to control the flow of fuel vapor entering the fuel tank vapor delivery line to the EVAP canister. The head valve portion of the assembly prevents the fuel tank from overfilling during refueling operations. The assembly also has a spring supported float which prevents liquid fuel from entering the fuel tank vapor delivery line under any vehicle severe handling or a vehicle rollover condition. In the vertical position, the open bottom float will lift and shut off the orifice. In the rollover position, the spring will push the float closed when the rollover angle permits liquid gasoline to reach the orifice. In the upside down position, the weight of the open bottom float and the spring force will close the orifice. Two types of fuel vapor vent valves are used that can be serviceable. They are: (1) O-ring type (Figure 99) and (2) rubber grommet type (Figure 100). The Escort/Tracer, Contour/Mystique, Ranger, Expedition/Navigator and heavy duty F-Series (F250, F350) have fuel vapor vent valves that are an integral part of the plastic fuel tank and cannot be repaired separately.

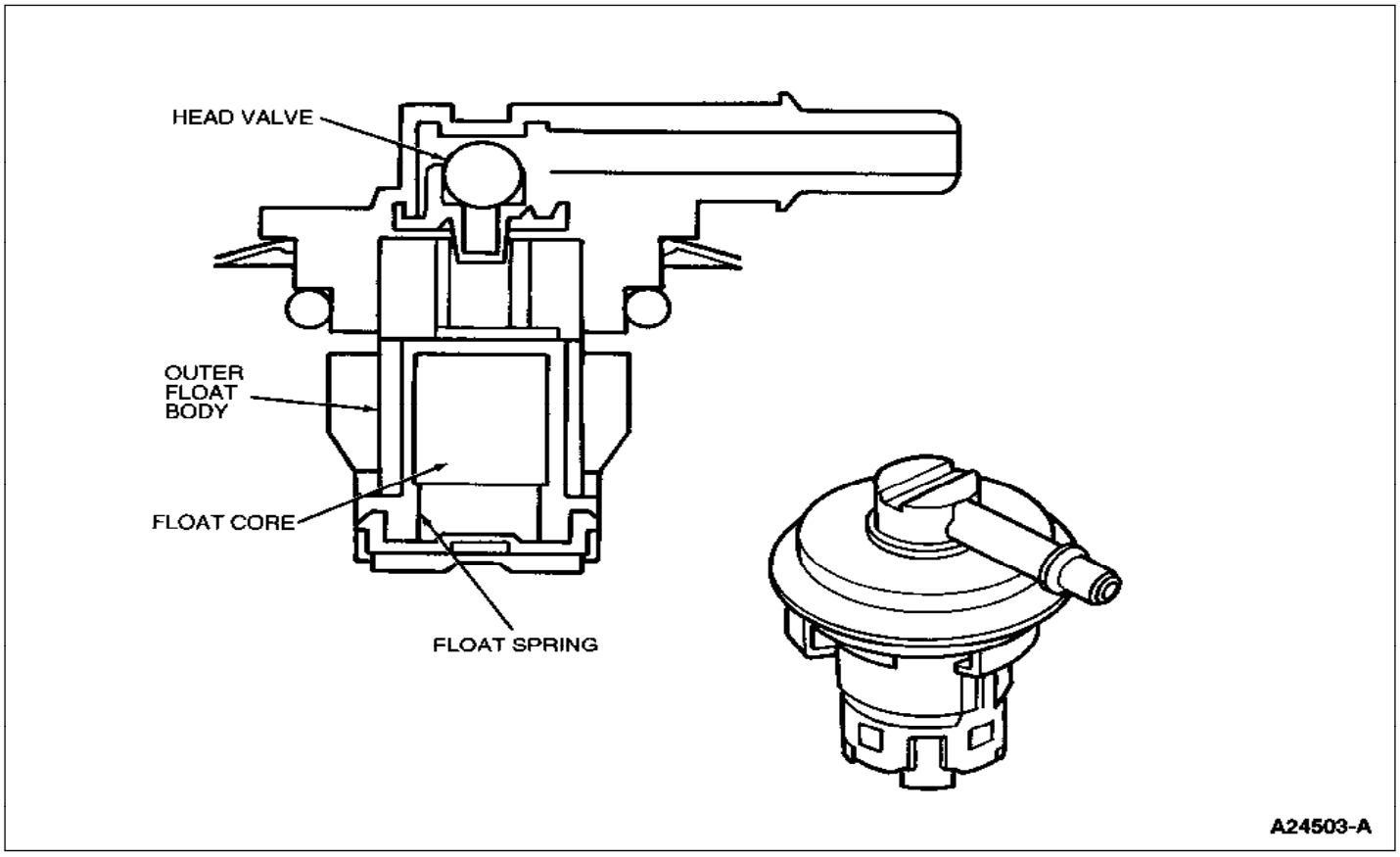

Figure 99: Fuel Vapor Vent Valve (O-Ring Type)

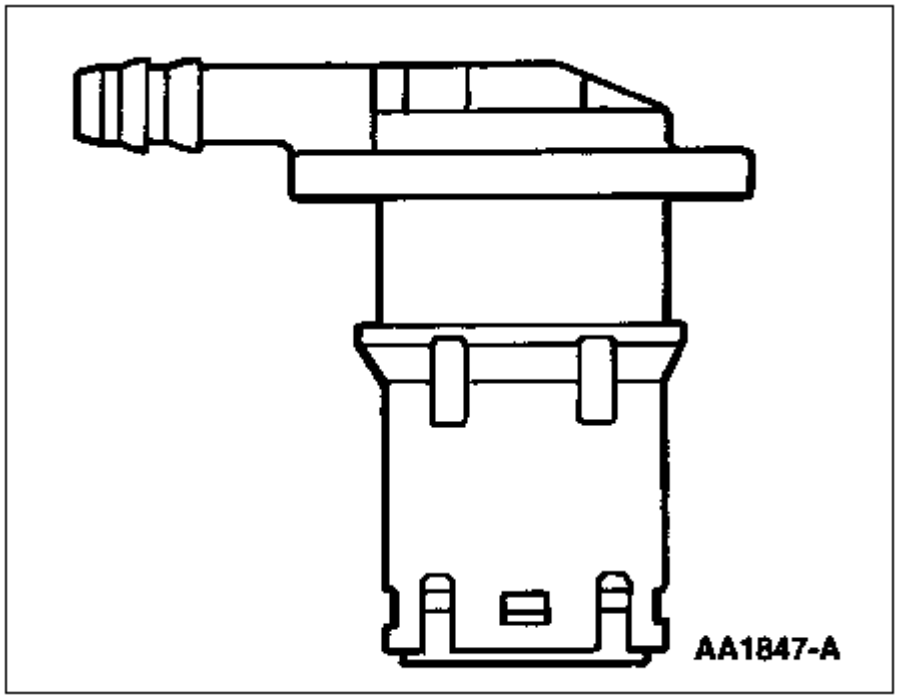

Figure 100: Fuel Vapor Vent Valve (Rubber Grommet Type)

Fuel Filler Cap

The fuel filler cap (Figure 101) is used to prevent fuel spill and close the evaporative emission/fuel system to

atmosphere.

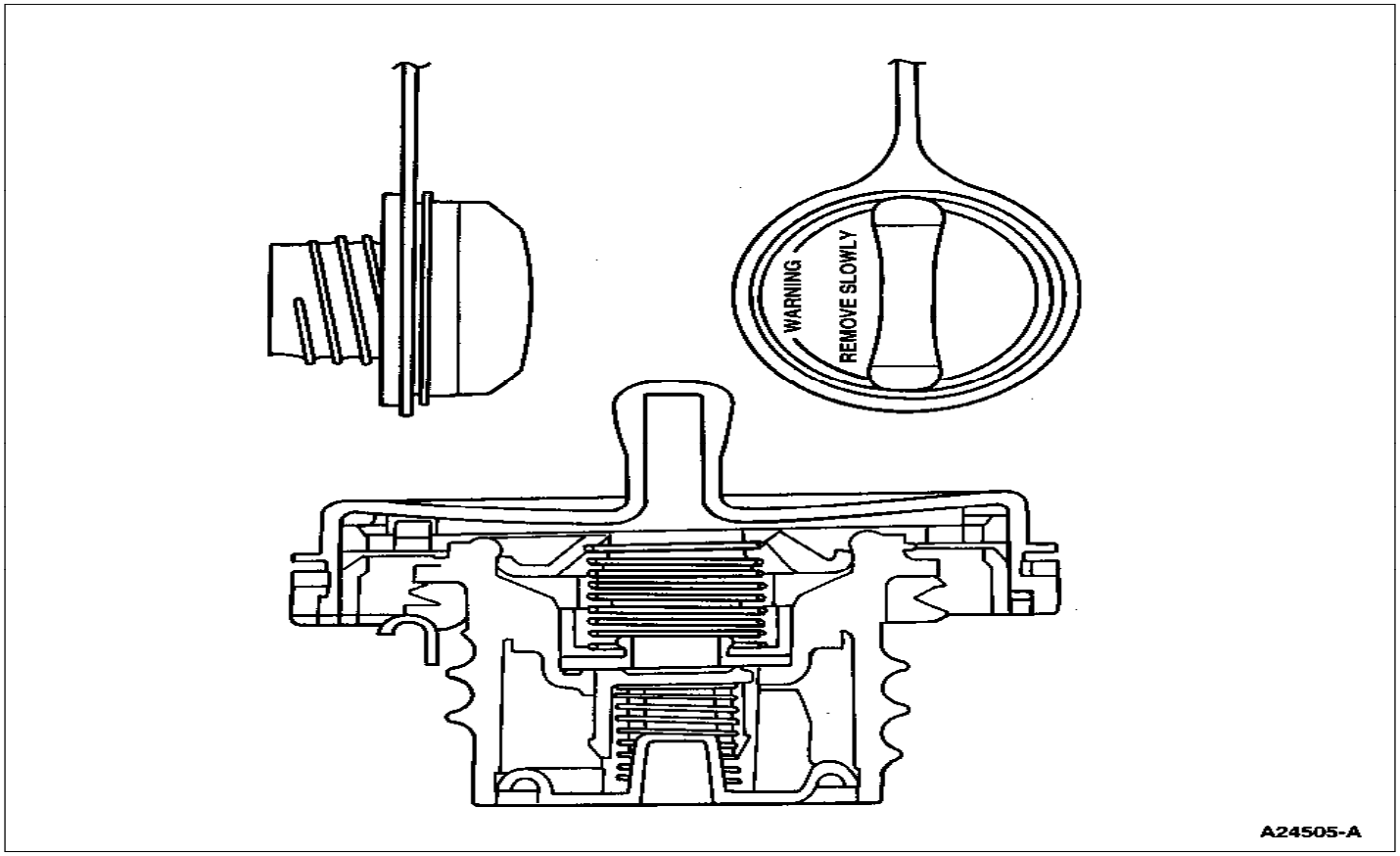

Figure 101: Fuel Filler Cap

Liquid/Vapor Fuel Discriminator

The liquid/vapor fuel discriminator (Figure 102) is a device that separates the liquid and vapor state of fuel at the fuel tank vent and allows only the fuel vapor to move through the EVAP Running Loss system with the liquid fuel remaining in the fuel tank. This is part of the fuel vapor control valve assembly on the Escort/Tracer (2V).

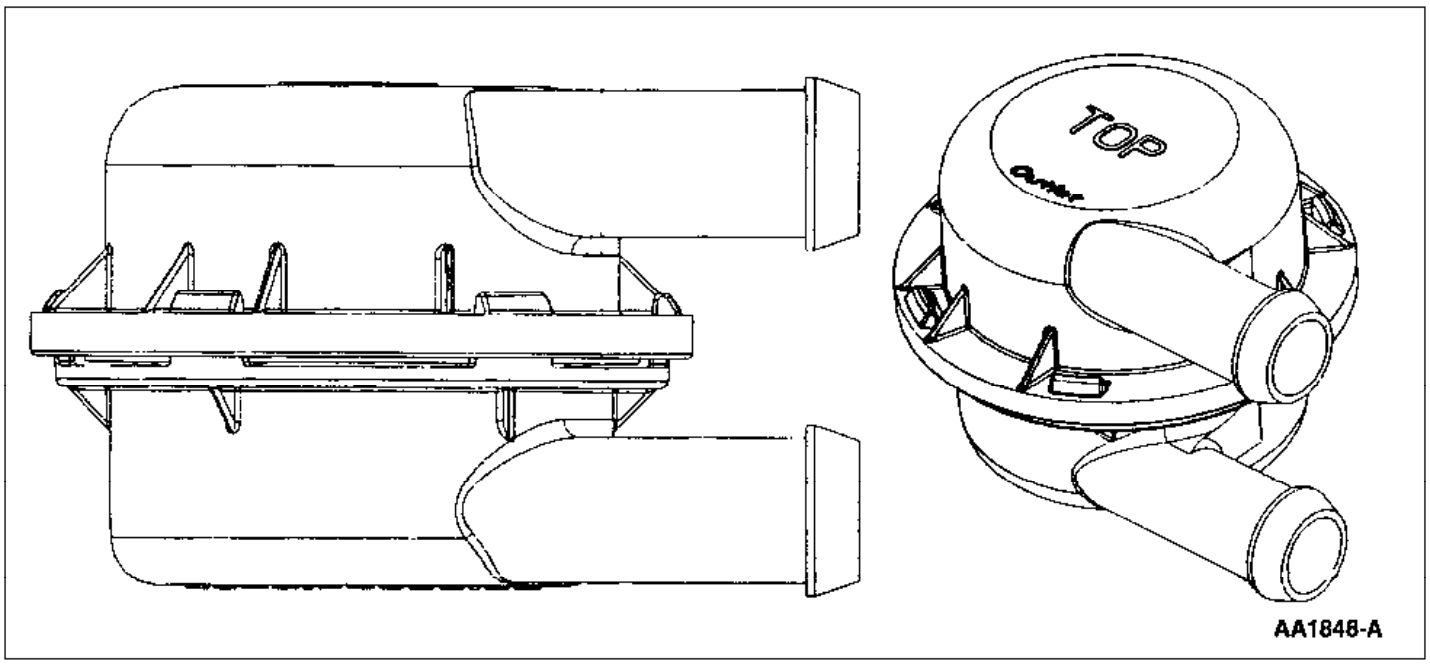

Figure 102: Liquid/Vapor Fuel Discriminator

On-Board Refueling Vapor Recovery (ORVR) Evaporative Emission (EVAP) System

The basic elements forming the ORVR system (Figure 103) and (Figure 104) operation are as follows when fuel is dispensed:

1. The fuel filler pipe forms a seal to prevent vapors from escaping the fuel tank, while liquid is entering the fuel tank (liquid in the one inch diameter tube blocks vapors from rushing back up the fuel filler pipe).
2. A fuel vapor control valve controls the flow of vapors out of the fuel tank (valve closes when liquid level reaches a height associated with the fuel tank usable capacity). This valve accomplishes the following:
    a. Limits the total amount of fuel that can be dispensed into the fuel tank.
    b. Prevents liquid gasoline from exiting the fuel tank when submerged (and also when tipped well beyond a horizontal plane as part of the vehicle roll-over protection in road accidents).
    c. Minimizes vapor flow resistance during anticipated refueling conditions.
3. Fuel vapor tubing connects the fuel vapor control valve to the EVAP canister. This routes the fuel tank vapors (displaced by the incoming liquid) to the EVAP canister.
4. A check valve in the bottom of the fuel filler pipe prevents liquid from rushing back up the fuel filler pipe during the liquid flow variations associated with the filler nozzle shut-off.

Between refueling events, the EVAP canister is purged with fresh air so that it may be used again to store vapors accumulated during engine shut off or subsequent refueling events. The vapors drawn off of the carbon in the EVAP canister are consumed into the engine

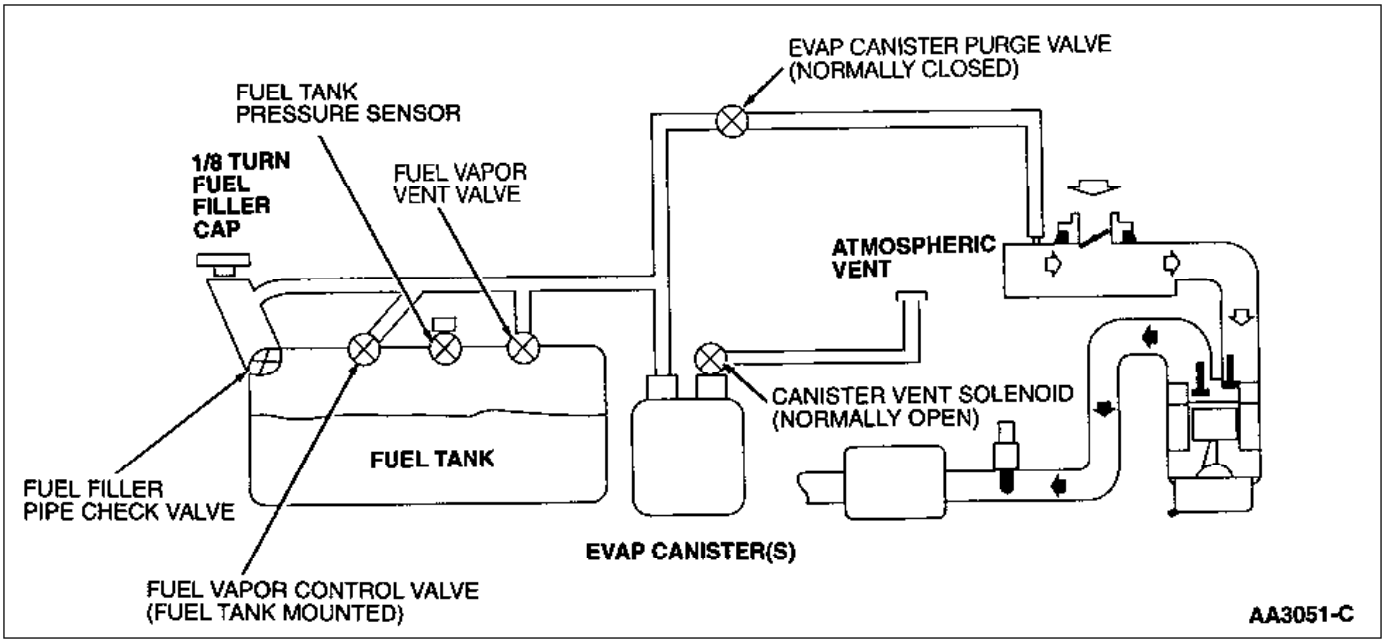

Figure 103: On-Board Refueling Vapor Recovery Evaporative Emission System Operation (Refer to the On-Board Diagnostics II System Overview for icon definitions)

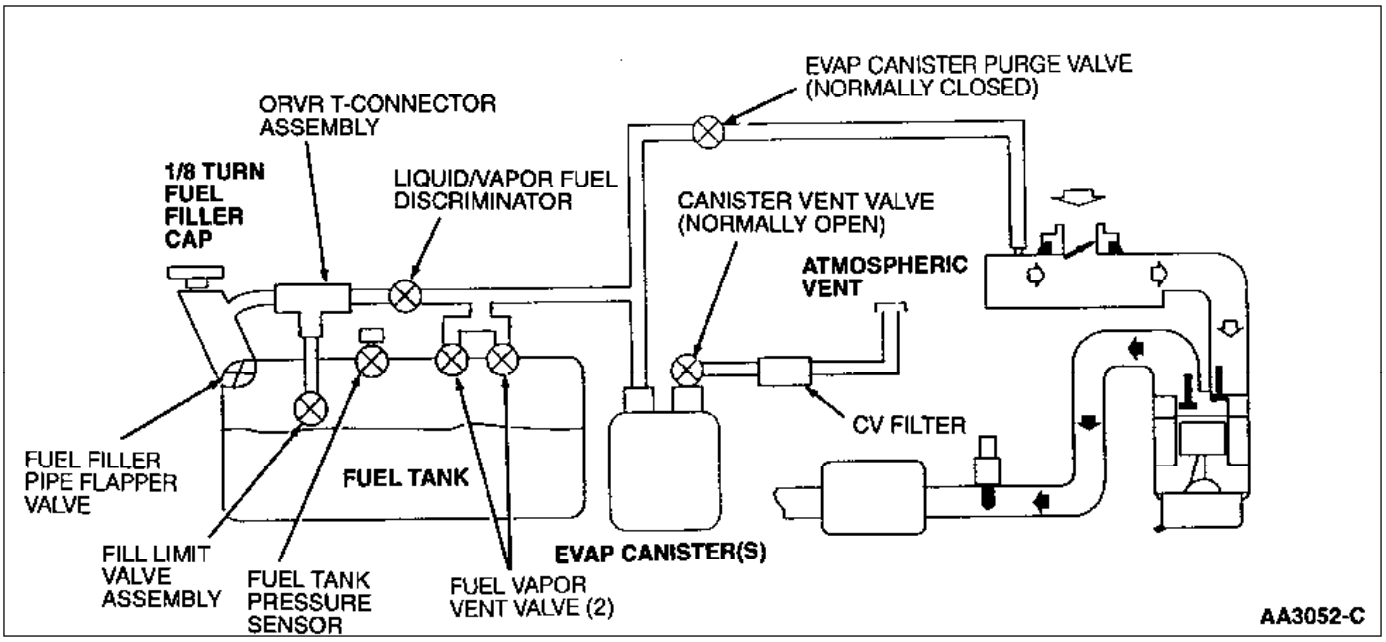

Figure 104: On-Board Refueling Vapor Recovery Evaporative Emission System Operation for Escort/Tracer (2V) Only (Refer to the On-Board Diagnostics II System Overview for icon definitions)

Hardware

Fuel Filler Pipe Check Valve

The fuel filler pipe check valve (Figure 105) on ORVR systems for Taurus/Sable (2V), Crown Victoria/Grand Marquis and Town Car is located internal to the fuel filler pipe where the tube joins the fuel tank. The purpose of this check valve is to prevent liquid fuel from re-entering the fuel filler pipe from the fuel tank during refueling or a rollover condition.

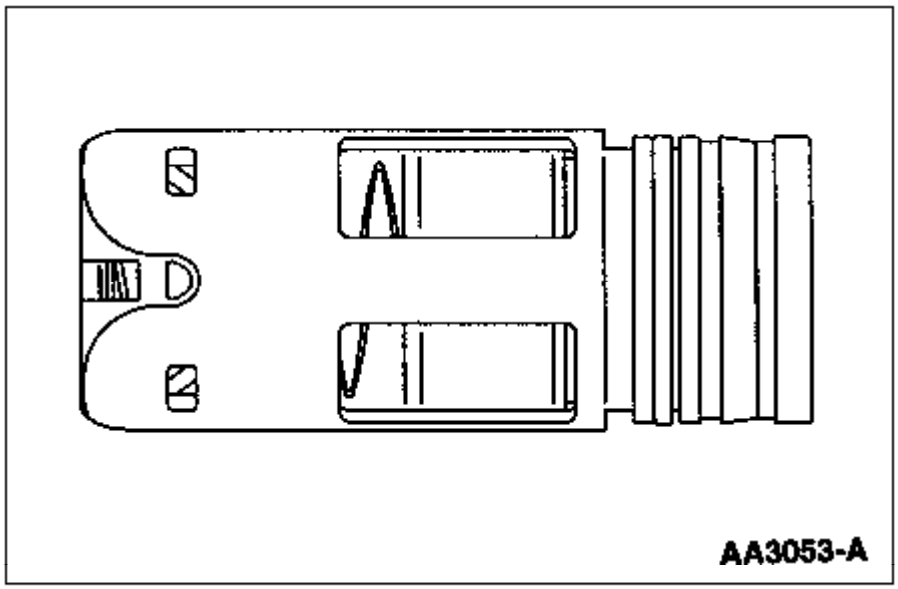

Figure 105: Fuel Filler Pipe Check Valve

Fill Limit Valve Assembly

The fill limit valve assembly (Figure 106) on the Escort/Tracer (2V) provides two functions. These functions are to control fuel tank volume and to prevent fuel from entering the vent tube in a roll-over condition. The fill limit valve assembly is a three piece device consisting of a vent tube, a vapor seal (which has an O-ring on both ends for leak protection) and a check valve which consists of a float with a spring assembly. The vent valve during vehicle driving (in upright position), controls fuel level by a float point based on the fuel density. In a roll-over situation, the spring closes the float and the vapor seal O-rings provide the additional seal to prevent fuel from entering the vent tube.

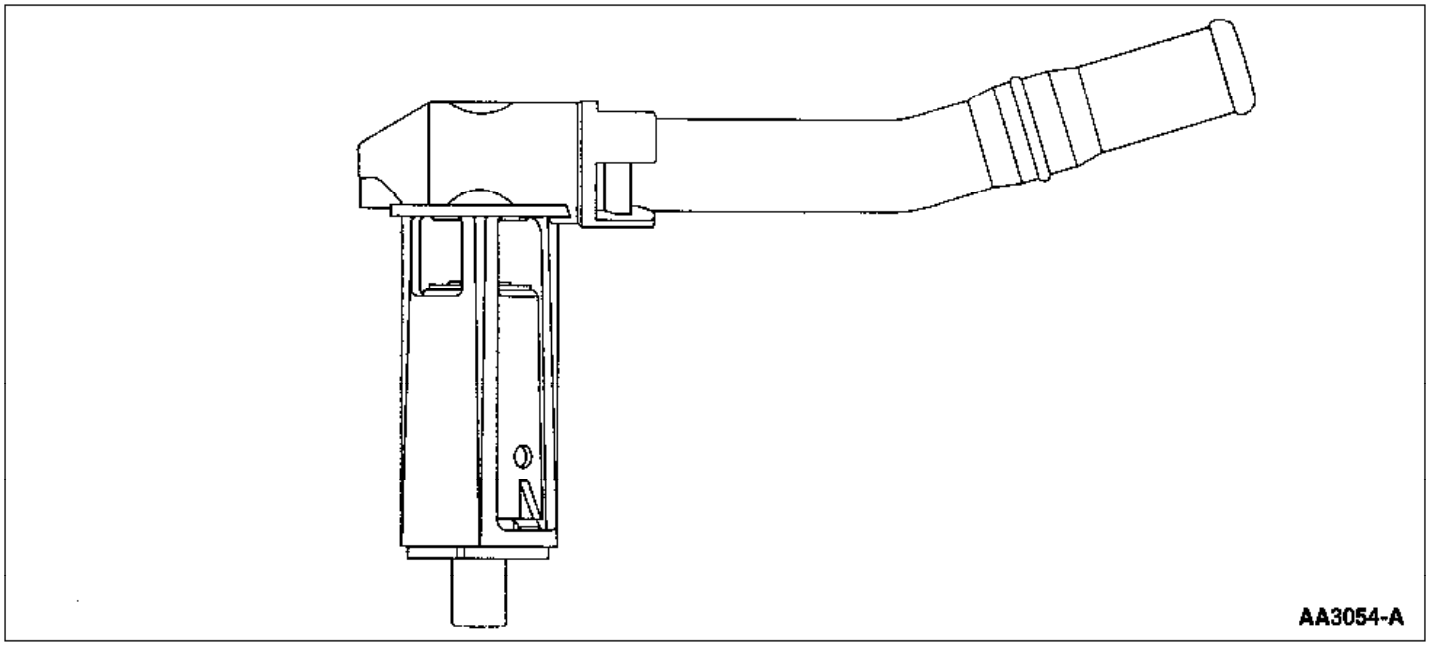

Figure 106: Fill Limit Valve Assembly

Fuel Filler Pipe Flapper Valve

The fuel filler pipe flapper valve (Figure 107) is located internally between bottom of the fuel filler pipe and the fuel tank. The purpose of this valve is to minimize fuel accumulation in the fuel filler pipe. Also, this valve is not a positive seal to the fuel tank.

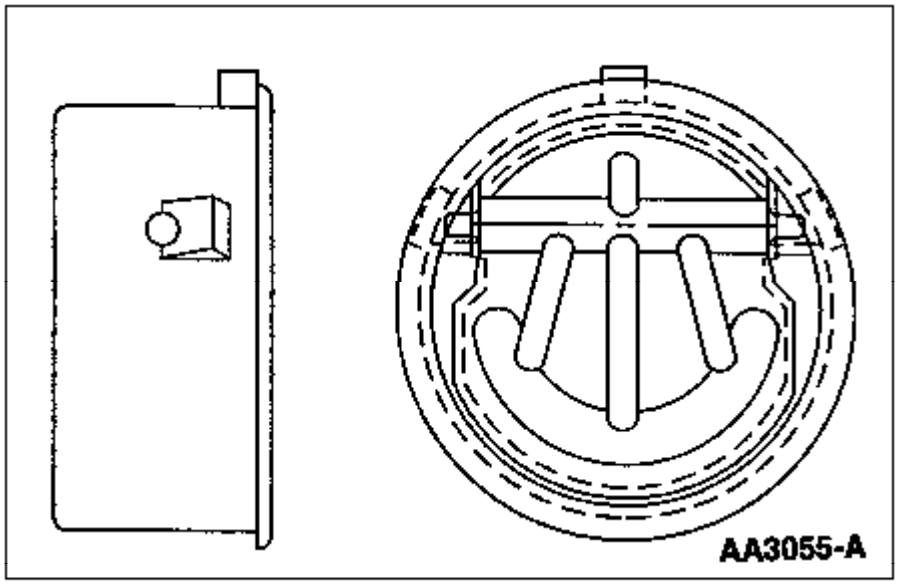

Figure 107: Fuel Filler Pipe Flapper Valve

Fuel Vapor Control Valve (Fuel Tank Mounted)

The fuel vapor control valve (fuel tank mounted) (Figure 108) is part of the On-Board Refueling Vapor Recovery (ORVR) system used on the Taurus/Sable (2V), Crown Victoria/Grand Marquis and Town Car for preventing liquid fuel from entering the EVAP canister and EVAP canister purge valve.

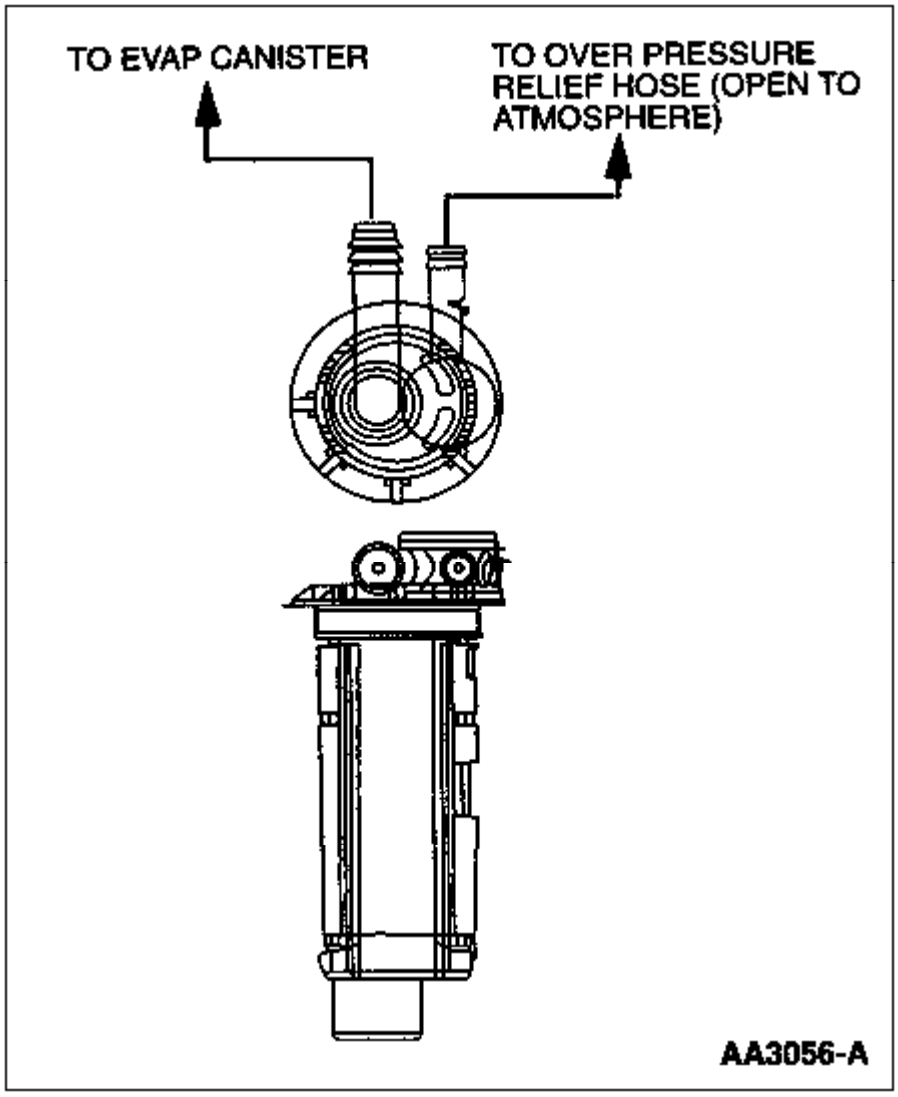

Figure 108: Fuel Vapor Control Valve (Fuel Tank Mounted)

Fuel Vapor Vent Valve

The fuel vapor vent valve (Figure 99) and (Figure 100), dependent on vehicle application) for the ORVR systems functions in the same manner as in the EVAP Running Loss system.

Liquid/Vapor Fuel Discriminator

The liquid/vapor fuel discriminator (Figure 102) description for the ORVR system on the Escort/Tracer (2V) is located in the EVAP Running Loss system hardware in this section.

ORVR T - Connector Assembly

The fuel vapor recovery system primary component on the Escort/Tracer (2V) is a fixed orifice and a roll-over

check valve contained in a T - connector assembly (Figure 109). The T - connector assembly is located between the liquid/vapor fuel discriminator inlet port (hose) and the fuel tank vent tube path. The orifice recirculates fuel vapor to the fuel filler pipe during the refueling process to displace fresh air (along with vapor) pulled into the fuel filler pipe by the refueling nozzle. The system vapor generation is reduced by replacing the fresh air with the recirculated vapor. The roll-over feature of the T- connector protects fuel passing back from the fuel tank through the fuel filler pipe and down the fuel filler recirculation tube during a crash roll-over. This prevents fuel leakage in cases where fuel vapor hoses or EVAP components may be displaced during a high speed crash.

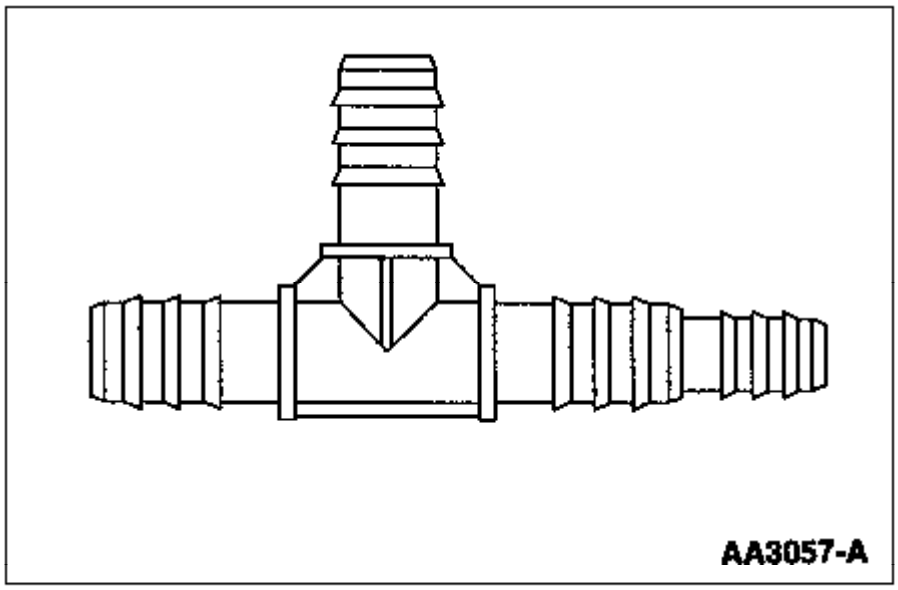

Figure 109: ORVR T-Connector Assembly

EVAP Canister (All Vehicles)

The fuel vapors from the fuel tank are stored in the EVAP canister. When the engine is running, the vapors are purged from the EVAP canister into the engine for combustion. OBD II vehicle EVAP canisters are sometimes used in pairs depending on the size or number of fuel tanks. The OBD II vehicle applications and number of EVAP canisters used are shown in the following table:

EVAPORATIVE EMISSION SYSTEM EVAP CANISTER CONFIGURATIONS

Vehicle Application	Number of EVAP Canisters	EVAP Canister Volume	Figure Number
Mustang (Federal)	1	0.925L	113
Mark VIII, Explorer /Mountaineer	2	1.0L	110
Windstar	2	1.0L and 1.5L	110 and 111
Escort/Tracer, Mustang (California)	1	1.5L	111
4.2L/4.6L/5.4L/6.8L (F150 and F250)	2	1.5L	111
Contour/Mystique, Taurus SHO, Taurus /Sable, Town Car, Crown Victoria/Grand Marquis, Continental, Ranger	1	2.0L	112
Taurus 2V (ORVR)	2	1.0L and 2.0L	110 and 112
Taurus Flexible Fuel	2	2.0L	112

Expedition/Navigator	1	2.8L	not shown
4.2L/4.6L/5.4L E	1 or 2	2.8L	not shown
-Series, 4.2L/5.4L			
/6.8L (F350 or F700)			

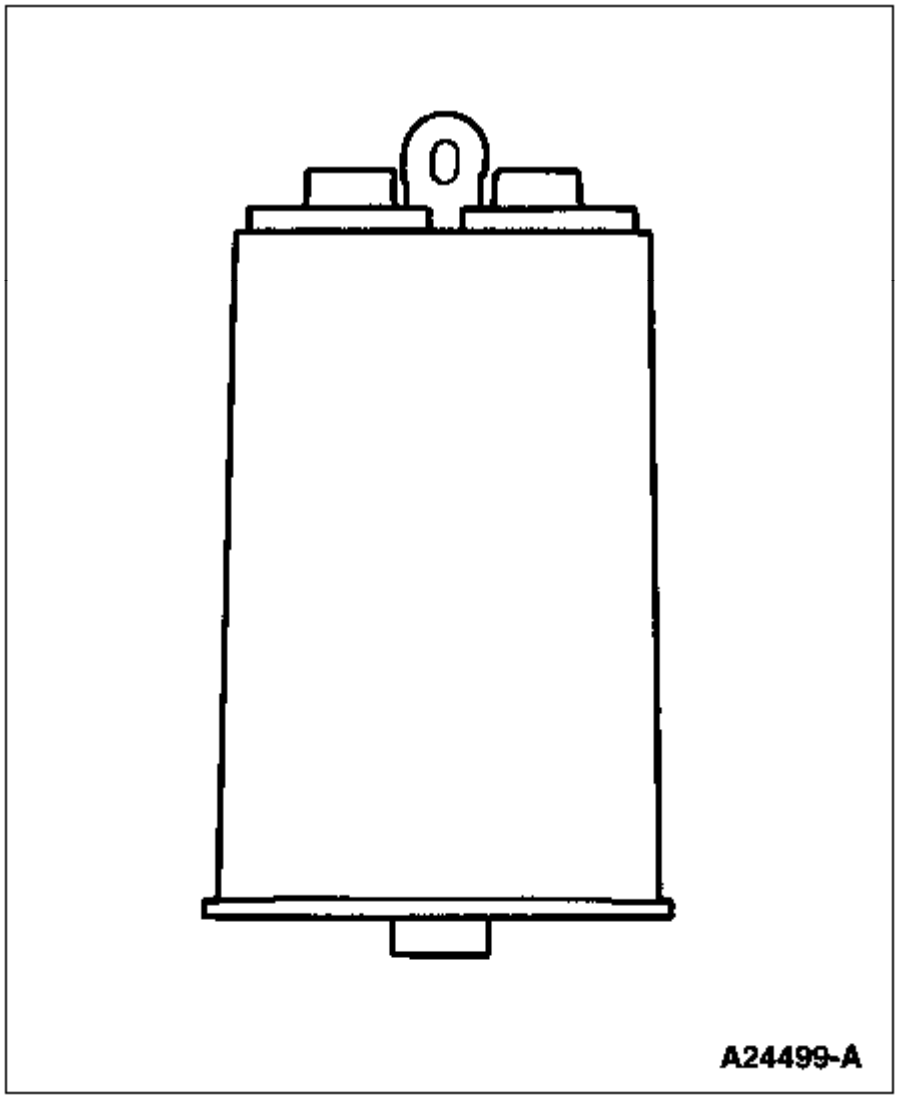

Figure 110: 1.0 Liter EVAP Canister

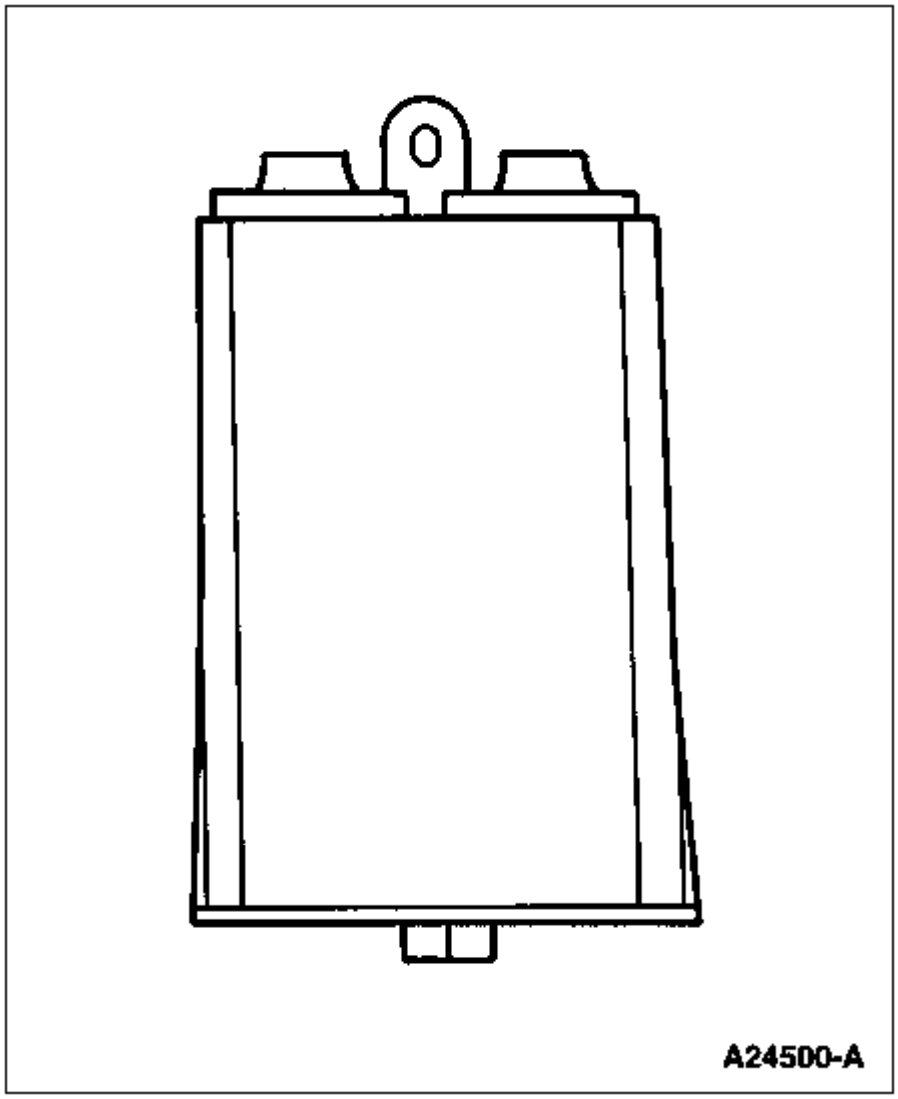

Figure 111: 1.5 Liter EVAP Canister

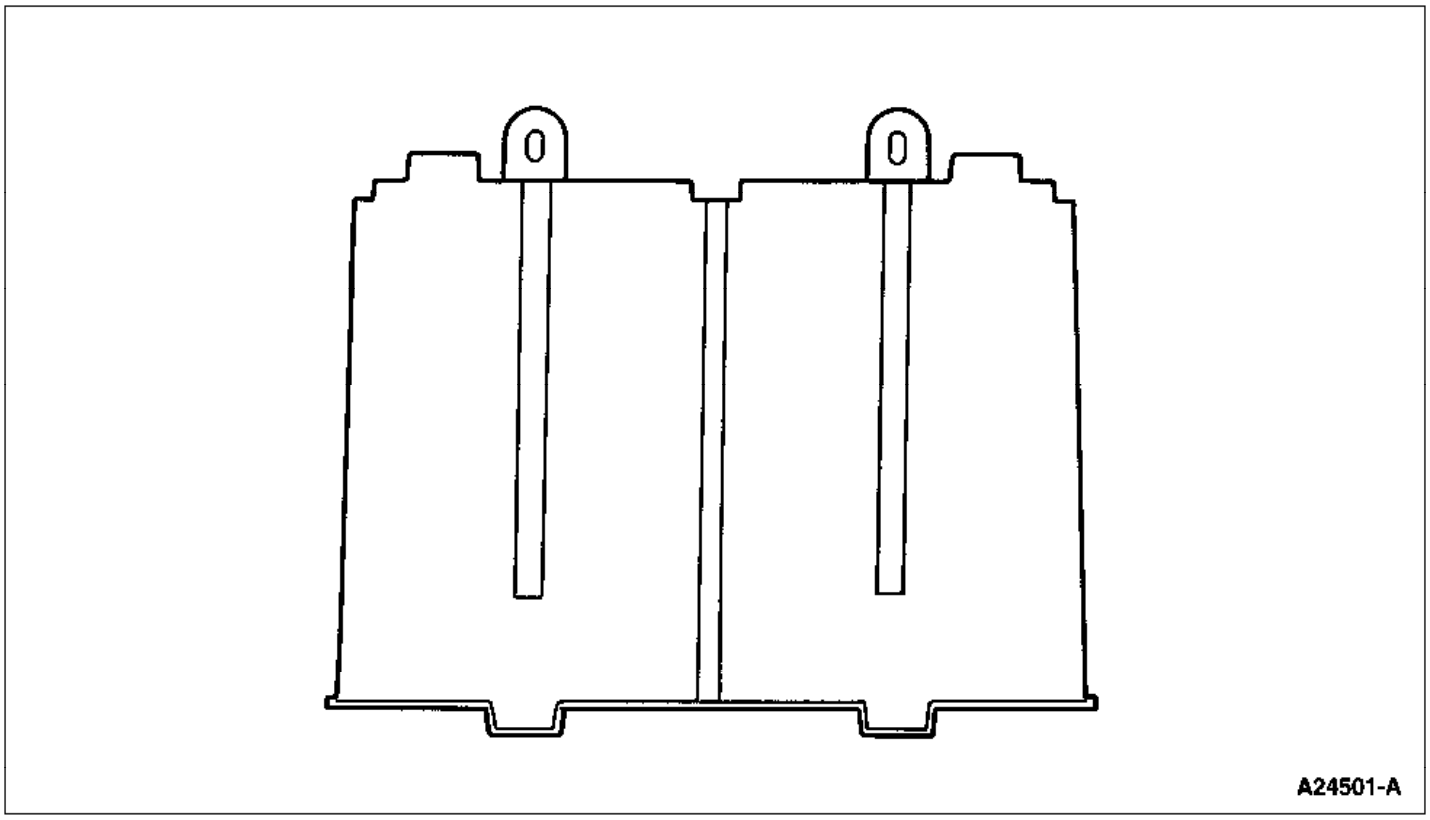

Figure 112: 2.0 Liter EVAP Canister

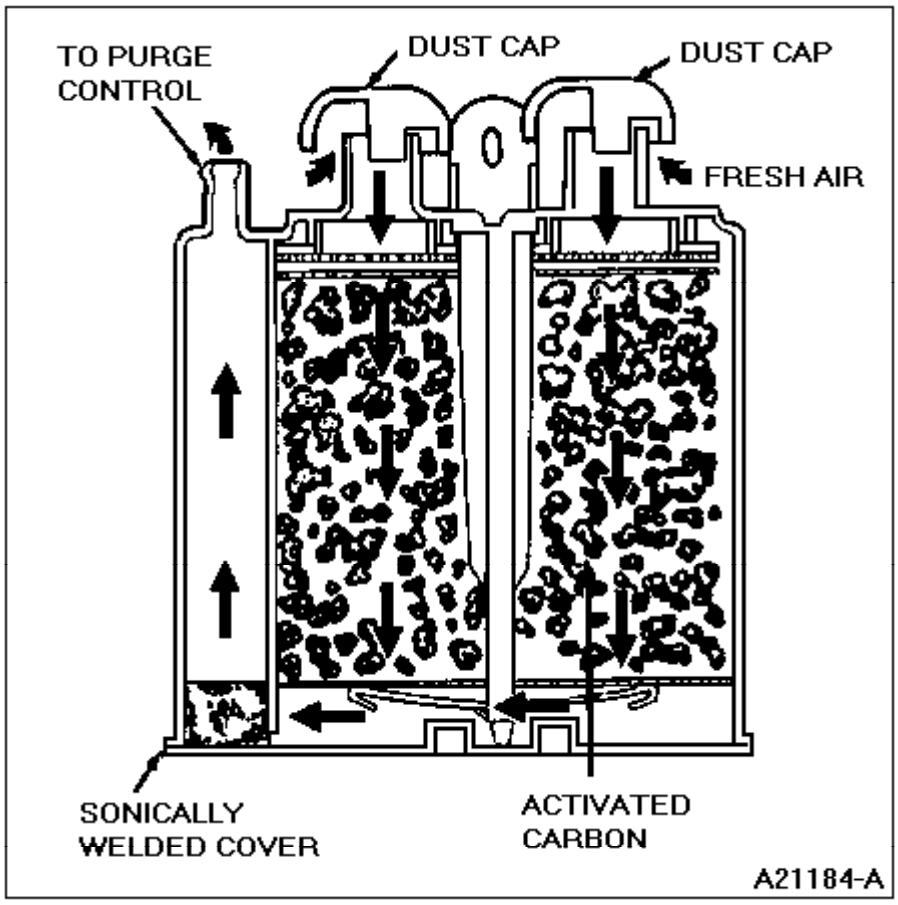

Figure 113: 0.925 Liter EVAP Canister