EMISSION CONTROL SYSTEMS

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GENERAL INFORMATION

INTRODUCTION

Throughout this group, references are made to particular vehicle models by alphabetical designation or by the particular vehicle nameplate. A chart showing a breakdown of the alphabetical designations is included in the Introduction section at the beginning of this manual.

All vehicles are equipped with either a 3.9L (V-6) engine, a 5.2L (V-8) engine, two different 5.9L (V-8) engines, two different 8.0L (V-10) engines, or a 5.9L Cummins in-line 6–cylinder, two-valve-per-cylinder diesel engine.

- The 3.9L (V-6) and 5.2L (V-8) engines will be referred to in this group as: LDC (Light Duty Emission Cycle) engines.
- The 5.9L (V-8) gas powered engine will be referred to as either: LDC (Light Duty Emission Cycle) or HDC (Heavy Duty Emission Cycle) engine.
- The 8.0L (V-10) engine will be referred to as either: MDC (Medium Duty Emission Cycle) or HDC (Heavy Duty Emission Cycle) engine.
- The diesel engine will be referred to as: HDC (Heavy Duty Emission Cycle) engine. When equipped with the California Emission Package, the diesel engine will use an Exhaust Gas Recirculation (EGR) system.

Either of the HDC gas powered engines can be easily identified by the use of an engine mounted air injection pump. The 3.9L/5.2L/5.9L LDC gas engines, the 8.0L MDC V-10 engine or the diesel engine will not use an air injection pump.

Maintenance requirements for LDC, MDC and HDC emission systems differ because of different load and operating conditions. For required part replacement or maintenance schedules in time or mileage intervals, refer to either Group 0, Lubrication and Maintenance in this manual, or the vehicle Owners Manual.

SERVICE REMINDER INDICATOR (SRI) LAMP

The Service Reminder Indicator (SRI) lamp is used with the 5.9L HDC V-8 gasoline powered engine only. The lamp is displayed on the instrument panel as the MAINT REQ'D lamp.

The SRI system is incorporated into the powertrain control module (PCM). The PCM records the vehicles mileage and stores it into memory. At that time, the PCM checks for certain mileage trip points. When the current mileage matches one of the trip points, the SRI lamp is activated.

Certain parts are to be replaced, or certain maintenance must be performed at either an indicated mileage or when the SRI lamp remains on when the key is in the ON position. After performing the part replacement or required maintenance, the SRI lamp must be reset to turn the lamp off. Use the DRB scan tool to reset the SRI lamp.

For required part replacement or maintenance schedules in time or mileage intervals, refer to either Group 0, Lubrication and Maintenance in this manual, or the vehicle Owners Manual.

Failure to perform the part replacement or required maintenance and only reset the SRI lamp may be a violation of federal law. Only after performing the part replacement or required maintenance, should the SRI lamp be reset.

ON-BOARD DIAGNOSTICS

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GENERAL INFORMATION

SYSTEM DESCRIPTION

The Powertrain Control Module (PCM) monitors many different circuits in the fuel injection, ignition, emission and engine systems. If the PCM senses a problem with a monitored circuit often enough to indicate an actual problem, it stores a Diagnostic Trouble Code (DTC) in the PCM's memory. If the problem is repaired or ceases to exist, the PCM cancels the code after 40 warm-up cycles. Diagnostic trouble codes that affect vehicle emissions illuminate the Malfunction Indicator (check engine) Lamp. Refer to Malfunction Indicator Lamp in this section.

Certain criteria must be met before the PCM stores a DTC in memory. The criteria may be a specific range of engine RPM, engine temperature, and/or input voltage to the PCM.

The PCM might not store a DTC for a monitored circuit even though a malfunction has occurred. This may happen because one of the DTC criteria for the circuit has not been met. **For example**, assume the diagnostic trouble code criteria requires the PCM to monitor the circuit only when the engine operates between 750 and 2000 RPM. Suppose the sensor's output circuit shorts to ground when engine operates above 2400 RPM (resulting in 0 volt input to the PCM). Because the condition happens at an engine speed above the maximum threshold (2000 rpm), the PCM will not store a DTC.

There are several operating conditions for which the PCM monitors and sets DTC's. Refer to Monitored Systems, Components, and Non-Monitored Circuits in this section.

Technicians must retrieve stored DTC's by connecting the DRB scan tool (or an equivalent scan tool) to the 16–way data link connector (Fig. 1). Refer to Diagnostic Trouble Codes in this section.

NOTE: Various diagnostic procedures may actually cause a diagnostic monitor to set a DTC. For instance, pulling a spark plug wire to perform a spark test may set the misfire code. When a repair is completed and verified, connect the DRB scan tool to the 16–way data link connector to erase all DTC's and extinguish the MIL (Check Engine Lamp).

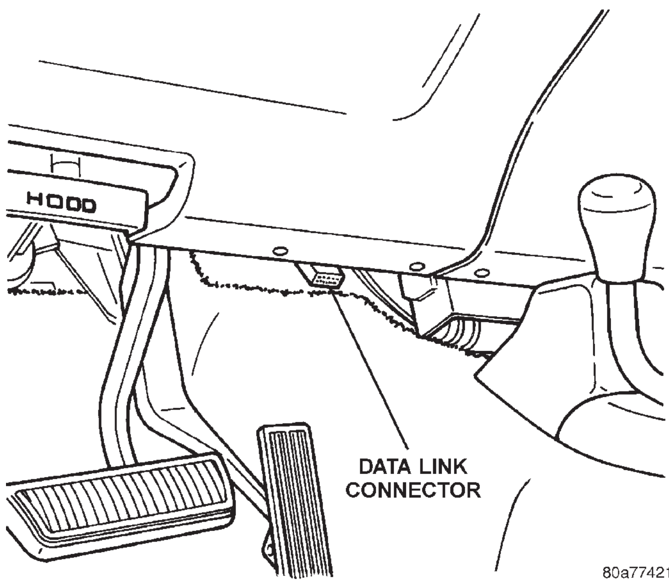

Fig. 1 16–Way Data Link (Diagnostic) Connector Location

DESCRIPTION AND OPERATION

MALFUNCTION INDICATOR LAMP (MIL)

As a functional test, the MIL (check engine) illuminates at key-on before engine cranking. Whenever the Powertrain Control Module (PCM) sets a Diagnostic Trouble Code (DTC) that affects vehicle emissions, it illuminates the MIL. If a problem is detected, the PCM sends a message to the instrument cluster to illuminate the lamp. The PCM illuminates the MIL only for DTC's that affect vehicle emissions. There are some monitors that may take two consecutive trips, with a detected fault, before the MIL is illuminated. The MIL stays on continu-

DESCRIPTION AND OPERATION (Continued)

ously when the PCM has entered a Limp-In mode or identified a failed emission component. Refer to the Diagnostic Trouble Code charts in this group for emission related codes.

Also, the MIL either flashes or illuminates continuously when the PCM detects active engine misfire. Refer to Misfire Monitoring in this section.

Additionally, the PCM may reset (turn off) the MIL when one of the following occur:

- PCM does not detect the malfunction for 3 consecutive trips (except misfire and Fuel system Monitors).
- PCM does not detect a malfunction while performing three successive engine misfire or fuel system tests. The PCM performs these tests while the engine is operating within ± 375 RPM of and within 10 % of the load of the operating condition at which the malfunction was first detected.

STATE DISPLAY TEST MODE

The switch inputs to the Powertrain Control Module (PCM) have two recognized states; HIGH and LOW. For this reason, the PCM cannot recognize the difference between a selected switch position versus an open circuit, a short circuit, or a defective switch. If the State Display screen shows the change from HIGH to LOW or LOW to HIGH, assume the entire switch circuit to the PCM functions properly. Connect the DRB scan tool to the data link connector and access the state display screen. Then access either State Display Inputs and Outputs or State Display Sensors.

CIRCUIT ACTUATION TEST MODE

The Circuit Actuation Test Mode checks for proper operation of output circuits or devices the Powertrain Control Module (PCM) may not internally recognize. The PCM attempts to activate these outputs and allow an observer to verify proper operation. Most of the tests provide an audible or visual indication of device operation (click of relay contacts, fuel spray, etc.). Except for intermittent conditions, if a device functions properly during testing, assume the device, its associated wiring, and driver circuit work correctly. Connect the DRB scan tool to the data link connector and access the Actuators screen.

DIAGNOSTIC TROUBLE CODES

A Diagnostic Trouble Code (DTC) indicates the PCM has recognized an abnormal condition in the system.

Diagnostic trouble codes are the results of a system or circuit failure, but do not directly identify the failed component or components.

Technicians must retrieve stored DTC's by connecting the DRB scan tool (or an equivalent scan tool) to the 16–way data link connector (Fig. 1).

NOTE: For a list of DTC's, refer to the charts in this section.

OBTAINING DIAGNOSTIC TROUBLE CODES

WARNING: APPLY PARKING BRAKE AND/OR BLOCK WHEELS BEFORE PERFORMING ANY TEST ON AN OPERATING ENGINE.

(1) Connect the DRB scan tool to data link (diagnostic) connector.

(2) Turn the ignition switch on, access Read Fault Screen. Record all the DTC's shown on the DRB scan tool.

(3) To erase DTC's, use the Erase Trouble Code data screen on the DRB scan tool.

DIAGNOSTIC TROUBLE CODE DESCRIPTIONS

* Check Engine Lamp (MIL) will illuminate during engine operation if this Diagnostic Trouble Code was recorded.

Hex Code	Generic Scan Tool Code	DRB Scan Tool Display	Description of Diagnostic Trouble Code
00			DTC Error
*01	P0340	No Cam Signal at PCM	No camshaft signal detected during engine cranking.
*02	P0601	Internal Controller Failure	PCM Internal fault condition detected.
05	P0162	Charging System Voltage Too Low	Battery voltage sense input below target charging during engine operation. Also, no significant change detected in battery voltage during active test of generator output circuit.
06	P1594	Charging System Voltage Too High	Battery voltage sense input above target charging voltage during engine operation.

DESCRIPTION AND OPERATION (Continued)

Hex Code	Generic Scan Tool Code	DRB Scan Tool Display	Description of Diagnostic Trouble Code
0A	P1388	Auto Shutdown Relay Control Circuit	An open or shorted condition detected in the auto shutdown relay circuit.
0B	P0622	Generator Field Not Switching Properly	An open or shorted condition detected in the generator field control circuit.
*0C	P0743	Torque Converter Clutch Solenoid/Trans Relay Circuits	An open or shorted condition detected in the torque converter part throttle unlock solenoid control circuit (3 speed auto RH trans. only).
0F	P1595	Speed Control Solenoid Circuits	An open or shorted condition detected in the Speed Control vacuum or vent solenoid circuits.
10	P0645	A/C Clutch Relay Circuit	An open or shorted condition detected in the A/C clutch relay circuit.
*11	P0403	EGR Solenoid Circuit	An open or shorted condition detected in the EGR solenoid control circuit.
*12	P0443	EVAP Purge Solenoid Circuit	An open or shorted condition detected in the duty cycle purge solenoid circuit.
*13 *14 *15	P0203 or P0202 or P0201	Injector #3 Control Circuit Injector #2 Control Circuit Injector #1 Control Circuit	Injector #3 output driver does not respond properly to the control signal. Injector #2 output driver does not respond properly to the control signal. Injector #1 output driver does not respond properly to the control signal.
*19	P0505	Idle Air Control Motor Circuits	A shorted or open condition detected in one or more of the idle air control motor circuits.
*1A *1B	P0122 or P0123	Throttle Position Sensor Voltage Low Throttle Position Sensor Voltage High	Throttle position sensor input below the minimum acceptable voltage Throttle position sensor input above the maximum acceptable voltage.
*1E *1F	P0117 or P0118	ECT Sensor Voltage Too Low ECT Sensor Voltage Too High	Engine coolant temperature sensor input below minimum acceptable voltage. Engine coolant temperature sensor input above maximum acceptable voltage.
21	P1281	Engine Is Cold Too Long	Engine did not reach operating temperature within acceptable limits.
*24 *25	P0107 or P0108	MAP Sensor Voltage Too Low MAP Sensor Voltage Too High	MAP sensor input below minimum acceptable voltage. MAP sensor input above maximum acceptable voltage.
*27	P1297	No Change in MAP From Start to Run	No difference recognized between the engine MAP reading and the barometric (atmospheric) pressure reading from start-up.

DESCRIPTION AND OPERATION (Continued)

Hex Code	Generic Scan Tool Code	DRB Scan Tool Display	Description of Diagnostic Trouble Code
28	P0320	No Crank Reference Signal at PCM	No crank reference signal detected during engine cranking.
*29	P0353	Ignition Coil #3 Primary Circuit	Peak primary circuit current not achieved with maximum dwell time.
*2A	P0352	Ignition Coil #2 Primary Circuit	Peak primary circuit current not achieved with maximum dwell time.
2B	P0351	Ignition Coil #1 Primary Circuit	Peak primary circuit current not achieved with maximum dwell time.
*2C	P1389	No ASD Relay Output Voltage at PCM	An Open condition Detected In The ASD Relay Output Circuit.
31	P1696	PCM Failure EEPROM Write Denied	Unsuccessful attempt to write to an EEPROM location by the PCM.
*32	P0753	Trans 3-4 Shift Sol/Trans Relay Circuits	Current state of output port for the solenoid is different from expected state.
*37	P0209	INJ 9 Control Circuit	Injector #9 output driver stage does not respond properly to the control signal.
*38	P0210	INJ 10 Control Circuit	Injector #10 output driver stage does not respond properly to the control signal.
*39 *3A	P0112 or P0113	Intake Air Temp Sensor Voltage Low Intake Air Temp Sensor Voltage High	Intake air temperature sensor input below the maximum acceptable voltage. Intake air temperature sensor input above the minimum acceptable voltage.
*3D	P0204	Injector #4 Control Circuit	Injector #4 output driver does not respond properly to the control signal.
*3E	P0132	Left Upstream O2S Shorted to Voltage	Oxygen sensor input voltage maintained above the normal operating range.
*42	P0152	O2 2/1 Shorted high	Oxygen sensor input voltage sustained above the normal operating range.
*45 *46	P0205 or P0206	Injector #5 Control Circuit Injector #6 Control Circuit	Injector #5 output driver does not respond properly to the control signal. Injector #6 output driver does not respond properly to the control signal.
4A 4B	P0712 or P0713	Trans Temp Sensor Voltage Too Low Trans Temp Sensor Voltage Too High	Voltage less than 1.55 volts. Voltage greater than 3.76 volts.
*4C	P0354	Ignition coil #4 circuit	Peak primary circuit current not achieved with maximum dwell time (high impedance).
*4D	P0355	Ignition coil #5 circuit	Peak primary circuit current not achieved with maximum dwell time (high impedance).
*4F	P0207 or	Injector #7 Control Circuit	Injector #7 output driver does not respond properly to the control signal.

DESCRIPTION AND OPERATION (Continued)

Hex Code	Generic Scan Tool Code	DRB Scan Tool Display	Description of Diagnostic Trouble Code
*50	P0208	Injector #8 Control Circuit	Injector #8 output driver does not respond properly to the control signal.
52	P1683	S/C Power Circuit	An open or shorted condition detected in the speed control servo power control circuit.
56	P1596	Speed Control Switch Always High	Speed control switch input above the maximum acceptable voltage.
	or		
57	P1597	Speed Control Switch Always Low	Speed control switch input below the minimum acceptable voltage.
65	P1282	Fuel Pump Relay Control Circuit	An open or shorted condition detected in the fuel pump relay control circuit.
*66	P0133 or P0152	Left Upstream O2S Slow Response	Oxygen sensor response slower than minimum required switching frequency.
	or		
*67	P0135	Left Upstream O2S Heater Failure	Upstream oxygen sensor heating element circuit malfunction
*68	P0139	O2 1/1 Response	Oxygen sensor response slower than minimum required switching frequency.
*69	P0141	Downstream,Left Bank Downstream or Pre-Catalyst Heater Failure	Oxygen sensor heating element circuit malfunction.
*6A	P0300	Multiple Cylinder Mis-fire	Misfire detected in multiple cylinders.
	or		
*6B	P0301	Cylinder #1 Mis-fire	Misfire detected in cylinder #1.
	or		
*6C	P0302	Cylinder #2 Mis-fire	Misfire detected in cylinder #2.
	or		
*6D	P0303	Cylinder #3 Mis-fire	Misfire detected in cylinder #3.
	or		
*6E	P0304	Cylinder #4 Mis-fire	Misfire detected in cylinder #4.
*70	P0420	Left Bank Catalytic (or just) Catalytic Efficency Failure	Catalyst efficiency below required level.
*71	P0441	Evap Purge Flow Monitor Failure	Insufficient or excessive vapor flow detected during evaporative emission system operation.
*72	P1899	P/N Switch Stuck in Park or in Gear	Incorrect input state detected for the Park/Neutral switch, auto. trans. only.
*76	P0172	Left Bank or Fuel System Rich	A rich air/fuel mixture has been indicated by an abnormally lean correction factor.
*77	P0171	Right Rear (or just) Fuel System Lean	A lean air/fuel mixture has been indicated by an abnormally rich correction factor.
*78	P0175	Fuel system 2/1 rich	A rich air/fuel mixture has been indicated by an abnormally lean correction factor.
*79	P0174	Fuel system 2/1 lean	A lean air/fuel mixture has been indicated by an abnormally rich correction factor.

DESCRIPTION AND OPERATION (Continued)

Hex Code	Generic Scan Tool Code	DRB Scan Tool Display	Description of Diagnostic Trouble Code
*7A	P0153	O2 2/1 slow response	Oxygen sensor response slower than mimimum required switching frequency.
*7B	P0159	O2 2/2 slow response	Oxygen sensor response slower than mimimum required switching frequency.
*7C	P0155	O2 2/1 heater circuit	Oxygen sensor heater element malfunction.
*7D	P0161	O2 2/2 heater circuit	Oxygen sensor heater element malfunction.
*7E	P0138	Left Bank Downstream or Downstream and Pre-Catalyst O2S Shorted to Voltage	Oxygen sensor input voltage maintained above the normal operating range.
*7F	P0158	O2 2/2 Shorted High	Oxygen sensor input voltage maintained above the normal operating range.
*80	P0125	Closed Loop Temp Not Reached	Engine does not reach 20°F within 5 minutes with a vehicle speed signal.
*84	P0121	TPS Voltage Does Not Agree With MAP	TPS signal does not correlate to MAP sensor
*87	P1296	No 5 Volts To MAP Sensor	5 Volt output to MAP sensor open.
*8A	P1294	Target Idle Not Reached	Actual idle speed does not equal target idle speed.
*8C	P0400	Diesel EGR system	PCM (Powertrain Control Module) not active or a fault condition of the dedicated EGR sensors and/or EGR solenoid was detected by the PCM.
*8D *8E	P1756 or P1757	Governor Pressure Not Equal to Target @ 15-20 PSI Governor Pressure Above 3 PSI In Gear With 0 MPH	Governor sensor input not between 10 and 25 psi when requested. Governor pressure greater than 3 psi when requested to be 0 psi.
*94	P0740	Torq Conv Clu, No RPM Drop At Lockup	Relationship between engine speed and vehicle speed indicates no torque converter clutch engagement (auto. trans. only).
95 96 97	P0462 or P0463 or P0460	Fuel Level Sending Unit Volts Too Low Fuel Level Sending Unit Volts Too High Fuel Level Unit No Change Over Miles	Open circuit between PCM and fuel gauge sending unit. Circuit shorted to voltage between PCM and fuel gauge sending unit. No movement of fuel level sender detected.
*99 *9A	P1493 or P1492	Ambient/Batt Temp Sen VoltsToo Low Ambient/Batt Temp Sensor VoltsToo High	Battery temperature sensor input voltage below an acceptable range. Battery temperature sensor input voltage above an acceptable range.
*9B	P0131	Left Bank and Upstream O2S Shorted to Ground	O2 sensor voltage too low, tested after cold start.

DESCRIPTION AND OPERATION (Continued)

Hex Code	Generic Scan Tool Code	DRB Scan Tool Display	Description of Diagnostic Trouble Code
 *9C	or P0137	 Downstream, Left Bank Downstream and Pre-Catalyst O2S Shorted to Ground	 O2 sensor voltage too low, tested after cold start.
*9D	P1391	Intermittent Loss of CMP or CKP	Intermittent loss of either camshaft or crankshaft position sensor
A0	P0442	EVAP leak monitor Small leak detected	A small leak has been detected by the leak detection monitor.
A1	P0455	EVAP leak monitor Large leak detected	The leak detection monitor is unable to pressurize EVAP system indicating large leak.
A4	P0711	Trans Temp Sensor, No Rise After Start	Sump temp did not rise more than 16°F within 10 minutes when starting temp is below 40°F or sump temp is above 260°F with coolant below 100°F.
*A5	P0783	3-4 Shift Sol, No RPM Drop @ 3-4 Shift	The ratio of engine rpm/output shaft speed did not change beyond on the minimum required.
*A6	P0720	Low Ouput Spd Sensor RPM Above 15 mph	Output shaft speed is less than 60 rpm with vehicle speed above 15 mph.
*A7 *A8 *A9	P1764 or P1763 or P1762	Governor Pessure Sensor Volts Too Low Governor Pressure Sensor Volts Too HI Governor Press Sen Offset Volts Too Lo or High	Voltage less than .10 volts. Voltage greater than 4.89 volts. Sensor input greater or less than calibration for 3 consecutive Neutral/Park occurances.
*AB	P0748	Governor Pressure Sol Control/Trans Relay Circuits	Current state of solenoid output port is different than expected.
*AD	P1765	Trans 12 Volt Supply Relay Ctrl Circuit	Current state of solenoid output port is different than expeted.
*AE *AF *B0 *B1	P0305 or P0306 or P0307 or P0308	Cylinder #5 Mis-fire Cylinder #6 Mis-fire Cylinder #7 Mis-fire Cylinder #8 Mis-fire	Misfire detected in cylinder #5. Misfire detected in cylinder #6. Misfire detected in cylinder #7. Misfire detected in cylinder #8.
*B2	P0309	Cylinder #9 Mis-fire	Misfire detected in cylinder #9.
*B3	P0310	Cylinder #10 Mis-fire	Misfire detected in cylinder #10.
*B4	P0432	Catalyst 2/1 EFFIC	Catalyst 2/1 efficiency below required level.
*B5	P0151	O2 2/1 Voltage Low	Oxygen sensor input voltage maintained below normal operating range.

DESCRIPTION AND OPERATION (Continued)

Hex Code	Generic Scan Tool Code	DRB Scan Tool Display	Description of Diagnostic Trouble Code
*B6	P0157	O2 2/2 Voltage Low	Oxygen sensor input voltage maintained below normal operating range.
*BA	P1398	Mis-fire Adaptive Numerator at Limit	CKP sensor target windows have too much variation
BC	P0751	O/D Switch Pressed (LO) More Than 5 Min	Overdrive Off switch input too low for more than 5 minutes.
*C0	P1195 or P0133	Cat Mon slow O2 1/1	A slow switching oxygen sensor has been detected in bank 1/1 during catalyst monitor test.
*C1	P0153 or P1196	Cat Mon slow O2 2/1	A slow switching oxygen sensor has been detected in bank 2/1 during catalyst monitor test.
*C2	P0129 or P1197	Cat Mon slow O2 1/2	A slow switching oxygen sensor has been detected in bank 1/2 during catalyst monitor test.
*DE	P1694	No Engine Bus Msgs	
*DF	P1693	Flt in Comp Module	

MONITORED SYSTEMS

There are new electronic circuit monitors that check fuel, emission, engine and ignition performance. These monitors use information from various sensor circuits to indicate the overall operation of the fuel, engine, ignition and emission systems and thus the emissions performance of the vehicle.

The fuel, engine, ignition and emission systems monitors do not indicate a specific component problem. They do indicate that there is an implied problem within one of the systems and that a specific problem must be diagnosed.

If any of these monitors detect a problem affecting vehicle emissions, the Malfunction Indicator (Check Engine) Lamp will be illuminated. These monitors generate Diagnostic Trouble Codes that can be displayed with the check engine lamp or a scan tool.

The following is a list of the system monitors:

- Misfire Monitor
- Fuel System Monitor
- Oxygen Sensor Monitor
- Oxygen Sensor Heater Monitor
- Catalyst Monitor
- Leak Detection Pump Monitor (if equipped)

All these system monitors require two consecutive trips with the malfunction present to set a fault.

Refer to the appropriate Powertrain Diagnostics Procedures manual for diagnostic procedures.

The following is an operation and description of each system monitor:

OXYGEN SENSOR (O2S) MONITOR

Effective control of exhaust emissions is achieved by an oxygen feedback system. The most importantelement of the feedback system is the O2S. The O2S is located in the exhaust path. Once it reaches operating temperature 300° to 350°C (572° to 662°F), the sensor generates a voltage that is inversely proportional to the amount of oxygen in the exhaust. The information obtained by the sensor is used to calculate the fuel injector pulse width. This maintains a 14.7 to 1 Air Fuel (A/F) ratio. At this mixture ratio, the catalyst works best to remove hydrocarbons (HC), carbon monoxide (CO) and nitrogen oxide (NOx) from the exhaust.

The O2S is also the main sensing element for the Catalyst and Fuel Monitors.

The O2S can fail in any or all of the following manners:

- slow response rate
- reduced output voltage
- dynamic shift
- shorted or open circuits

Response rate is the time required for the sensor to switch from lean to rich once it is exposed to a richer than optimum A/F mixture or vice versa. As the sensor starts malfunctioning, it could take longer to detect the changes in the oxygen content of the exhaust gas.

The output voltage of the O2S ranges from 0 to 1 volt. A good sensor can easily generate any output voltage in this range as it is exposed to different concentrations of oxygen. To detect a shift in the A/F mixture (lean or rich), the output voltage has to change beyond a threshold value. A malfunctioning sensor could have difficulty changing beyond the threshold value.

OXYGEN SENSOR HEATER MONITOR

If there is an oxygen sensor (O2S) shorted to voltage DTC, as well as a O2S heater DTC, the O2S fault MUST be repaired first. Before checking the O2S fault, verify that the heater circuit is operating correctly.

DESCRIPTION AND OPERATION (Continued)

Effective control of exhaust emissions is achieved by an oxygen feedback system. The most important element of the feedback system is the O2S. The O2S is located in the exhaust path. Once it reaches operating temperature 300° to 350°C (572 ° to 662°F), the sensor generates a voltage that is inversely proportional to the amount of oxygen in the exhaust. The information obtained by the sensor is used to calculate the fuel injector pulse width. This maintains a 14.7 to 1 Air Fuel (A/F) ratio. At this mixture ratio, the catalyst works best to remove hydrocarbons (HC), carbon monoxide (CO) and nitrogen oxide (NOx) from the exhaust.

The voltage readings taken from the O2S sensor are very temperature sensitive. The readings are not accurate below 300°C. Heating of the O2S sensor is done to allow the engine controller to shift to closed loop control as soon as possible. The heating element used to heat the O2S sensor must be tested to ensure that it is heating the sensor properly.

The O2S sensor circuit is monitored for a drop in voltage. The sensor output is used to test the heater by isolating the effect of the heater element on the O2S sensor output voltage from the other effects.

LEAK DETECTION PUMP MONITOR (IF EQUIPPED)

The leak detection assembly incorporates two primary functions: it must detect a leak in the evaporative system and seal the evaporative system so the leak detection test can be run.

The primary components within the assembly are: A three port solenoid that activates both of the functions listed above; a pump which contains a switch, two check valves and a spring/diaphragm, a canister vent valve (CVV) seal which contains a spring loaded vent seal valve.

Immediately after a cold start, between predetermined temperature thresholds limits, the three port solenoid is briefly energized. This initializes the pump by drawing air into the pump cavity and also closes the vent seal. During non test conditions the vent seal is held open by the pump diaphragm assembly which pushes it open at the full travel position. The vent seal will remain closed while the pump is cycling due to the reed switch triggering of the three port solenoid that prevents the diaphragm assembly from reaching full travel. After the brief initialization period, the solenoid is de-energized allowing atmospheric pressure to enter the pump cavity, thus permitting the spring to drive the diaphragm which forces air out of the pump cavity and into the vent system. When the solenoid is energized and de energized, the cycle is repeated creating flow in typical diaphragm pump fashion. The pump is controlled in 2 modes:

Pump Mode: The pump is cycled at a fixed rate to achieve a rapid pressure build in order to shorten the overall test length.

Test Mode: The solenoid is energized with a fixed duration pulse. Subsequent fixed pulses occur when the diaphragm reaches the Switch closure point.

The spring in the pump is set so that the system will achieve an equalized pressure of about 7.5” H20. The cycle rate of pump strokes is quite rapid as the system begins to pump up to this pressure. As the pressure increases, the cycle rate starts to drop off. If there is no leak in the system, the pump would eventually stop pumping at the equalized pressure. If there is a leak, it will continue to pump at a rate representative of the flow characteristic of the size of the leak. From this information we can determine if the leak is larger than the required detection limit (currently set at .040” orifice by CARB). If a leak is revealed during the leak test portion of the test, the test is terminated at the end of the test mode and no further system checks will be performed.

After passing the leak detection phase of the test, system pressure is maintained by turning on the LDP’s solenoid until the purge system is activated. Purge activation in effect creates a leak. The cycle rate is again interrogated and when it increases due to the flow through the purge system, the leak check portion of the diagnostic is complete.

The canister vent valve will unseal the system after completion of the test sequence as the pump diaphragm assembly moves to the full travel position.

Evaporative system functionality will be verified by using the stricter evap purge flow monitor. At an appropriate warm idle the LDP will be energized to seal the canister vent. The purge flow will be clocked up from some small value in an attempt to see a shift in the 02 control system. If fuel vapor, indicated by a shift in the 02 control, is present the test is passed. If not, it is assumed that the purge system is not functioning in some respect. The LDP is again turned off and the test is ended.

MISFIRE MONITOR

Excessive engine misfire results in increased catalyst temperature and causes an increase in HC emissions. Severe misfires could cause catalyst damage. To prevent catalytic convertor damage, the PCM monitors engine misfire.

The Powertrain Control Module (PCM) monitors for misfire during most engine operating conditions (positive torque) by looking at changes in the crankshaft speed. If a misfire occurs the speed of the crankshaft will vary more than normal.

FUEL SYSTEM MONITOR

To comply with clean air regulations, vehicles are equipped with catalytic converters. These converters

DESCRIPTION AND OPERATION (Continued)

reduce the emission of hydrocarbons, oxides of nitrogen and carbon monoxide. The catalyst works best when the Air Fuel (A/F) ratio is at or near the optimum of 14.7 to 1.

The PCM is programmed to maintain the optimum air/fuel ratio of 14.7 to 1. This is done by making short term corrections in the fuel injector pulse width based on the O2S sensor output. The programmed memory acts as a self calibration tool that the engine controller uses to compensate for variations in engine specifications, sensor tolerances and engine fatigue over the life span of the engine. By monitoring the actual fuel-air ratio with the O2S sensor (short term) and multiplying that with the program long-term (adaptive) memory and comparing that to the limit, it can be determined whether it will pass an emissions test. If a malfunction occurs such that the PCM cannot maintain the optimum A/F ratio, then the MIL will be illuminated.

CATALYST MONITOR

To comply with clean air regulations, vehicles are equipped with catalytic converters. These converters reduce the emission of hydrocarbons, oxides of nitrogen and carbon monoxide.

Normal vehicle miles or engine misfire can cause a catalyst to decay. A meltdown of the ceramic core can cause a reduction of the exhaust passage. This can increase vehicle emissions and deteriorate engine performance, driveability and fuel economy.

The catalyst monitor uses dual oxygen sensors (O2S's) to monitor the efficiency of the converter. The dual O2S's sensor strategy is based on the fact that as a catalyst deteriorates, its oxygen storage capacity and its efficiency are both reduced. By monitoring the oxygen storage capacity of a catalyst, its efficiency can be indirectly calculated. The upstream O2S is used to detect the amount of oxygen in the exhaust gas before the gas enters the catalytic converter. The PCM calculates the A/F mixture from the output of the O2S. A low voltage indicates high oxygen content (lean mixture). A high voltage indicates a low content of oxygen (rich mixture).

When the upstream O2S detects a lean condition, there is an abundance of oxygen in the exhaust gas. A functioning converter would store this oxygen so it can use it for the oxidation of HC and CO. As the converter absorbs the oxygen, there will be a lack of oxygen downstream of the converter. The output of the downstream O2S will indicate limited activity in this condition.

As the converter loses the ability to store oxygen, the condition can be detected from the behavior of the downstream O2S. When the efficiency drops, no chemical reaction takes place. This means the concentration of oxygen will be the same downstream as upstream. The output voltage of the downstream O2S copies the voltage of the upstream sensor. The only difference is a time lag (seen by the PCM) between the switching of the O2S's.

To monitor the system, the number of lean-to-rich switches of upstream and downstream O2S's is counted. The ratio of downstream switches to upstream switches is used to determine whether the catalyst is operating properly. An effective catalyst will have fewer downstream switches than it has upstream switches i.e., a ratio closer to zero. For a totally ineffective catalyst, this ratio will be one-to-one, indicating that no oxidation occurs in the device.

The system must be monitored so that when catalyst efficiency deteriorates and exhaust emissions increase to over the legal limit, the MIL (check engine lamp) will be illuminated.

TRIP DEFINITION

The term "Trip" has different meanings depending on what the circumstances are. If the MIL (Malfunction Indicator Lamp) is OFF, a Trip is defined as when the Oxygen Sensor Monitor and the Catalyst Monitor have been completed in the same drive cycle.

When any Emission DTC is set, the MIL on the dash is turned ON. When the MIL is ON, it takes 3 good trips to turn the MIL OFF. In this case, it depends on what type of DTC is set to know what a "Trip" is.

For the Fuel Monitor or Mis-Fire Monitor (continuous monitor), the vehicle must be operated in the "Similar Condition Window" for a specified amount of time to be considered a Good Trip.

If a Non-Contiuous OBDII Monitor, such as:

- Oxygen Sensor
- Catalyst Monitor
- Purge Flow Monitor
- Leak Detection Pump Monitor (if equipped)
- EGR Monitor (if equipped)
- Oxygen Sensor Heater Monitor

fails twice in a row and turns ON the MIL, re-running that monitor which previously failed, on the next start-up and passing the monitor is considered to be a Good Trip.

If any other Emission DTC is set (not an OBDII Monitor), a Good Trip is considered to be when the Oxygen Sensor Monitor and Catalyst Monitor have been completed; or 2 Minutes of engine run time if the Oxygen Sensor Monitor or Catalyst Monitor have been stopped from running.

It can take up to 2 Failures in a row to turn on the MIL. After the MIL is ON, it takes 3 Good Trips to turn the MIL OFF. After the MIL is OFF, the PCM will self-erase the DTC after 40 Warm-up cycles. A Warm-up cycle is counted when the ECT (Engine Coolant Temperature Sensor) has crossed 160°F and has risen by at least 40°F since the engine has been started.

DESCRIPTION AND OPERATION (Continued)

COMPONENT MONITORS

There are several components that will affect vehicle emissions if they malfunction. If one of these components malfunctions the Malfunction Indicator Lamp (Check Engine) will illuminate.

Some of the component monitors are checking for proper operation of the part. Electrically operated components now have input (rationality) and output (functionality) checks. Previously, a component like the Throttle Position sensor (TPS) was checked by the PCM for an open or shorted circuit. If one of these conditions occurred, a DTC was set. Now there is a check to ensure that the component is working. This is done by watching for a TPS indication of a greater or lesser throttle opening than MAP and engine rpm indicate. In the case of the TPS, if engine vacuum is high and engine rpm is 1600 or greater and the TPS indicates a large throttle opening, a DTC will be set. The same applies to low vacuum if the TPS indicates a small throttle opening.

All open/short circuit checks or any component that has an associated limp in will set a fault after 1 trip with the malfunction present. Components without an associated limp in will take two trips to illuminate the MIL.

Refer to the Diagnostic Trouble Codes Description Charts in this section and the appropriate Powertrain Diagnostic Procedure Manual for diagnostic procedures.

NON-MONITORED CIRCUITS

The PCM does not monitor the following circuits, systems and conditions that could have malfunctions causing driveability problems. The PCM might not store diagnostic trouble codes for these conditions. However, problems with these systems may cause the PCM to store diagnostic trouble codes for other systems or components. For example, a fuel pressure problem will not register a fault directly, but could cause a rich/lean condition or misfire. This could cause the PCM to store an oxygen sensor or misfire diagnostic trouble code.

FUEL PRESSURE

The fuel pressure regulator controls fuel system pressure. The PCM cannot detect a clogged fuel pump inlet filter, clogged in-line fuel filter, or a pinched fuel supply or return line. However, these could result in a rich or lean condition causing the PCM to store an oxygen sensor or fuel system diagnostic trouble code.

SECONDARY IGNITION CIRCUIT

The PCM cannot detect an inoperative ignition coil, fouled or worn spark plugs, ignition cross firing, or open spark plug cables.

CYLINDER COMPRESSION

The PCM cannot detect uneven, low, or high engine cylinder compression.

EXHAUST SYSTEM

The PCM cannot detect a plugged, restricted or leaking exhaust system, although it may set a fuel system fault.

FUEL INJECTOR MECHANICAL MALFUNCTIONS

The PCM cannot determine if a fuel injector is clogged, the needle is sticking or if the wrong injector is installed. However, these could result in a rich or lean condition causing the PCM to store a diagnostic trouble code for either misfire, an oxygen sensor, or the fuel system.

EXCESSIVE OIL CONSUMPTION

Although the PCM monitors engine exhaust oxygen content when the system is in closed loop, it cannot determine excessive oil consumption.

THROTTLE BODY AIR FLOW

The PCM cannot detect a clogged or restricted air cleaner inlet or filter element.

VACUUM ASSIST

The PCM cannot detect leaks or restrictions in the vacuum circuits of vacuum assisted engine control system devices. However, these could cause the PCM to store a MAP sensor diagnostic trouble code and cause a high idle condition.

PCM SYSTEM GROUND

The PCM cannot determine a poor system ground. However, one or more diagnostic trouble codes may be generated as a result of this condition. The module should be mounted to the body at all times, also during diagnostic.

PCM CONNECTOR ENGAGEMENT

The PCM may not be able to determine spread or damaged connector pins. However, it might store diagnostic trouble codes as a result of spread connector pins.

HIGH AND LOW LIMITS

The PCM compares input signal voltages from each input device with established high and low limits for the device. If the input voltage is not within limits and other criteria are met, the PCM stores a diagnostic trouble code in memory. Other diagnostic trouble code criteria might include engine RPM limits or input voltages from other sensors or switches that must be present before verifying a diagnostic trouble code condition.

DESCRIPTION AND OPERATION (Continued)

LOAD VALUE

ENGINE	IDLE/NEUTRAL	2500 RPM/NEUTRAL
All Engines	2% to 8% of Maximum Load	9% to 17% of Maximum Load

EVAPORATIVE EMISSION CONTROLS

INDEX

DESCRIPTION AND OPERATION

EVAPORATION (EVAP) CONTROL SYSTEM

The evaporation control system prevents the emission of fuel tank vapors into the atmosphere. When fuel evaporates in the fuel tank, the vapors pass through vent hoses or tubes into the two charcoal filled evaporative canisters. The canisters temporarily hold the vapors. The Powertrain Control Module (PCM) allows intake manifold vacuum to draw vapors into the combustion chambers during certain operating conditions.

All 3.9L/5.2L/5.9L/8.0L gasoline powered engines use a duty cycle purge system. The PCM controls vapor flow by operating the duty cycle EVAP purge solenoid. Refer to Duty Cycle EVAP Canister Purge Solenoid for additional information.

When equipped with certain emissions packages, a Leak Detection Pump (LDP) will be used as part of the evaporative system. This pump is used as part of OBD II requirements. Refer to Leak Detection Pump in this group for additional information.

NOTE: The hoses used in this system are specially manufactured. If replacement becomes necessary, it is important to use only fuel resistant hose.

ROLLOVER VALVE(S)

Diesel Powered Engine: One rollover valve is used. The valve is used only to vent the fuel tank to the atmosphere. A check valve is located within the rollover valve to prevent fuel flow from the fuel tank in the event of an accidental vehicle rollover. The rollover valve is located on the top of the fuel tank module (Fig. 1). The valve may be serviced separately. If replacement is necessary, refer to the Removal/Installation section of this group.

Gasoline Powered Engines: Two rollover valves are used. Fuel vapors from the fuel tank are drawn through these valves into both of the EVAP canisters by engine vacuum. A check valve is located within each of the rollover valves to prevent fuel flow from the fuel tank in the event of an accidental vehicle rollover.

If equipped with a 26 or 34 gallon fuel tank, two rollover valves are used. One of the valves is permanently mounted to the top of fuel tank (Fig. 2). If replacement of this particular valve is necessary, the fuel tank must be replaced. The other rollover valve is located on the top of the fuel pump module (Fig. 2). This valve may be serviced separately. If replacement is necessary, refer to the Removal/Installation section of this group.

If equipped with a 35 gallon fuel tank, two rollover valves are used. Both valves are permanently mounted to the top of fuel tank (Fig. 3). If replacement is necessary, the fuel tank must be replaced.

DESCRIPTION AND OPERATION (Continued)

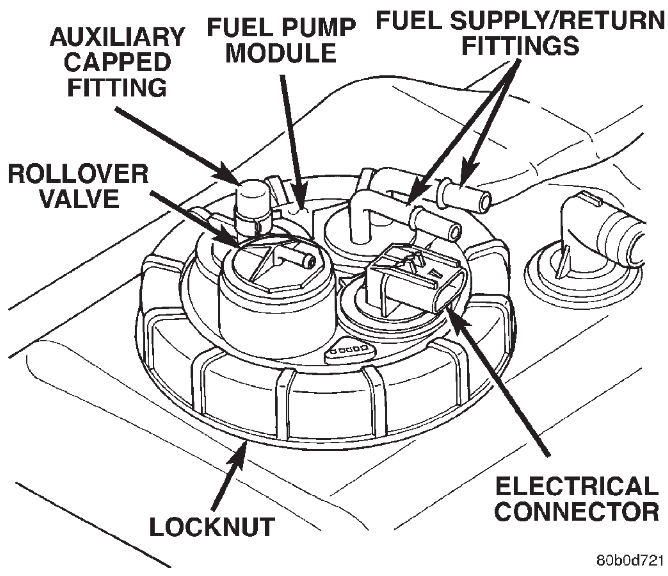

Fig. 1 Rollover Valve Location—Diesel Powered

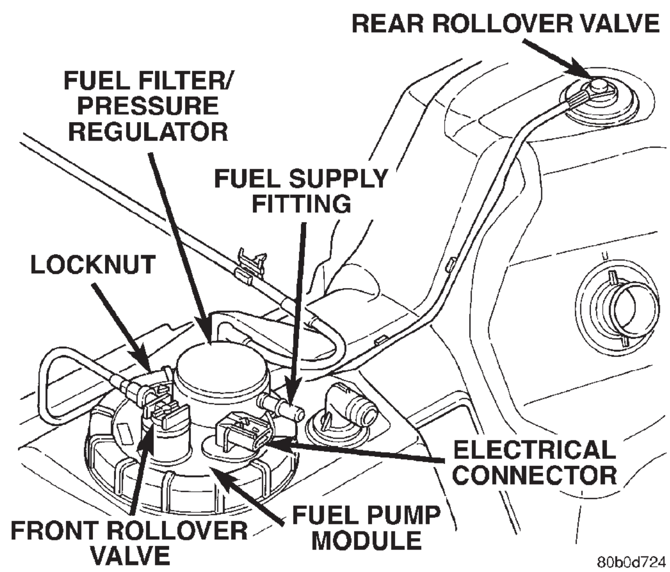

Fig. 2 Rollover Valve Locations—Gas Powered with 26 or 34 Gallon Tank

EVAPORATIVE (EVAP) CANISTER

Two, maintenance free, EVAP canisters are used with all 3.9L/5.2L/5.9L/8.0L gasoline powered engines. Both canisters are mounted to a bracket located below rear of vehicle cab on outside of right frame rail (Fig. 4). The EVAP canisters are filled with granules of an activated carbon mixture. Fuel vapors entering the EVAP canisters are absorbed by the charcoal granules.

Fuel tank pressure vents into the EVAP canisters. Fuel vapors are temporarily held in the canisters until they can be drawn into the intake manifold. The duty cycle EVAP canister purge solenoid allows the EVAP canisters to be purged at predetermined times and at certain engine operating conditions.

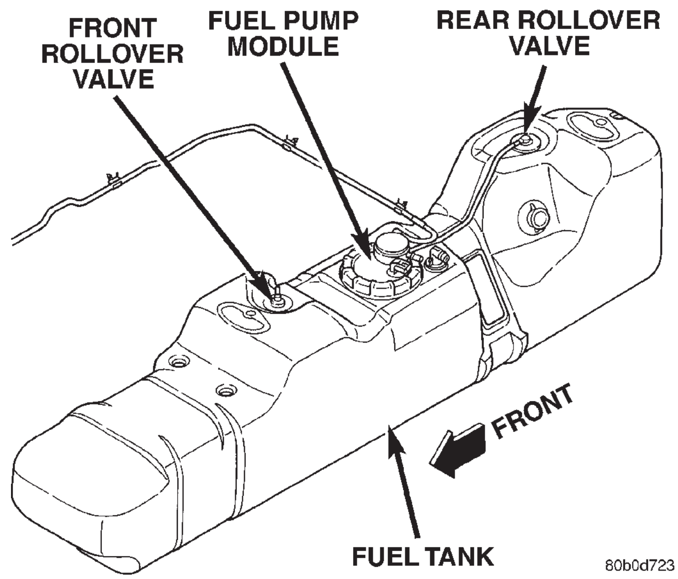

Fig. 3 Rollover Valve Locations—Gas Powered with 35 Gallon Tank

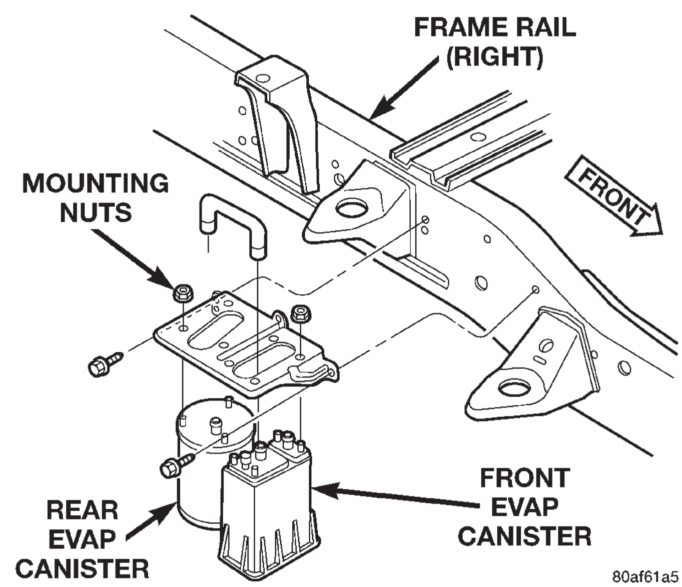

Fig. 4 Location of EVAP Canisters

DUTY CYCLE EVAP CANISTER PURGE SOLENOID

All 3.9L/5.2L/5.9L/8.0L gasoline powered engines use a duty cycle EVAP canister purge solenoid. The solenoid regulates the rate of vapor flow from the EVAP canister to the throttle body. The PCM operates the solenoid.

During the cold start warm-up period and the hot start time delay, the PCM does not energize the solenoid. When de-energized, no vapors are purged. The PCM de-energizes the solenoid during open loop operation.

The engine enters closed loop operation after it reaches a specified temperature and the time delay ends. During closed loop operation, the PCM energizes and de-energizes the solenoid 5 or 10 times per

DESCRIPTION AND OPERATION (Continued)

second, depending upon operating conditions. The PCM varies the vapor flow rate by changing solenoid pulse width. Pulse width is the amount of time the solenoid energizes. The PCM adjusts solenoid pulse width based on engine operating condition.

The solenoid attaches to a bracket mounted to the right inner fender (Fig. 5).

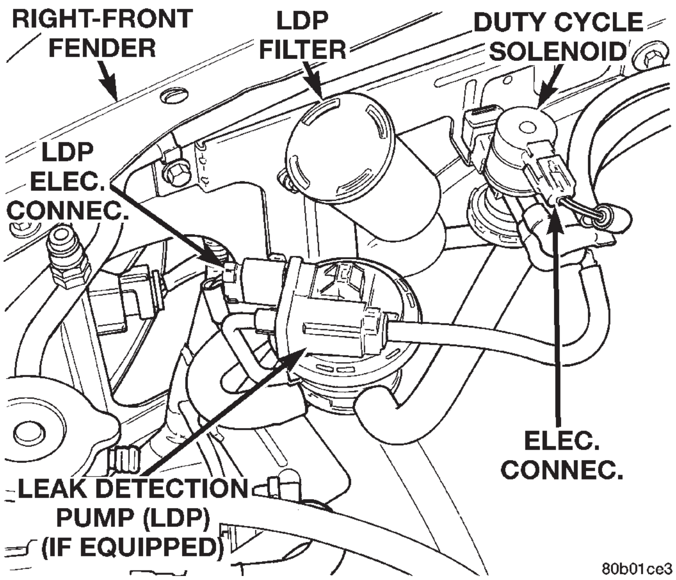

Fig. 5 EVAP Canister Purge Solenoid and LDP Location

LEAK DETECTION PUMP (LDP)

The Leak Detection Pump (LDP) is used only with certain emission packages. The LDP and LDP filter are located in the engine compartment on the right-inner fender (Fig. 5). The EVAP system test port is located in front of the Powertrain Control Module (PCM) (Fig. 6).

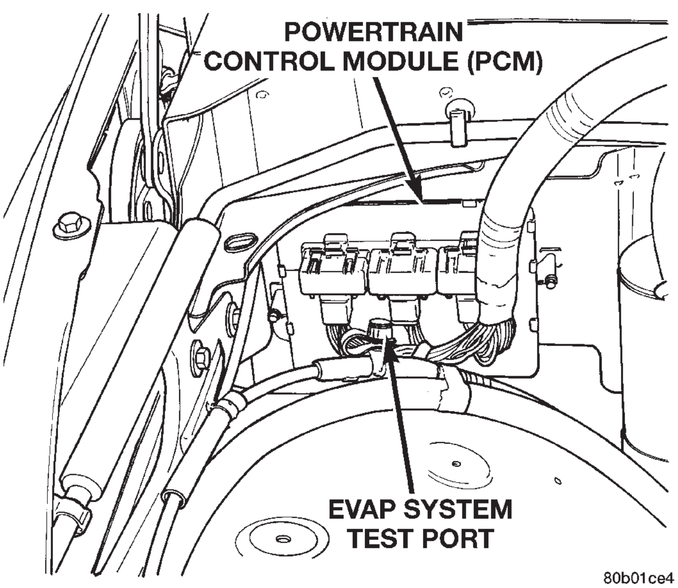

Fig. 6 EVAP System Test Port Location

The LDP is a device used to detect a leak in the evaporative system.

The pump contains a 3 port solenoid, a pump that contains a switch, a spring loaded canister vent valve seal, 2 check valves and a spring/diaphragm.

Immediately after a cold start, engine temperature between 40°F and 86°F, the 3 port solenoid is briefly energized. This initializes the pump by drawing air into the pump cavity and also closes the vent seal. During non-test test conditions, the vent seal is held open by the pump diaphragm assembly which pushes it open at the full travel position. The vent seal will remain closed while the pump is cycling. This is due to the operation of the 3 port solenoid which prevents the diaphragm assembly from reaching full travel. After the brief initialization period, the solenoid is de-energized, allowing atmospheric pressure to enter the pump cavity. This permits the spring to drive the diaphragm which forces air out of the pump cavity and into the vent system. When the solenoid is energized and de-energized, the cycle is repeated creating flow in typical diaphragm pump fashion. The pump is controlled in 2 modes:

PUMP MODE: The pump is cycled at a fixed rate to achieve a rapid pressure build in order to shorten the overall test time.

TEST MODE: The solenoid is energized with a fixed duration pulse. Subsequent fixed pulses occur when the diaphragm reaches the switch closure point.

The spring in the pump is set so that the system will achieve an equalized pressure of about 7.5 inches of water.

When the pump starts, the cycle rate is quite high. As the system becomes pressurized pump rate drops. If there is no leak the pump will quit. If there is a leak, the test is terminated at the end of the test mode.

If there is no leak, the purge monitor is run. If the cycle rate increases due to the flow through the purge system, the test is passed and the diagnostic is complete.

The canister vent valve will unseal the system after completion of the test sequence as the pump diaphragm assembly moves to the full travel position.

POSITIVE CRANKCASE VENTILATION (PCV) SYSTEM

All 3.9L V-6 and 5.2L/5.9L V-8 gas powered engines are equipped with a closed crankcase ventilation system and a positive crankcase ventilation (PCV) valve. The 8.0L V-10 engine is not equipped with a PCV valve. Refer to Crankcase Ventilation System—8.0L V-10 Engine for information.

This system consists of a PCV valve mounted on the cylinder head (valve) cover with a hose extending from the valve to the intake manifold. Another hose connects the opposite cylinder head (valve) cover to the air cleaner housing to provide a source of clean air for the system. A separate crankcase breather/filter is not used.

DESCRIPTION AND OPERATION (Continued)

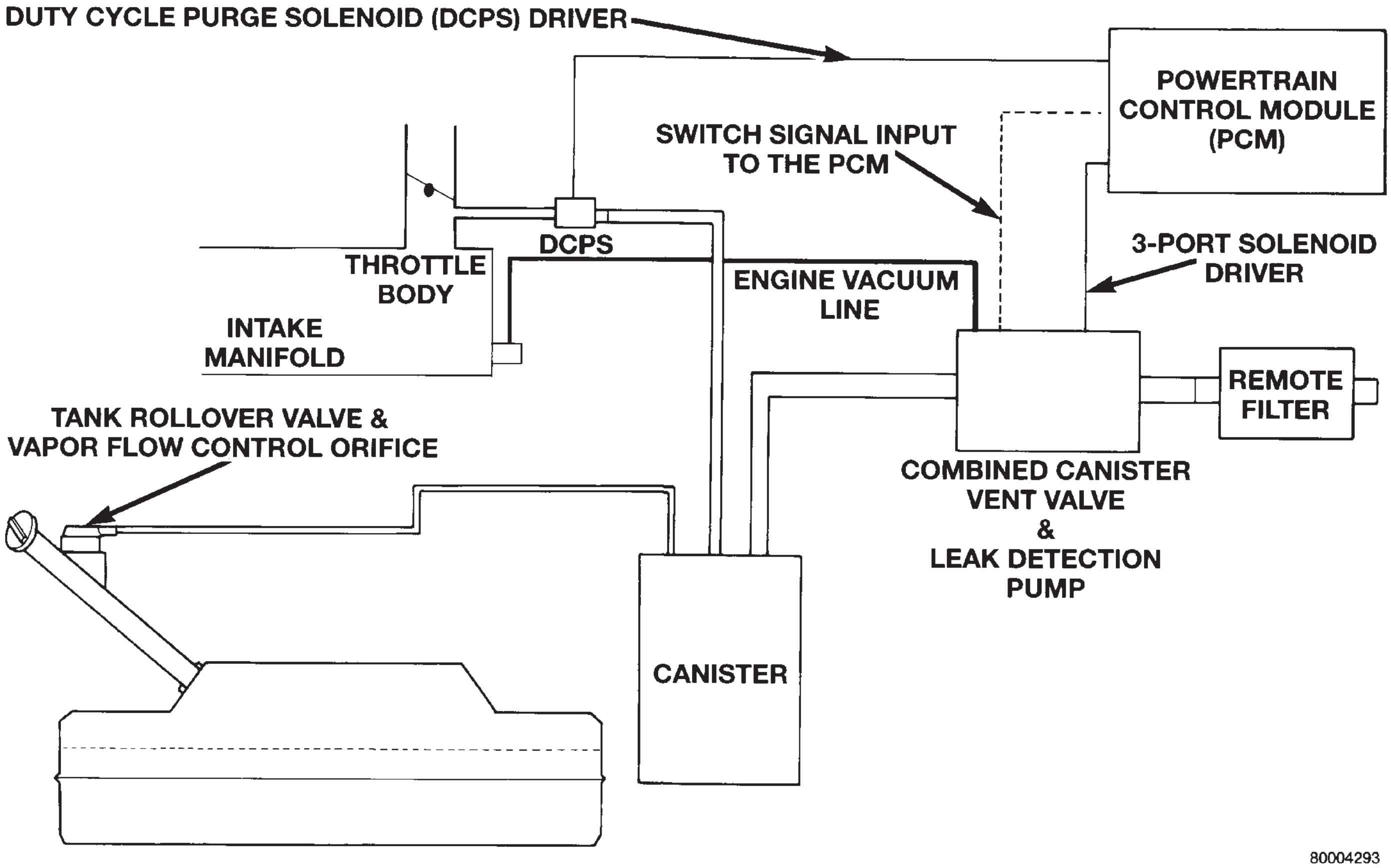

Fig. 7 Evaporative System Monitor Schematic—Typical

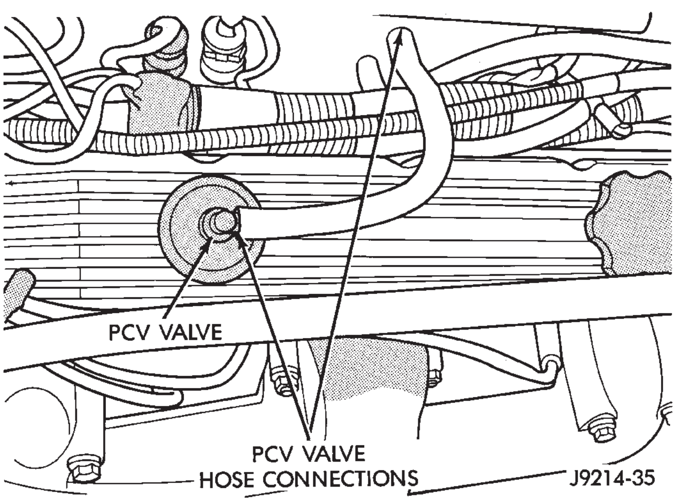

Fig. 8 PCV Valve/Hose—Typical

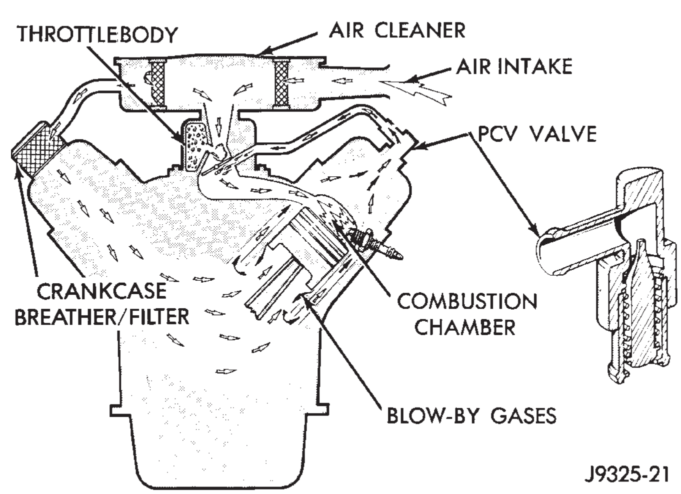

Fig. 9 Typical Closed Crankcase Ventilation System

The PCV system operates by engine intake manifold vacuum (Fig. 9). Filtered air is routed into the crankcase through the air cleaner hose. The metered air, along with crankcase vapors, are drawn through the PCV valve and into a passage in the intake manifold. The PCV system manages crankcase pressure and meters blow by gases to the intake system, reducing engine sludge formation.

The PCV valve contains a spring loaded plunger. This plunger meters the amount of crankcase vapors routed into the combustion chamber based on intake manifold vacuum.

When the engine is not operating or during an engine pop-back, the spring forces the plunger back against the seat. This will prevent vapors from flowing through the valve.

DESCRIPTION AND OPERATION (Continued)

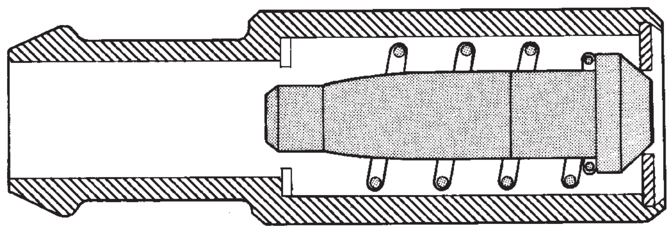

Fig. 10 Engine Off or Engine Pop-Back—No Vapor Flow

During periods of high manifold vacuum, such as idle or cruising speeds, vacuum is sufficient to completely compress spring. It will then pull the plunger to the top of the valve (Fig. 11). In this position there is minimal vapor flow through the valve.

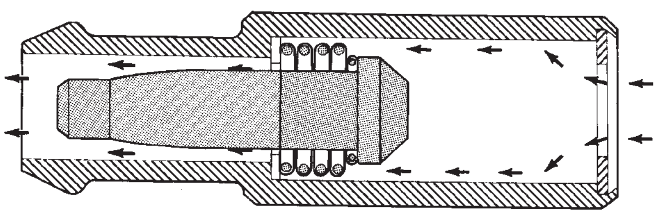

Fig. 11 High Intake Manifold Vacuum—Minimal Vapor Flow

During periods of moderate manifold vacuum, the plunger is only pulled part way back from inlet. This results in maximum vapor flow through the valve (Fig. 12).

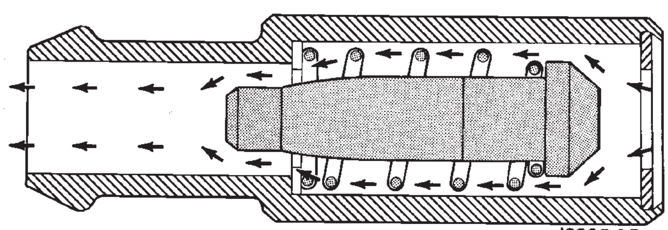

Fig. 12 Moderate Intake Manifold Vacuum—Maximum Vapor Flow

CRANKCASE VENTILATION SYSTEM—8.0L V-10 ENGINE

The 8.0L V-10 engine is equipped with a Crankcase Ventilation (CCV) system. The CCV system performs the same function as a conventional PCV system, but does not use a vacuum controlled valve (PCV valve).

A molded vacuum tube connects manifold vacuum to the top of the right cylinder head (valve) cover. The vacuum tube connects to a fixed orifice fitting (Fig. 13) of a calibrated size 2.6 mm (0.10 inches). It meters the amount of crankcase vapors drawn out of the engine. **The fixed orifice fitting is grey in color.** A similar fitting (but does not contain a fixed orifice) is used on the left cylinder head (valve) cover. This fitting is black in color. Do not interchange these two fittings.

When the engine is operating, fresh air enters the engine and mixes with crankcase vapors. Manifold vacuum draws the vapor/air mixture through the fixed orifice and into the intake manifold. The vapors are then consumed during engine combustion.

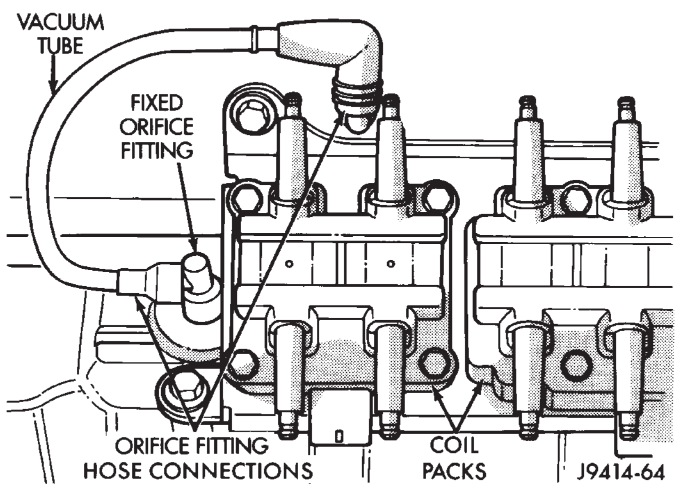

Fig. 13 Fixed Orifice Fitting—8.0L V-10 Engine—Typical

CRANKCASE BREATHER/FILTER

The crankcase breather/filter is no longer used with the 3.9L, 5.2L or 5.9L engine.

VEHICLE EMISSION CONTROL INFORMATION (VECI) LABEL

Vehicles equipped with 3.9L V-6 or 5.2L/5.9L V-8 LDC-gas powered engines have a VECI label.

The label combines both emission control information and vacuum hose routing. This label is located in the engine compartment in front of the radiator (Fig. 14) and contains the following:

- Engine family and displacement
- Evaporative family
- Emission control system schematic
- Certification application
- Engine timing specifications (if adjustable)
- Idle speeds (if adjustable)
- Spark plug and gap

The 5.9L HDC-gas powered engine will have two labels. One of the labels is located in front of the radiator in the engine compartment (Fig. 14) and will contain vacuum hose routing only. The other is attached to the drivers side of the engine air cleaner housing (Fig. 14) and will contain the following:

- Engine family and displacement
- Evaporative family
- Certification application

DESCRIPTION AND OPERATION (Continued)

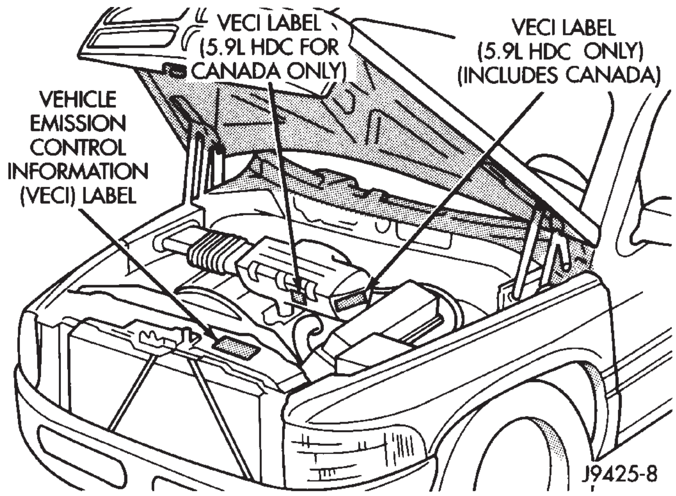

Fig. 14 VECI Label Location

- Engine timing specifications (if adjustable)
- Idle speeds (if adjustable)
- Spark plug and gap

The label for the 8.0L V-10 HDC-gas powered engine is also located in the engine compartment. It is attached to a riveted metal plate located to the right side of the generator (Fig. 15).

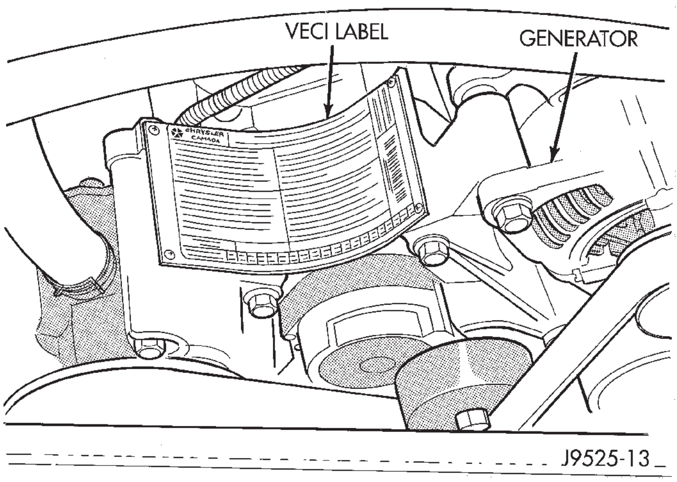

Fig. 15 VECI Label Location—8.0L V-10 Engine

There are unique labels for vehicles built for sale in the country of Canada and for both Light Duty Cycle (LDC) and Heavy Duty Cycle (HDC) engines. Canadian labels are written in both the English and French languages. For all Canadian vehicles, the label is split into two different labels.

The VECI labels are permanently attached and cannot be removed without defacing information and destroying label.

DIAGNOSIS AND TESTING

PCV VALVE TEST—3.9/5.2/5.9L ENGINE

(1) With engine idling, remove the PCV valve from cylinder head (valve) cover. If the valve is not plugged, a hissing noise will be heard as air passes through the valve. Also, a strong vacuum should be felt at the valve inlet (Fig. 16).

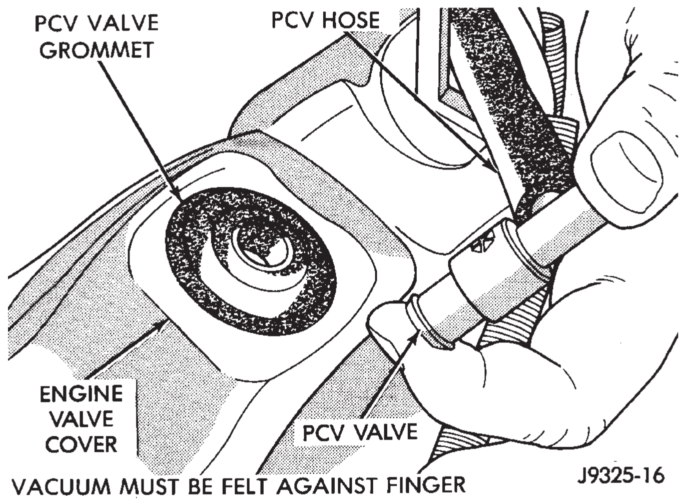

Fig. 16 Vacuum Check at PCV Valve—Typical

(2) Return the PCV valve into the valve cover. Remove the fitting and air hose at the opposite valve cover. Loosely hold a piece of stiff paper, such as a parts tag, over the opening (rubber grommet) at the valve cover (Fig. 17).

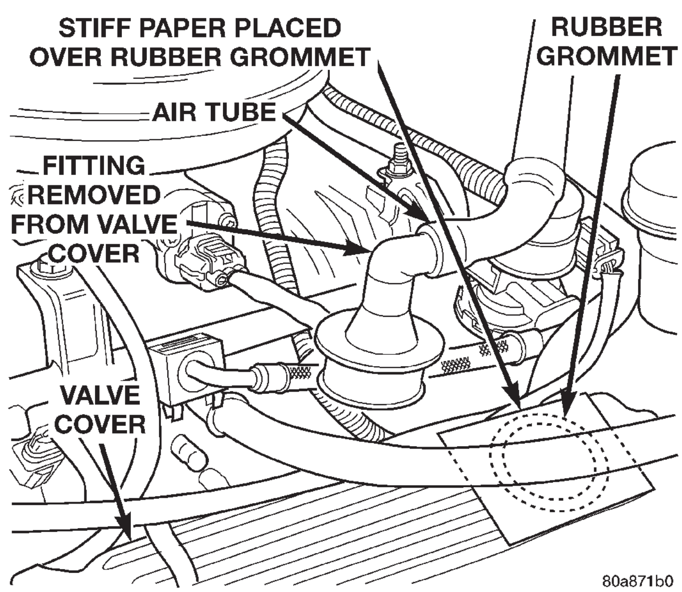

Fig. 17 Vacuum Check at Valve Cover Opening

DIAGNOSIS AND TESTING (Continued)

(3) The paper should be drawn against the opening in the valve cover with noticeable force. This will be after allowing approximately one minute for crankcase pressure to reduce.

(4) Turn engine off and remove PCV valve from valve cover. The valve should rattle when shaken (Fig. 18).

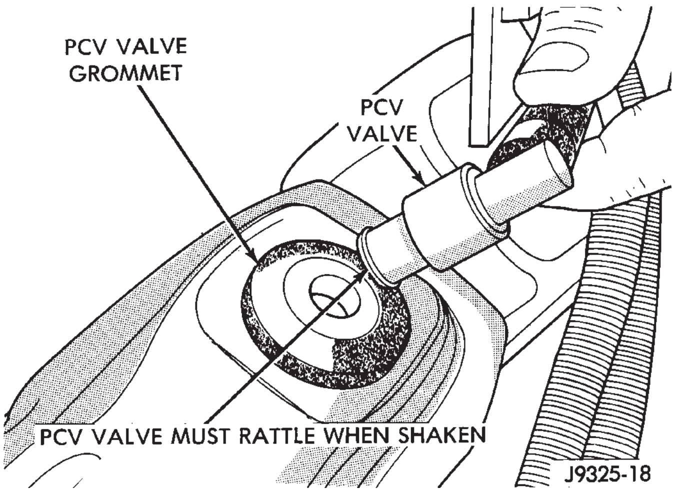

Fig. 18 Shake PCV Valve—Typical

(5) Replace the PCV valve and retest the system if it does not operate as described in the preceding tests. **Do not attempt to clean the old PCV valve.**

(6) If the paper is not held against the opening in valve cover after new valve is installed, the PCV valve hose may be restricted and must be replaced. The passage in the intake manifold must also be checked and cleaned.

(7) To clean the intake manifold fitting, turn a 1/4 inch drill (by hand) through the fitting to dislodge any solid particles. Blow out the fitting with shop air. If necessary, use a smaller drill to avoid removing any metal from the fitting.

VACUUM SCHEMATICS

A vacuum schematic for emission related items can be found on the VECI label. Refer to Vehicle Emission Control Information (VECI) Label in this group for label location.

LEAK DETECTION PUMP (LDP)

Refer to the appropriate Powertrain Diagnostic Procedures service manual for LDP testing procedures.

REMOVAL AND INSTALLATION

EVAPORATIVE (EVAP) CANISTER

Two EVAP canisters are used. Both canisters are mounted to a bracket located below rear of vehicle cab on outside of right frame rail (Fig. 19).

REMOVAL

(1) Remove fuel tubes/lines at each EVAP canister. Note location of tubes/lines before removal for easier installation.

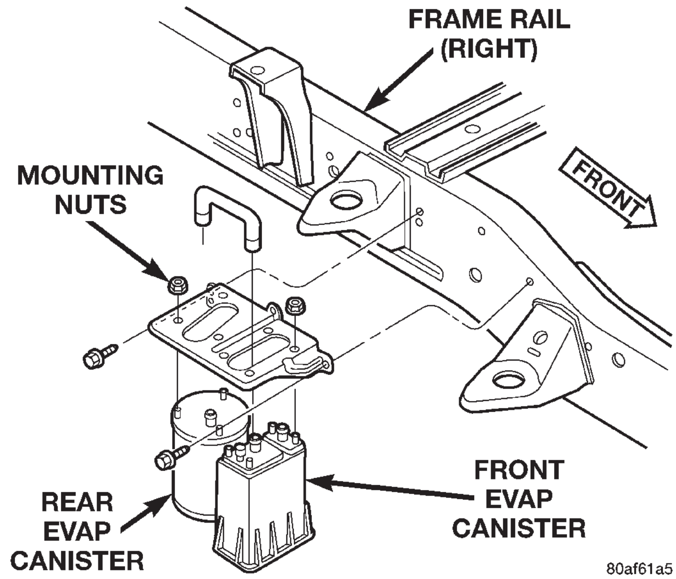

Fig. 19 EVAP Canister Location

(2) Remove mounting nuts at each canister (Fig. 19).

(3) Remove each canister from mounting bracket.

INSTALLATION

(1) Place each canister to mounting bracket (Fig. 19).

(2) Install nuts and tighten to 9 N·m (80 in. lbs.) torque.

(3) Install fuel tubes/lines to each canister.

DUTY CYCLE EVAP CANISTER PURGE SOLENOID

REMOVAL

The duty cycle solenoid is attached to a bracket mounted to the right inner fender (Fig. 20).

(1) Disconnect electrical wiring connector at solenoid (Fig. 20).

(2) Disconnect vacuum harness at solenoid.

(3) Remove solenoid from support bracket.

INSTALLATION

(1) Install solenoid assembly to support bracket.

(2) Connect vacuum harness.

(3) Connect wiring connector.

ROLLOVER VALVE(S)

REMOVAL

WARNING: THE FUEL SYSTEM IS UNDER A CONSTANT PRESSURE (EVEN WITH THE ENGINE OFF). BEFORE SERVICING THE ROLLOVER VALVE, FUEL SYSTEM PRESSURE MUST BE RELEASED (GASOLINE POWERED ENGINES ONLY). REFER TO THE FUEL PRESSURE RELEASE PROCEDURE IN GROUP 14, FUEL SYSTEM.

REMOVAL AND INSTALLATION (Continued)

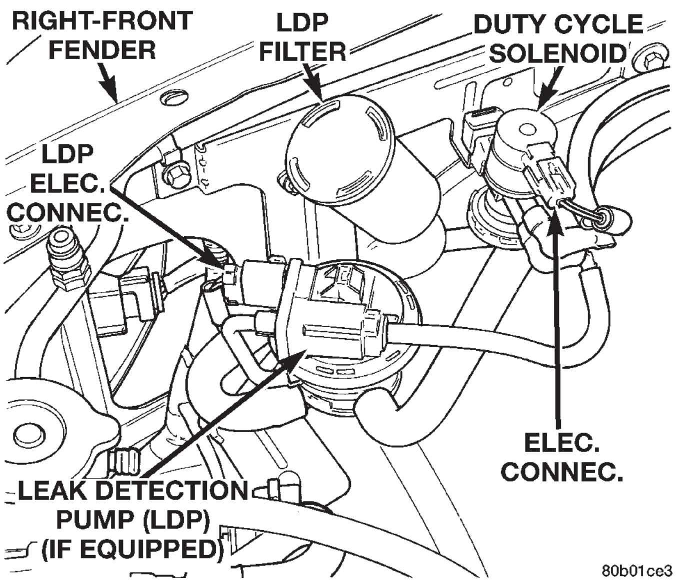

Fig. 20 Duty Cycle EVAP Canister Purge Solenoid Location

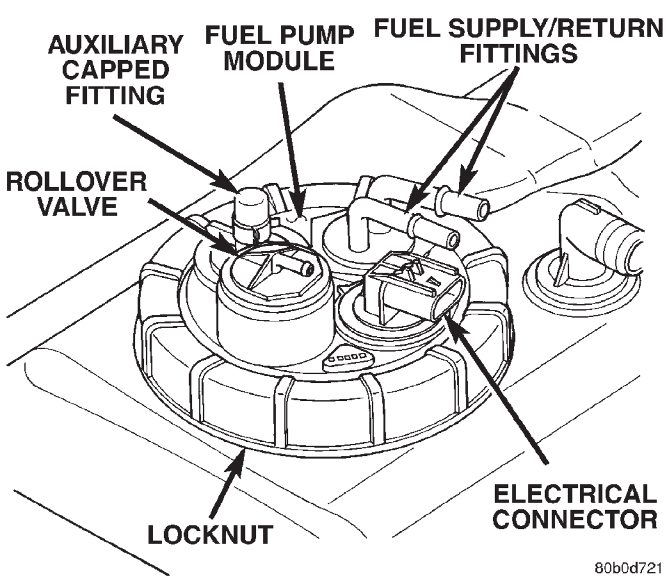

Fig. 21 Rollover Valve Location—Diesel Powered

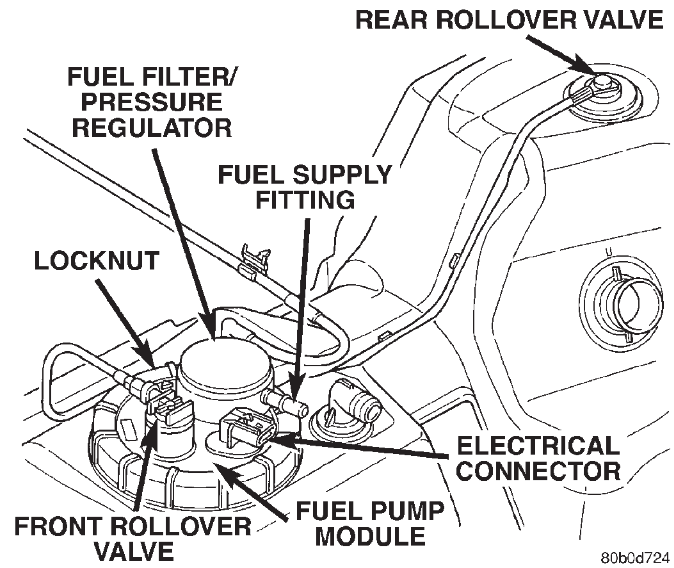

Fig. 22 Rollover Valve Locations—Gas Powered with 26 or 34 Gallon Tank

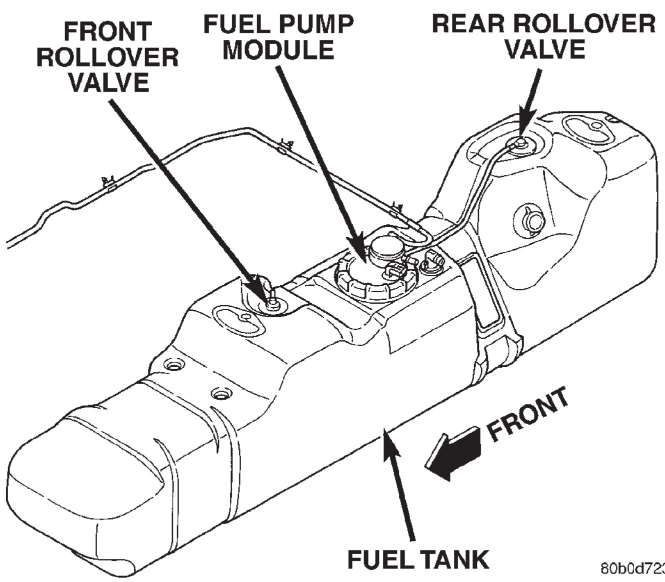

Fig. 23 Rollover Valve Locations—Gas Powered with 35 Gallon Tank

(1) **Diesel Powered Engine:** One rollover valve is used. The valve is located on top of fuel tank module (Fig. 21) and may be serviced separately.

(a) Disconnect both negative battery cables at both batteries.

(b) Remove fuel filler cap and drain fuel tank.

(c) Remove fuel tank. Refer to Fuel Tank Removal/Installation in Group 14, Fuel System.

(d) The rollover valve is seated into a rubber grommet. Remove valve by prying one side upward and then roll valve out of grommet.

(e) Discard old grommet.

(2) **Gasoline Powered Engines:** If equipped with a 26 or 34 gallon fuel tank, two rollover valves are used. One of the valves is permanently mounted to top of fuel tank (Fig. 22). If replacement of this particular valve is necessary, fuel tank must be replaced. Refer to Fuel Tank Removal/Installation in Group 14, Fuel System. The other rollover valve is located on top of fuel pump module (Fig. 22). This valve may be serviced separately. Refer to following steps for procedures.

If equipped with a 35 gallon fuel tank, two rollover valves are also used, but both valves are permanently mounted to top of fuel tank (Fig. 23). If replacement is necessary, fuel tank must be replaced. Refer to Fuel Tank Removal/Installation in Group 14, Fuel System.

REMOVAL AND INSTALLATION (Continued)

(3)

(a) Disconnect negative battery cable at battery.

(b) Remove fuel filler cap and drain fuel tank.

(c) Remove fuel tank. Refer to Fuel Tank Removal/Installation in Group 14, Fuel System.

(d) Disconnect tube (line) at valve.

(e) The rollover valve is seated into a rubber grommet. Remove valve by prying one side upward and then roll valve out of grommet.

(f) Discard old grommet.

INSTALLATION

(1) Install new grommet into fuel pump (or fuel tank) module.

(2) Using finger pressure only, press valve into place.

(3) Install fuel tank. Refer to Fuel Tank Installation.

(4) Fill fuel tank. Install fuel tank filler cap.

(5) Connect negative battery cable(s).

(6) Start vehicle and check for leaks.

LEAK DETECTION PUMP (LDP)

The LDP and LDP filter are attached to a bracket mounted to the right-inner fender (Fig. 20). The LDP and LDP filter are replaced (serviced) as one unit.

REMOVAL

(1) Carefully remove hose at LDP filter.

(2) Remove LDP filter mounting bolt and remove from vehicle.

(3) Carefully remove vapor/vacuum lines at LDP.

(4) Disconnect electrical connector at LDP (Fig. 20).

(5) Remove LDP mounting screws and remove LDP from vehicle.

INSTALLATION

(1) Install LDP to mounting bracket. Tighten screws to 1 N·m (11 in. lbs.) torque.

(2) Install LDP filter to mounting bracket. Tighten bolt to 7 N·m (65 in. lbs.) torque.

(3) Carefully install vapor/vacuum lines to LDP, and install hose to LDP filter. **The vapor/vacuum lines and hoses must be firmly connected. Check the vapor/vacuum lines at the LDP, LDP filter and EVAP canister purge solenoid for damage or leaks. If a leak is present, a Diagnostic Trouble Code (DTC) may be set.**

(4) Connect electrical connector to LDP.

SPECIFICATIONS

TORQUE CHART

Description	Torque
EVAP Canister Mounting Nuts	9 N·m (80 in. lbs.)
Leak Detection Pump Mounting Screws	1 N·m (11 in. lbs.)
Leak Detection Pump Filter Mounting Bolt	7 N·m (65 in. lbs.)

AIR INJECTION SYSTEM-HDC GAS ENGINES

INDEX

GENERAL INFORMATION

GENERAL INFORMATION

The air injection system (Fig. 1), (Fig. 2) or (Fig. 3) is used on 5.9L V-8 and 8.0L V-10 heavy duty cycle (HDC) gas powered engines only. The air injection system consists of:

- A belt-driven air injection (AIR) pump
- Two air pressure relief valves
- Rubber connecting air injection hoses with clamps
- Metal connecting air tubes
- Two one-way check valves
- A replaceable injection pump air filter (8.0L V-10 engine only)

DESCRIPTION AND OPERATION

AIR INJECTION SYSTEM OPERATION

The air injection system adds a controlled amount of air to the exhaust gases aiding oxidation of hydrocarbons and carbon monoxide in the exhaust stream. The system does not interfere with the ability of the EGR system (if used) to control nitrous oxide (NOx) emissions.

5.9L HDC ENGINE: Air is drawn into the pump through a rubber tube that is connected to a fitting on the air cleaner housing (Fig. 2).

8.0L V-10 ENGINE: Air is drawn into the pump through a rubber tube that is connected to a fitting

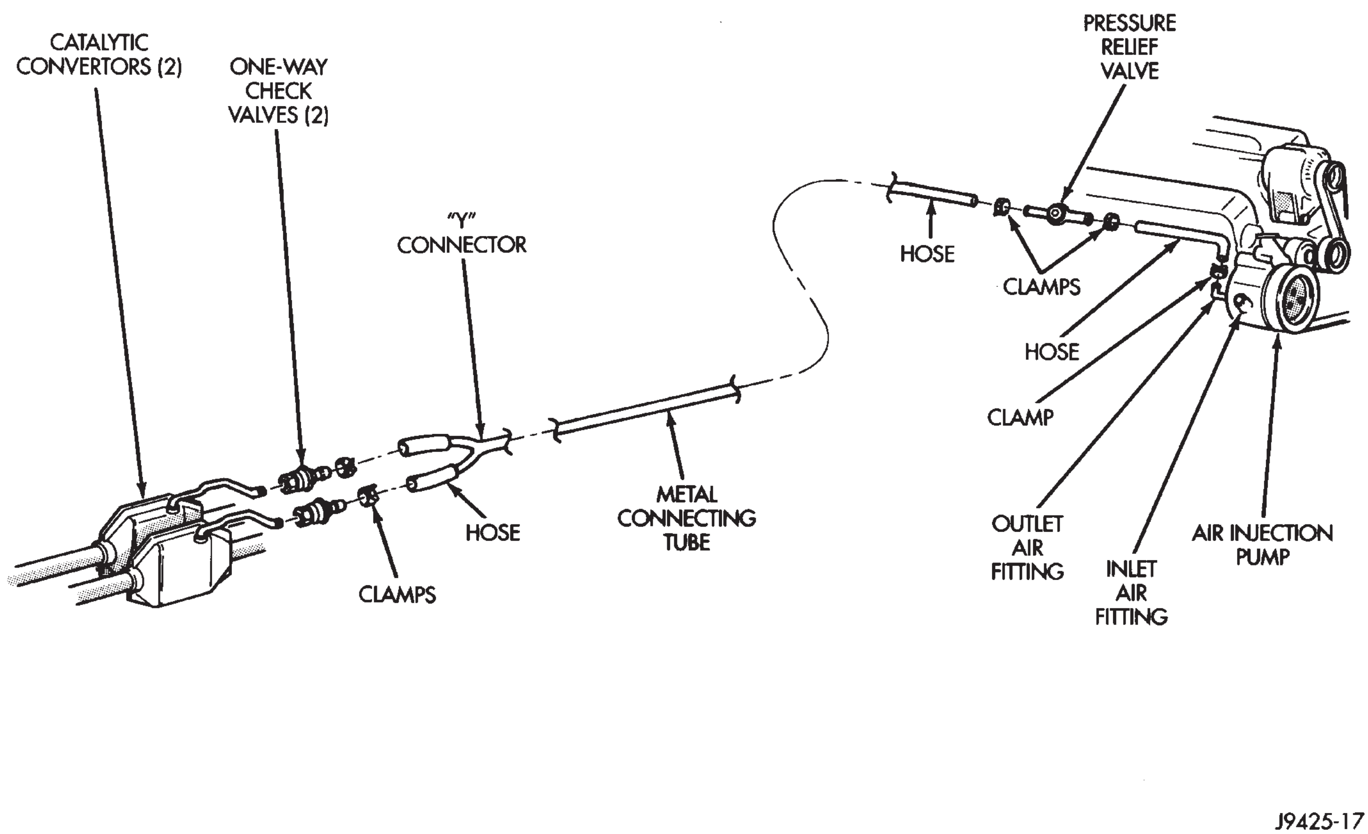

Fig. 1 Air Injection System Components—Typical

DESCRIPTION AND OPERATION (Continued)

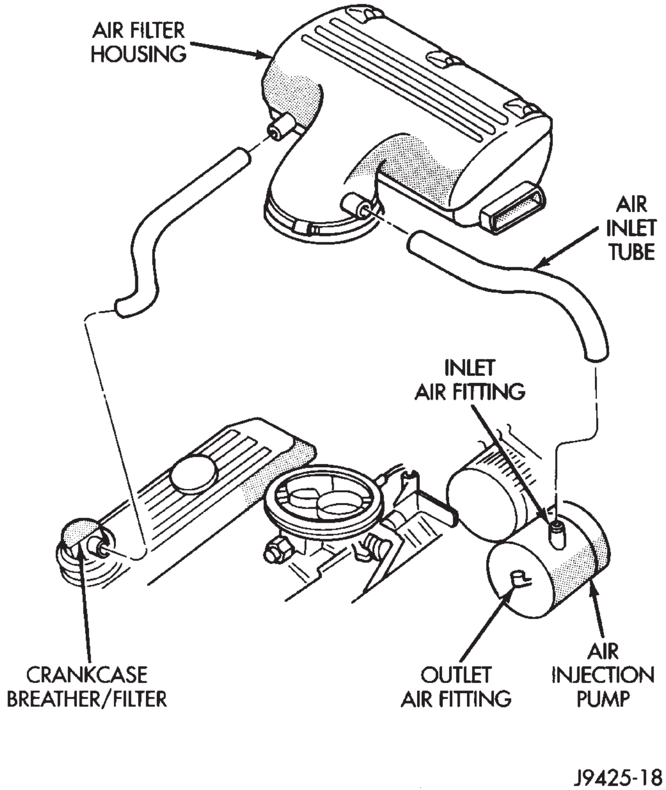

Fig. 2 Air Inlet for Air Pump—5.9L HDC Engine

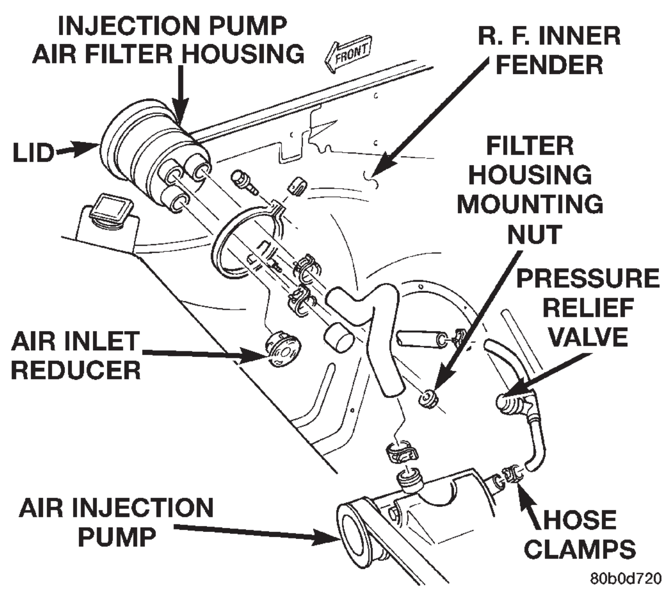

Fig. 3 Air Inlet and Air Pump Air Filter—8.0L V-10 Engine

on the air injection pump filter housing (Fig. 3). Air is drawn into the filter housing from the front of the vehicle with rubber tube. This tube is used as a silencer to help prevent air intake noise at the opening to the pump filter housing. An air filter is located within the air pump filter housing (Fig. 3).

Air is then compressed by the air injector pump. It is expelled from the pump and routed into a rubber tube where it reaches the air pressure relief valve (Fig. 1). Pressure relief holes in the relief valve will prevent excess downstream pressure. If excess downstream pressure occurs at the relief valve, it will be vented into the atmosphere.

Air is then routed (Fig. 1) from the relief valve, through a tube, down to a "Y" connector, through the two one-way check valves and injected at both of the catalytic convertors (referred to as downstream).

The two one-way check valves (Fig. 1) protect the hoses, air pump and injection tubes from hot exhaust gases backing up into the system. Air is allowed to flow through these valves in one direction only (towards the catalytic convertors).

Downstream air flow assists the oxidation process in the catalyst, but does not interfere with EGR operation (if EGR system is used).

AIR INJECTION PUMP

The air pump is mounted on the front of the engine and driven by a belt connected to the crankshaft pulley (Fig. 4).

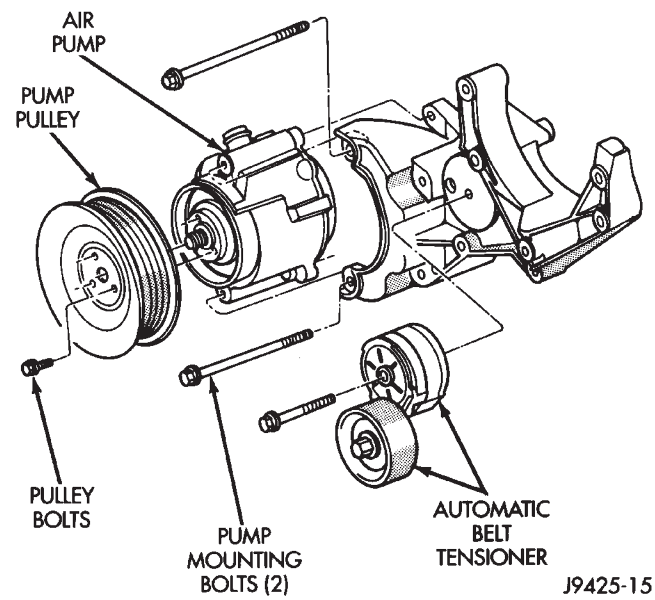

Fig. 4 Air Injection Pump Mounting—Typical

The air injection system is not completely noiseless. Under normal conditions, noise rises in pitch as engine speed increases. To determine if excessive noise is fault of air injection system, disconnect drive belt and operate engine.

CAUTION: Do not attempt to lubricate the air injection pump. Oil in the pump will cause rapid deterioration and failure.

Refer to the AIR PUMP DIAGNOSIS chart for additional information.

DESCRIPTION AND OPERATION (Continued)

AIR PUMP DIAGNOSIS

EXCESSIVE BELT NOISE	1. Loose belt or defective automatic belt tensioner. 2. Seized pump.	1. Refer to Group 7, Cooling System. 2. Replace pump.
EXCESSIVE PUMP NOISE CHIRPING	1. Insufficient break-in.	1. Recheck for noise after 1600 km (1,000 miles) of operation.
EXCESSIVE PUMP NOISE CHIRPING, RUMBLING, OR KNOCKING	1. Leak in hose. 2. Loose hose. 3. Hose touching other engine parts. 4. Relief valve inoperative. 5. Check valve inoperative. 6. Pump mounting fasteners loose. 7. Pump failure.	1. Locate source of leak using soap solution and correct. 2. Reassemble and replace or tighten hose clamp. 3. Adjust hose position. 4. Replace relief valve. 5. Replace check valve. 6. Tighten mounting screws as specified. 7. Replace pump.
NO AIR SUPPLY. ACCELERATE ENGINE TO 1500 RPM AND OBSERVE AIR FLOW FROM HOSES. IF FLOW INCREASES AS RPM'S INCREASE, PUMP IS FUNCTIONING NORMALLY. IF NOT, CHECK POSSIBLE CAUSE.	1. Loose drive belt. 2. Leaks in supply hose. 3. Leak at fitting(s). 4. Check valve inoperative. 5. Plugged inlet air filter (8.0L).	1. Refer to Group 7, Cooling System. 2. Locate leak and repair or replace as required. 3. Tighten and replace clamps. 4. Replace check valve. 5. Replace filter

ONE-WAY CHECK VALVE

A check valve (Fig. 1) is located on each of the air injection downstream tubes.

Each check valve has a one-way diaphragm which prevents hot exhaust gases from backing up into the hose and pump. The check valve will protect the system if the air injection pump belt fails, an air hose ruptures or exhaust system pressure becomes abnormally high.

DIAGNOSIS AND TESTING

TESTING ONE-WAY CHECK VALVE

The one-way check valves are not repairable. To determine condition of valve, remove the rubber air tube from the inlet side of each check valve. Start the engine. If exhaust gas is escaping through the inlet side of check valve, it must be replaced.

REMOVAL AND INSTALLATION

AIR INJECTION PUMP

REMOVAL

The air injection pump does not have any internal serviceable parts.

(1) Disconnect both of the hoses (tubes) at the air injection pump.

(2) Loosen, but do not remove at this time, the three air pump pulley mounting bolts (Fig. 4).

(3) Relax the automatic belt tensioner and remove the engine accessory drive belt. Refer to Group 7, Cooling System. See Belt Removal/Installation.

(4) Remove the three air pump pulley bolts and remove pulley from pump.

(5) Remove the two air pump mounting bolts (Fig. 4) and remove pump from mounting bracket.

INSTALLATION

(1) Position air injection pump to mounting bracket.

(2) Install two pump mounting bolts to mounting bracket. Tighten bolts to 40 N·m (30 ft. lbs.) torque.

(3) Install pump pulley and three mounting bolts. Tighten bolts finger tight.

(4) Relax tension from automatic belt tensioner and install drive belt. Refer to Group 7, Cooling System. See Belt Removal/Installation.

(5) Tighten pump pulley bolts to 11 N·m (105 in. lbs.) torque.

(6) Install hoses and hose clamps at pump.

REMOVAL AND INSTALLATION (Continued)

AIR INJECTION PUMP AIR FILTER—8.0L V-10 ENGINE

The air filter for the air injection pump is located inside a housing located in right-front side of engine compartment (Fig. 3). A rubber hose connects the filter housing to air injection pump. The filter is used with 8.0L V-10 engines only.

For required maintenance schedules on the air pump filter (listed in time or mileage intervals), refer to Group 0, Lubrication and Maintenance. Also refer to the vehicle Owners Manual.

REMOVAL

(1) Remove rubber tubes at filter housing.
(2) Remove filter housing mounting nut and remove housing.
(3) Remove lid from filter housing (snaps off).
(4) Remove filter from housing.

INSTALLATION

(1) Clean inside of housing and lid before installing new filter.
(2) Install filter into housing.
(3) Install lid to filter housing (snaps on).
(4) Position filter housing to fender.
(5) Install mounting nut and tighten to 11 N·m (8 ft. lbs.) torque.
(6) Install rubber tubes and cap at filter housing.

ONE-WAY CHECK VALVE

REMOVAL

(1) Remove the hose clamp at inlet side of valve.
(2) Remove hose from valve.
(3) Remove valve from catalyst tube (unscrew). **To prevent damage to catalyst tube, a backup wrench must be used on the tube.**

INSTALLATION

(1) Install valve to catalyst tube. Tighten to 33 N·m (25 ft. lbs.) torque.
(2) Install hose and hose clamp to valve.

SPECIFICATIONS

TORQUE CHART

Description	Torque
Air Pump Filter Housing Nut	1 N·m (8 ft. lbs.)
Air Pump Mounting Bolts	40 N·m (30 ft. lbs.)
Air Pump Pulley Mounting Bolts	11 N·m (105 in. lbs.)
One-Way Check Valve to Catalyst Tube	33 N·m (25 ft. lbs.)

EXHAUST GAS RECIRCULATION (EGR) SYSTEM-DIESEL ENGINE

INDEX

GENERAL INFORMATION

EXHAUST GAS RECIRCULATION (EGR) SYSTEM

The Transitional Low Emission Vehicle (TLEV) EGR system is used with the 5.9L diesel engine when equipped with a California emissions package only.

The EGR system reduces oxides of nitrogen (NOx) in the engine exhaust. This is accomplished by allowing a predetermined amount of hot exhaust gas to recirculate and dilute the incoming fuel/air mixture. This dilution reduces peak flame temperature during combustion.

DESCRIPTION AND OPERATION

EGR SYSTEM OPERATION

The system consists of:

- An EGR valve assembly. The valve assembly is located at the front of intake manifold (Fig. 1). The EGR valve is a poppet style valve (on/off only) and is controlled by an internal diaphragm.
- An EGR valve vacuum regulator solenoid. The solenoid is located at the front/top of cylinder head (Fig. 1) and will control the on-time and off-time of the EGR valve. A vacuum transducer is not used with this solenoid (EGR valve will be fully open or fully closed).
- The Powertrain Control Module (PCM) to operate the EGR valve vacuum regulator solenoid.
- The Engine Coolant Temperature (ECT) sensor (Fig. 2) to supply an engine coolant temperature input to the PCM.
- The Intake Manifold Air Temperature (IAT) sensor (Fig. 3) to supply an intake manifold air temperature input to the PCM.
- The Throttle Position Sensor (TPS) (Fig. 4) to supply a voltage reference input to the PCM. This will tell the PCM how far the throttle has been opened. If equipped with the California Emissions Package (with EGR system), the TPS will be used with **both automatic and manual transmissions.**
- Unique exhaust and intake manifolds.
- An EGR tube (Fig. 1) connecting a passage in the EGR valve to the rear of the exhaust manifold.
- A vacuum pump to supply vacuum for the EGR valve vacuum regulator solenoid and EGR valve. The pump also supplies vacuum for operation of the speed control servo and the heating/air conditioning system. The crankshaft gear driven pump is located at the front of engine and is attached to power steering pump (Fig. 5).

DESCRIPTION AND OPERATION (Continued)

• A quick-release one-way check valve (Fig. 1) to provide a fast release of engine vacuum from EGR valve diaphragm when EGR system is shut down.

• Vacuum lines and hoses to connect the various components.

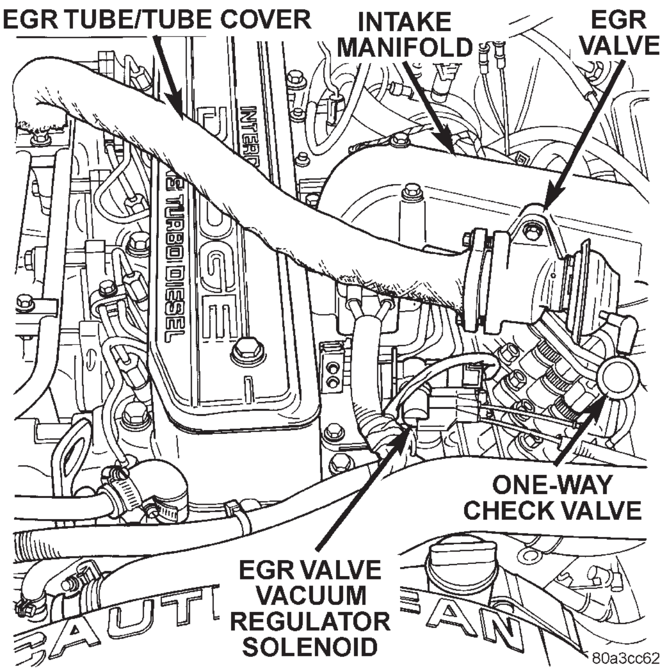

Fig. 1 EGR Valve and Components

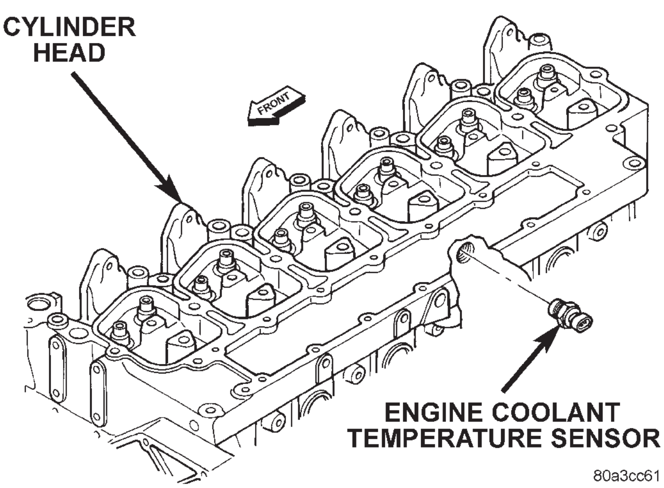

Fig. 2 Engine Coolant Temperature Sensor Location

When the PCM supplies a ground signal to the EGR valve vacuum regulator solenoid, EGR system operation starts to occur. The PCM will monitor and determine when to supply and remove this ground signal. This will depend on inputs from the engine coolant temperature, throttle position and intake manifold air temperature sensors.

When the ground signal is supplied to the EGR solenoid, vacuum from the vacuum pump will be allowed to pass through the EGR solenoid and on to the EGR valve with a connecting hose.

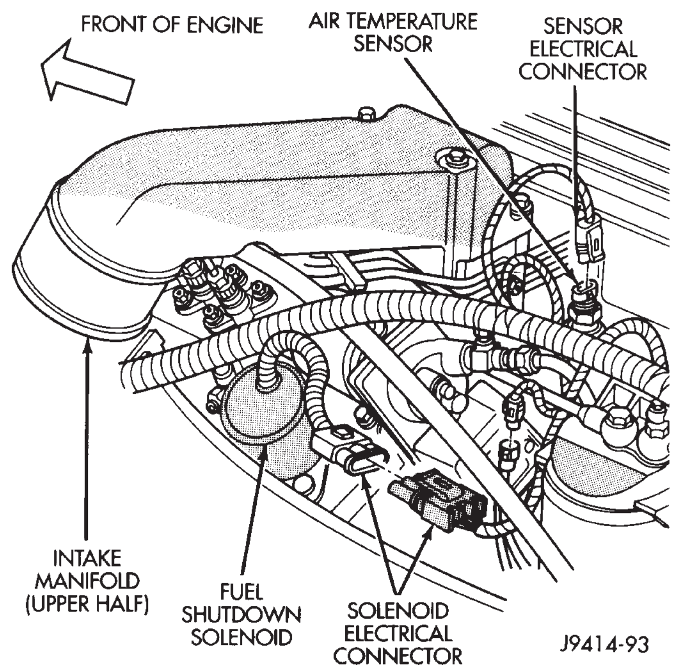

Fig. 3 Intake Manifold Air Temperature Sensor Location—Typical

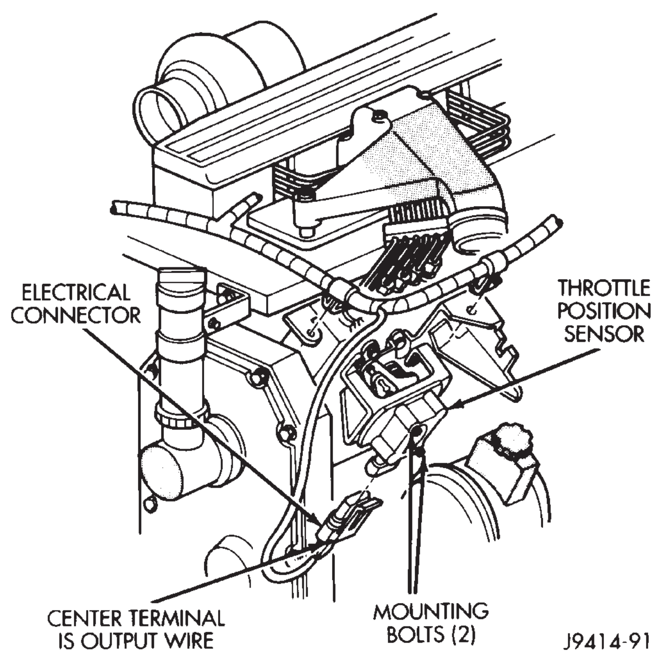

Fig. 4 Throttle Position Sensor Location—Typical

Exhaust gas recirculation will begin in this order when:

• The engine is running to operate the vacuum pump.

• The powertrain control module (PCM) determines that engine coolant temperature is more than

DESCRIPTION AND OPERATION (Continued)

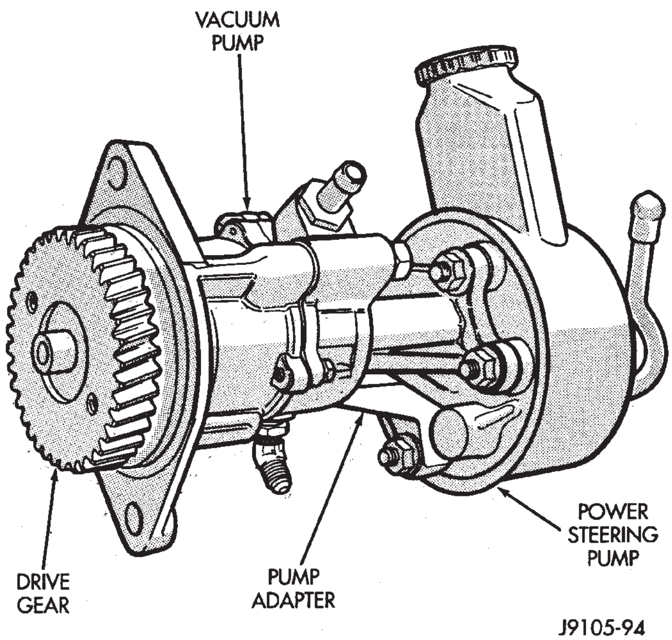

Fig. 5 Engine Vacuum Pump

140° F but less than 220° F, and intake manifold air temperature is more than 20° F but less than 170° F.

• A ground signal from the PCM is supplied to the EGR solenoid.

• Vacuum passes through the EGR solenoid to the EGR valve diaphragm.

• The inlet seat (poppet valve) at the bottom of the EGR valve opens to dilute and recirculate exhaust gas back into the intake manifold.

The EGR system will be activated at engine idle speed. This is if PCM operating parameters for EGR system operation have been met.

The EGR system will be shut down briefly if the PCM has determined that a rapid acceleration is occurring. This is determined by a change in TPS voltage (mechanical throttle movement). The PCM will leave the EGR system shut down for a few additional seconds after the throttle has been depressed.

The EGR system will also be shut down for wide open throttle (WOT) conditions.

The EGR system will also be shut down by the PCM if the PCM has not sensed a TPS voltage change (mechanical throttle movement) after 2 continuous minutes. This shut down may occur at either engine idle speed or normal cruising speeds.

Each time the engine is operated, an on-board diagnostic test will be run to verify EGR system operation. Certain failures will illuminate the MIL (Malfunction Indicator Lamp). The MIL is indicated on the instrument panel as the Check Engine Lamp. Refer to the On-Board Diagnostic section for additional information. Also refer to the appropriate Powertrain Diagnostic Procedures service manual.

DIAGNOSIS AND TESTING

EGR SYSTEM TEST

EGR system operation must first be checked with the DRB scan tool. To perform a test of the EGR system, refer to the appropriate Powertrain Diagnostic Procedures service manual. Check and correct any electrical malfunctions before proceeding.

Do not attempt to diagnose a defective EGR valve by applying vacuum to the EGR valve diaphragm fitting with engine running. Opening the EGR valve at idle speed will not change idle speed.

(1) Check operation of EGR valve vacuum regulator solenoid and EGR system with DRB scan tool.

(2) Start engine and verify that vacuum is available at inlet fitting of EGR valve vacuum regulator solenoid. Vacuum is supplied by an engine driven vacuum pump (Fig. 5). Refer to Group 9, Engines for vacuum pump specifications and test procedures.

(3) Check EGR valve for operation and leaks. Refer to EGR Valve Test.

(4) Check operation of one-way check valve (Fig. 1). Refer to Check Valve Test.

DIAGNOSIS AND TESTING (Continued)

EGR VALVE TEST

Use the following test procedure to determine if exhaust gas is flowing through the EGR valve. It can also be used to determine if the EGR tube is plugged, or the system passages in the intake or exhaust manifolds are plugged.

This is not to be used as a complete test of the EGR system.

(1) To verify EGR valve operation, it must be removed from intake manifold. Refer to EGR Valve Removal/Installation procedures.

(2) Examine the head of poppet valve at base opening on bottom of EGR valve. Look for heavy carbon build-up. A coating of carbon is normal with engine operation. Shine a bright light through valve opening and examine edge (seat) of poppet valve. No light should be evident at valve edge. If either condition exists, replace EGR valve. Do not attempt to clean the poppet valve within the EGR valve assembly.

(3) The EGR valve is equipped with a fitting located on the EGR valve vacuum motor (Fig. 6).

(4) Connect a hand–held vacuum pump equipped with a vacuum gauge to this fitting (Fig. 6).

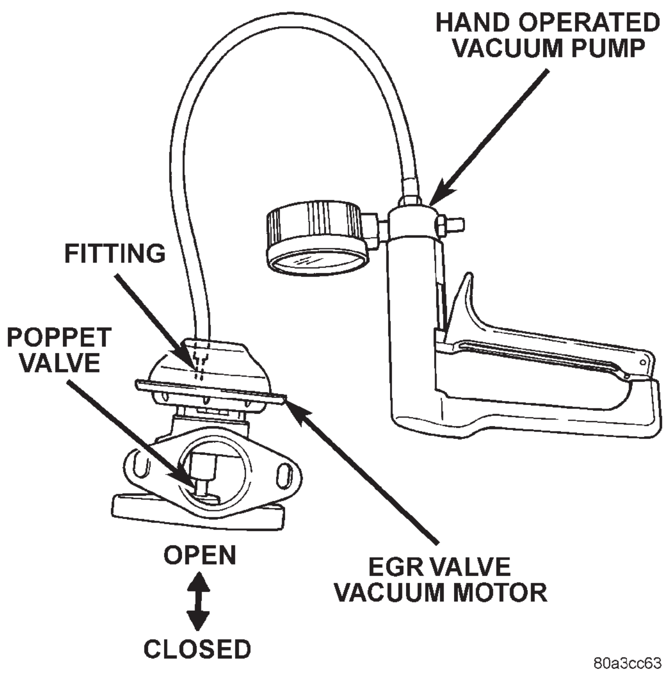

Fig. 6 Vacuum Pump at EGR Valve

(5) Slowly apply 10 inches HG of vacuum to the fitting on the EGR valve motor. The poppet valve (Fig. 6) should start to open at approximately 10 inches of vacuum. Vacuum should hold steady at 10 inches. If not, replace the EGR valve. If vacuum holds steady at 10 inches, and poppet valve has started to open, proceed to next step.

(6) Continue to apply vacuum until gauge reading is at 20 inches. The poppet valve should be fully open at approximately 20 inches of vacuum. Vacuum should also hold steady at 20 inches. If not, replace the EGR valve.

(7) If the EGR valve tested OK, the EGR tube may be plugged with carbon, or the passages in the intake and exhaust manifolds may be plugged with carbon.

(8) While the EGR valve is removed, check passages in EGR tube. Remove the EGR tube between the intake and exhaust manifolds. Check and clean the EGR tube and its related openings on the manifolds. Refer to EGR Tube Removal/Installation in this group for procedures.

(9) While the EGR valve is removed, check for carbon build-up at intake manifold openings. Clean carbon deposits as necessary.

Do not attempt to clean the poppet valve within the EGR valve assembly. If the valve shows evidence of heavy carbon build–up near the base or around poppet valve, replace it.

EGR VALVE VACUUM REGULATOR SOLENOID TEST

To perform an electrical test of this solenoid, refer to the DRB scan tool. Also refer to the appropriate Powertrain Diagnostic Procedures manual. Vacuum to the solenoid is supplied from an engine driven vacuum pump (Fig. 5). Refer to Group 9, Engines for vacuum pump specifications and test procedures.

CHECK VALVE TEST

This is not to be used as a test of the EGR system. Refer to DRB scan tool and appropriate Powertrain Diagnostic Procedures service manual.

A quick-release type, one-way check valve is located in the vacuum line between the EGR valve and the EGR valve vacuum regulator solenoid (Fig. 1). This check valve allows engine vacuum to be quickly bled from EGR valve. If the valve is defective, vacuum will be stored in the EGR valve diaphragm motor (EGR valve will remain open). If the valve is leaking, the EGR valve may not open.

(1) Attach a vacuum gauge with a “T” fitting into the vacuum line at EGR valve (between EGR valve and EGR vacuum regulator solenoid).

(2) Bring engine to operating temperature to allow EGR system operation.

(3) While driving at steady speed, high vacuum should be observed at gauge.

(4) Quickly open the throttle while observing gauge.

(5) Gauge should immediately drop to 0 inches. If any vacuum is being stored (gauge reading anything other than 0 inches), test EGR system electrical operation using the DRB scan tool. If EGR system electrical operation is OK, but gauge reading has not

DIAGNOSIS AND TESTING (Continued)

dropped to 0 inches, proceed to next step before replacing check valve.

(6) Disconnect the vacuum lines at both ends of check valve and remove valve from vehicle.

(7) Attach a hand-operated vacuum pump equipped with a vacuum gauge to the inlet fitting on check valve (to solenoid). The inlet end of fitting is marked with an S (Fig. 7).

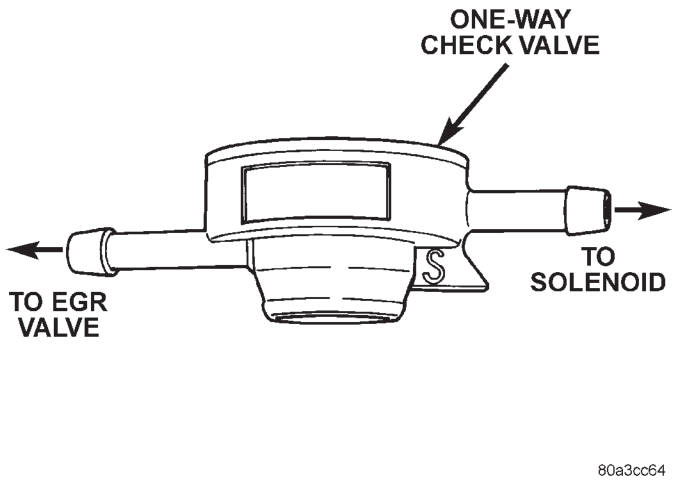

Fig. 7 One-Way Check Valve

(8) Apply a **minimum** of 20 in. vacuum or more to this fitting while plugging opposite fitting with a finger. Vacuum gauge should remain constant at 20 or more inches without any leakage. If not, replace check valve.

(9) Attach vacuum pump to the fitting at EGR valve end of check valve.

(10) Apply vacuum to this fitting while plugging opposite fitting with a finger. While operating vacuum pump, vacuum gauge should remain at or near 0 inches. If any vacuum is being stored, replace check valve.

VACUUM SUPPLY TEST

Vacuum for the EGR valve and EGR solenoid is provided by a vacuum pump. This pump is mounted to the gear housing at front of engine and attached to power steering pump (Fig. 8).

Refer to Group 9, Engines, for additional vacuum pump information and minimum/maximum vacuum specifications.

(1) Disconnect the vacuum supply line at EGR valve vacuum regulator solenoid.

(2) Attach a vacuum gauge at this point.

(3) Start the engine.

(4) If vacuum will not meet specifications as shown in Group 9, Engines, check for leaks in vacuum lines between solenoid and vacuum pump before condemning vacuum pump.

ENGINE COOLANT TEMPERATURE SENSOR—

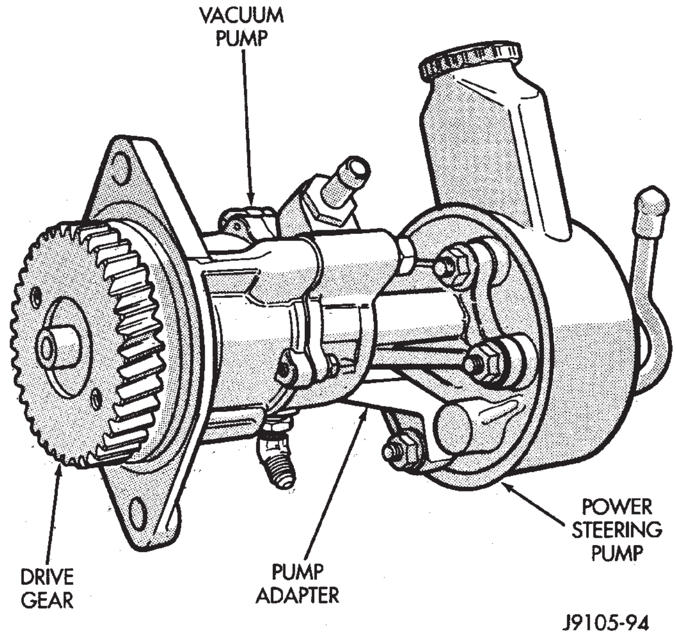

Fig. 8 Vacuum Pump

DIESEL ENGINE

To perform a complete test of the Engine Coolant Temperature (ECT) sensor and its circuitry, refer to DRB scan tool and appropriate Powertrain Diagnostics Procedures manual. To test the sensor only, refer to the following:

The ECT sensor is located on the left side of cylinder head behind fuel filter and below the intake manifold (Fig. 9).

(1) The ECT sensor is equipped with a 9 inch long jumper harness. This harness connects the ECT sensor to the main engine wiring harness. The end of the harness is located near the top of the fuel filter. It is used for sensor tests. Disconnect jumper harness connector from main engine wiring harness.

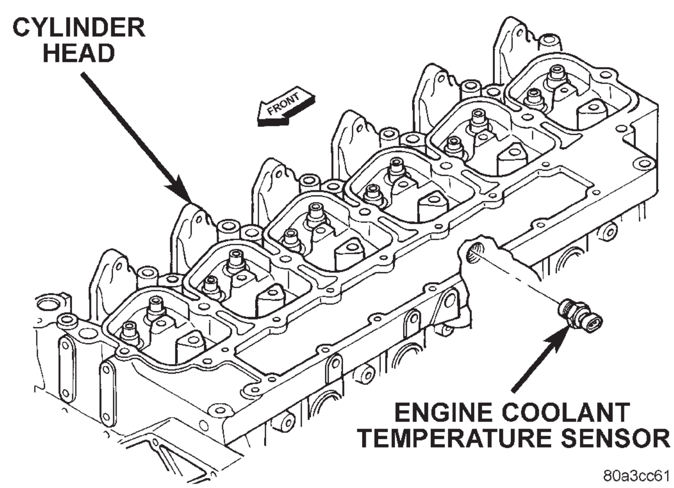

Fig. 9 ECT Sensor—Diesel Engine

DIAGNOSIS AND TESTING (Continued)

(2) Test resistance of sensor with a high input impedance (digital) volt-ohmmeter. The resistance (as measured across the jumper harness terminals) should be as shown in ECT SENSOR RESISTANCE (OHMS) chart. Replace sensor if it is not within range of resistance specified in chart.

ECT SENSOR RESISTANCE (OHMS)

TEMPERATURE		RESISTANCE (OHMS)	
°CEL.	°FAHR.	MIN.	MAX.
-40	-40	291,490	381,710
-20	-4	85,850	108,390
-10	14	49,250	61,430
0	32	29,330	35,990
10	50	17,990	21,810
20	68	11,370	13,610
25	77	9,120	10,880
30	86	7,370	8,750
40	104	4,900	5,750
50	122	3,330	3,880
60	140	2,310	2,670
70	158	1,630	1,870
80	176	1,170	1,340
90	194	860	970
100	212	640	720
110	230	480	540
120	248	370	410

(3) Test continuity of the wire harness between the PCM wire harness connector and the ECT sensor connector terminals. Refer to Group 8, Wiring for terminal/cavity locations. Repair the wire harness if an open circuit is indicated.

(4) After tests are completed, connect jumper harness.

REMOVAL AND INSTALLATION

EGR VALVE

REMOVAL

(1) Disconnect vacuum line at EGR valve vacuum supply fitting (Fig. 10).

(2) Remove the two bolts retaining EGR tube to side of EGR valve (Fig. 10).

(3) Remove the two EGR valve mounting bolts (Fig. 10) and remove EGR valve.

(4) Discard both of the old EGR mounting gaskets.

INSTALLATION

(1) Clean the intake manifold and EGR valve of any old gasket material.

(2) Clean the end of EGR tube of any old gasket material.

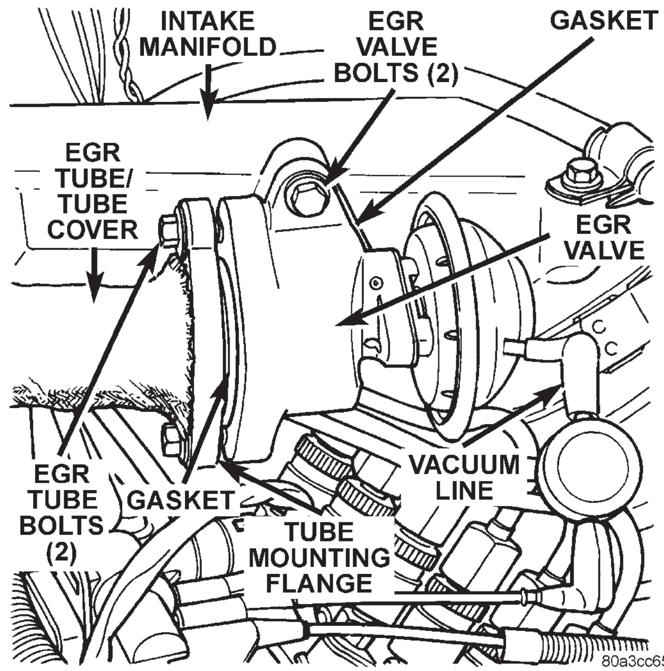

Fig. 10 EGR Valve Removal/Installation

(3) Position new gasket between EGR valve and EGR tube and position EGR valve to tube. Install 2 bolts finger tight only.

(4) Position new gasket between EGR valve and intake manifold.

(5) Install 2 EGR valve-to-intake manifold bolts finger tight only.

(6) A slotted mounting bolt hole is located at lower ear on EGR valve. Rotate EGR valve until square to EGR tube. Tighten 2 EGR valve-to-intake manifold bolts to 24 N·m (212 in. lbs.).

(7) Tighten 2 EGR tube-to-EGR valve mounting bolts to 24 N·m (212 in. lbs.). **When tightening these 2 bolts, alternate between the upper and lower bolt to allow face of EGR valve to remain square to tube mounting flange (Fig. 10) on EGR tube.**

(8) Connect vacuum line to EGR valve.

EGR TUBE

The EGR tube connects the EGR valve to the rear of the exhaust manifold (Fig. 10).

REMOVAL

(1) Remove 2 EGR tube mounting bolts at EGR valve end of tube (Fig. 10).

(2) Remove 2 EGR tube mounting nuts at exhaust manifold end of tube (Fig. 11).

(3) Remove EGR tube and discard old gaskets.

(4) Clean gasket mating surfaces and EGR tube flange gasket surfaces.

REMOVAL AND INSTALLATION (Continued)

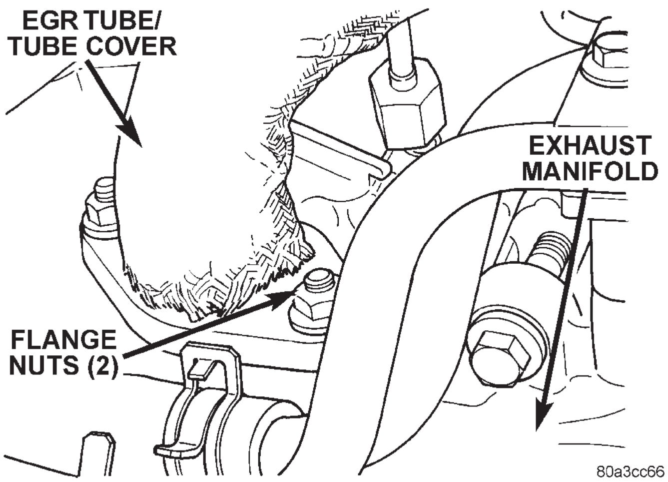

Fig. 11 EGR Tube Nuts at Exhaust Manifold

(5) Check for signs of leakage or cracked surfaces at both ends of tube, exhaust manifold and EGR valve.

INSTALLATION

(1) Install a new gasket to EGR valve end of EGR tube.

(2) Install a new gasket to manifold end of EGR tube.

(3) Position EGR tube to engine and install bolts/nuts.

(4) Tighten all bolts/nuts to 24 N·m (212 in. lbs.) torque. **When tightening bolts at EGR valve end of tube, alternate between the upper and lower bolt to allow face of EGR valve to remain square to tube mounting flange (Fig. 10) on EGR tube.**

EGR VALVE VACUUM REGULATOR SOLENOID

The solenoid is located at the top/front of cylinder head (Fig. 12).

REMOVAL/INSTALLATION

(1) Disconnect electrical connector at solenoid.

(2) Disconnect vacuum harness at solenoid.

(3) Remove solenoid bracket bolt (Fig. 12).

(4) Remove solenoid and bracket from engine.

(5) Reverse the removal steps for installation. Tighten mounting bolt to 24 N·m (212 in. lbs.) torque.

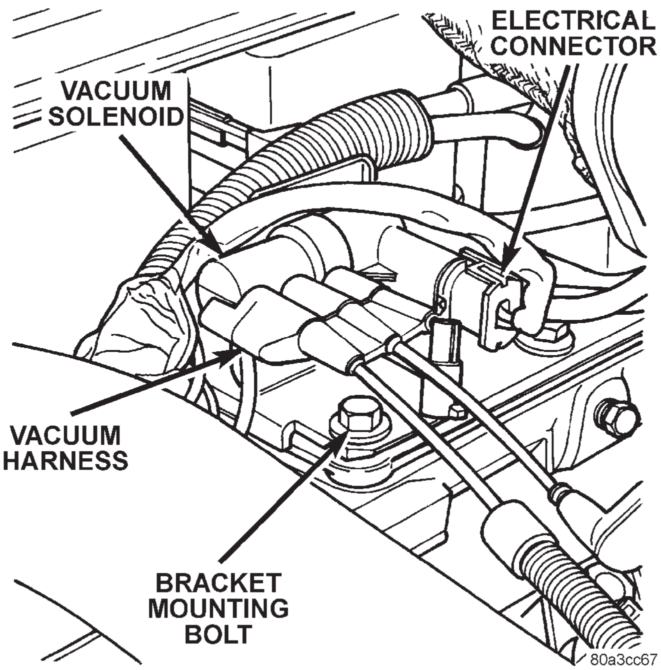

Fig. 12 EGR Valve Vacuum Regulator Solenoid

THROTTLE POSITION SENSOR

For removal, installation, testing and adjustment of the throttle position sensor (TPS), refer to the diesel sections of Group 14, Fuel System. The TPS may also be tested with the DRB scan tool. Refer to the appropriate Powertrain Diagnostic Procedures service manual.

ENGINE COOLANT TEMPERATURE SENSOR—DIESEL ENGINE

The Engine Coolant Temperature (ECT) sensor is located on the left side of the cylinder head behind the fuel filter and below the intake manifold (Fig. 13).

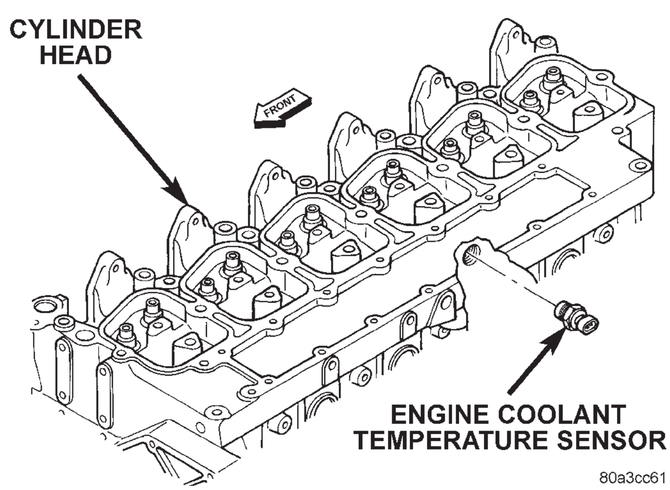

Fig. 13 ECT Sensor Location—Diesel Engine

REMOVAL AND INSTALLATION (Continued)

REMOVAL

WARNING: THE COOLING SYSTEM MAY BE UNDER PRESSURE. HOT COOLANT CAN CAUSE BURNS. OBSERVE THE WARNINGS IN GROUP 7, COOLING SYSTEM BEFORE PROCEEDING.

(1) Partially drain cooling system until coolant level is below cylinder head.

(2) Drain and remove fuel filter/water separator. Refer to Fuel Filter/Water Separator Removal/Installation in the Diesel section of Group 14, Fuel System for procedures.

(3) Disconnect ECT sensor pigtail harness connector from sensor.

(4) Remove ECT sensor from cylinder head.

INSTALLATION

(1) Apply sealant to sensor threads.

(2) Install ECT sensor into cylinder head. Tighten to 55 N·m (40 ft. lbs.) torque.

(3) Connect ECT sensor wire connector.

(4) Install fuel filter and bleed fuel. Refer to Group 14, Fuel System for procedures.

(5) Fill cooling system and check for coolant leaks. Refer to Group 7, Cooling System for procedures.

SPECIFICATIONS

TORQUE CHART

Description	Torque
EGR Valve Mounting Bolts	24 N·m (212 in. lbs.)
EGR Valve Vacuum Regulator Solenoid Mounting Bolt	24 N·m (212 in. lbs.)
EGR Tube Mounting Bolts/Nuts	24 N·m (212 in. lbs.)
Engine Coolant Temperature (ECT) Sensor	55 N·m (40 ft. lbs.)