EMISSION CONTROL SYSTEMS

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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 code applies to a non-emissions related component or system, and 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.

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 (Fig. 1) to erase all DTC's and extinguish the MIL.

Technicians can display stored DTC's by three different methods. Refer to Diagnostic Trouble Codes in this section. For DTC information, refer to charts in this section.

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

DESCRIPTION AND OPERATION (Continued)

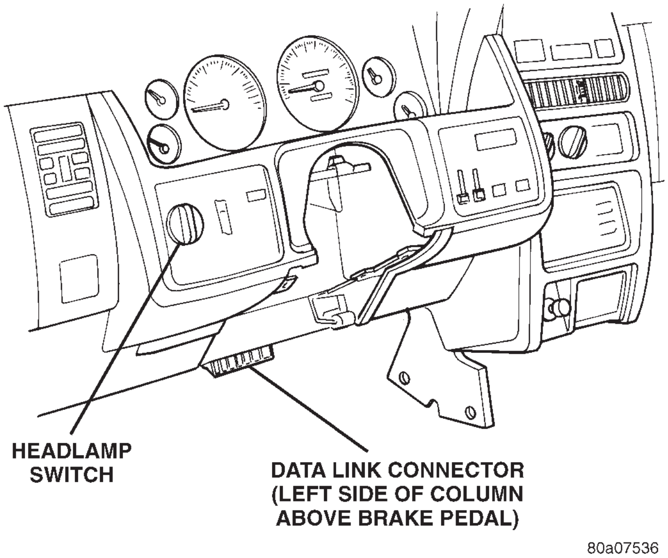

Fig. 1 Data Link (Diagnostic) ConnectorLocation

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 continuously 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.

The technician can retrieve and display DTC's in three different ways:

- The preferred and most accurate method of retrieving a DTC is by using the DRB scan tool. The scan tool supplies detailed diagnostic information which can be used to more accurately diagnose causes for a DTC.
- The second method is by observing the two-digit number displayed at the Malfunction Indicator Lamp (MIL). The MIL is displayed on the instrument panel as the Check Engine lamp. This method is to be used as a "quick-test" only. Always use the DRB scan tool for detailed information.
- The third method is by observing the two-digit number displayed at the vehicle odometer. This method, similar to the MIL lamp, is also to be used as a "quick-test" only.

Remember that DTC's are the results of a system or circuit failure, but do not directly identify the failed component or components.

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

BULB CHECK

Each time the ignition key is turned to the ON position, the malfunction indicator (check engine) lamp on the instrument panel should illuminate for approximately 2 seconds then go out. This is done for a bulb check.

OBTAINING DTC'S USING DRB SCAN TOOL

(1) Connect the DRB scan tool to the data link (diagnostic) connector. This connector is located in

DESCRIPTION AND OPERATION (Continued)

the passenger compartment; at the lower edge of instrument panel; near the steering column.

(2) Turn the ignition switch on and access the "Read Fault" screen.

(3) Record all the DTC's and "freeze frame" information shown on the DRB scan tool.

(4) To erase DTC's, use the "Erase Trouble Code" data screen on the DRB scan tool. **Do not erase any DTC's until problems have been investigated and repairs have been performed.**

OBTAINING DTC'S USING MIL LAMP

(1) Cycle the ignition key On - Off - On - Off - On within 5 seconds.

(2) Count the number of times the MIL (check engine lamp) on the instrument panel flashes on and off. The number of flashes represents the trouble code. There is a slight pause between the flashes representing the first and second digits of the code. Longer pauses separate individual two digit trouble codes.

An example of a flashed DTC is as follows:

- Lamp flashes 4 times, pauses, and then flashes 6 more times. This indicates a DTC code number 46.
- Lamp flashes 5 times, pauses, and flashes 5 more times. This indicates a DTC code number 55. A DTC 55 will always be the last code to be displayed. This indicates the end of all stored codes.

OBTAINING DTC'S USING VEHICLE ODOMETER

(1) Cycle the ignition key On - Off - On - Off - On within 5 seconds.

(2) After a short pause, the mileage shown on the vehicles digital odometer will be temporarily deleted. After this occurs, read the DTC number displayed on the odometer. Each two–digit number will be displayed with a slight delay between numbers.

(3) A DTC number 55 will always be the last code to be displayed. This indicates the end of all stored codes. After code 55 has been displayed, the odometer will return to its normal mode.

DIAGNOSTIC TROUBLE CODE DESCRIPTIONS

HEX CODE	MIL CODE	GENERIC SCAN TOOL CODE	DRB SCAN TOOL DISPLAY	DESCRIPTION OF DIAGNOSTIC TROUBLE CODE
	12*		Battery Disconnect	Direct battery input to PCM was disconnected within the last 50 Key-on cycles.
	55*			Completion of fault code display on Check Engine lamp.
01	54**	P0340	No Cam Signal at PCM	No camshaft signal detected during engine cranking.
02	53**	P0601	Internal Controller Failure	PCM Internal fault condition detected.
05	47***		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	46***		Charging System Voltage Too High	Battery voltage sense input above target charging voltage during engine operation.
0A	42*		Auto Shutdown Relay Control Circuit	An open or shorted condition detected in the auto shutdown relay circuit.
0B	41***		Generator Field Not Switching Properly	An open or shorted condition detected in the generator field control circuit.
0C	37**	P0743	Torque Converter Clutch Soleniod/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).
0E	35**	P1491	Rad Fan Control Relay Circuit	An open or shorted condition detected in the low speed radiator fan relay control circuit.

DESCRIPTION AND OPERATION (Continued)

HEX CODE	MIL CODE	GENERIC SCAN TOOL CODE	DRB SCAN TOOL DISPLAY	DESCRIPTION OF DIAGNOSTIC TROUBLE CODE
0F	34*		Speed Control Solenoid Circuits	An open or shorted condition detected in the Speed Control vacuum or vent solenoid circuits.
10	33*		A/C Clutch Relay Circuit	An open or shorted condition detected in the A/C clutch relay circuit.
12	31**	P0443	EVAP Purge Solenoid Circuit	An open or shorted condition detected in the duty cycle purge solenoid circuit.
13	27**	P0203	Injector #3 Control Circuit	Injector #3 output driver does not respond properly to the control signal.
		or		
14		P0202	Injector #2 Control Circuit	Injector #2 output driver does not respond properly to the control signal.
		or		
15		P0201	Injector #1 Control Circuit	Injector #1 output driver does not respond properly to the control signal.
19	25**	P0505	Idle Air Control Motor Circuits	A shorted or open condition detected in one or more of the idle air control motor circuits.
1A	24**	P0122	Throttle Position Sensor Voltage Low	Throttle position sensor input below the minimum acceptable voltage
		or		
1B		P0123	Throttle Position Sensor Voltage High	Throttle position sensor input above the maximum acceptable voltage.
1E	22**	P0117	ECT Sensor Voltage Too Low	Engine coolant temperature sensor input below minimum acceptable voltage.
		or		
1F		P0118	ECT Sensor Voltage Too High	Engine coolant temperature sensor input above maximum acceptable voltage.
21	17*		Engine Is Cold Too Long	Engine did not reach operating temperature within acceptable limits.
23	15**	P0500	No Vehicle Speed Sensor Signal	No vehicle speed sensor signal detected during road load conditions.
24	14**	P0107	MAP Sensor Voltage Too Low	MAP sensor input below minimum acceptable voltage.
		or		
25		P0108	MAP Sensor Voltage Too High	MAP sensor input above maximum acceptable voltage.
27	13**	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.
28	11*		No Crank Reference Signal at PCM	No crank reference signal detected during engine cranking.
2B		P0351	Ignition Coil #1 Primary Circuit	Peak primary circuit current not achieved with maximum dwell time.
2C	42*		No ASD Relay Output Voltage at PCM	An Open condition Detected In The ASD Relay Output Circuit.

DESCRIPTION AND OPERATION (Continued)

HEX CODE	MIL CODE	GENERIC SCAN TOOL CODE	DRB SCAN TOOL DISPLAY	DESCRIPTION OF DIAGNOSTIC TROUBLE CODE
31	63**	P1696	PCM Failure EEPROM Write Denied	Unsuccessful attempt to write to an EEPROM location by the PCM.
32	37**	P0753	Trans 3-4 Shift Sol/Trans Relay Circuits	Current state of output port for the solenoid is different from expected state.
39	23**	P0112	Intake Air Temp Sensor Voltage Low	Intake air temperature sensor input below the maximum acceptable voltage.
		or		
3A		P0113	Intake Air Temp Sensor Voltage High	Intake air temperature sensor input above the minimum acceptable voltage.
3D	27**	P0204	Injector #4 Control Circuit	Injector #4 output driver does not respond properly to the control signal.
3E	21**	P0132	Left Upstream O2S Shorted to Voltage	Oxygen sensor input voltage maintained above the normal operating range.
44	53**	PO600	PCM Failure SPI Communications	PCM internal fault condition detected
45	27**	P0205	Injector #5 Control Circuit	Injector #5 output driver does not respond properly to the control signal.
		or		
46		P0206	Injector #6 Control Circuit	Injector #6 output driver does not respond properly to the control signal.
4A	45*	P0712	Trans Temp Sensor Voltage Too Low	Voltage less than 1.55 volts.
		or		
4B		P0713	Trans Temp Sensor Voltage Too High	Voltage greater than 3.76 volts.
4F	27**	P0207	Injector #7 Control Circuit	Injector #7 output driver does not respond properly to the control signal.
		or		
50		P0208	Injector #8 Control Circuit	Injector #8 output driver does not respond properly to the control signal.
52	77*		SPD CTRL PWR RLY; or S/C 12V Driver CKT	Malfuntion detected with power feed to speed control servo solenoids
56	34*		Speed Control Switch Always High	Speed control switch input above the maximum acceptable voltage.
		or		
57			Speed Control Switch Always Low	Speed control switch input below the minimum acceptable voltage.
65	42*		Fuel Pump Relay Control Circuit	An open or shorted condition detected in the fuel pump relay control circuit.
66	21**	P0133	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

DESCRIPTION AND OPERATION (Continued)

HEX CODE	MIL CODE	GENERIC SCAN TOOL CODE	DRB SCAN TOOL DISPLAY	DESCRIPTION OF DIAGNOSTIC TROUBLE CODE
69		P0141	Downstream,Left Bank Downstream or Pre-Catalyst Heater Failure	Oxygen sensor heating element circuit malfunction.
6A	43**	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	72**	P0420	Left Bank Catalytic (or just) Catalytic Efficency Failure	Catalyst efficiency below required level.
71	31*	P0441	Evap Purge Flow Monitor Failure	Insufficient or excessive vapor flow detected during evaporative emission system operation.
72	37**	P1899	P/N Switch Stuck in Park or in Gear	Incorrect input state detected for the Park/Neutral switch, auto. trans. only.
76	52**	P0172	Left Bank or Fuel System Rich	A rich air/fuel mixture has been indicated by an abnormally lean correction factor.
77	51**	P0171	Right Rear (or just) Fuel System Lean	A lean air/fuel mixture has been indicated by an abnormally rich correction factor.
7E	21**	P0138	Left Bank Downstream or Downstream and Pre-Catalyst O2S Shorted to Voltage	Oxygen sensor input voltage maintained above the normal operating range.
80	17**	P0125	Closed Loop Temp Not Reached	Engine does not reach 20°F within 5 minutes with a vehicle speed signal.
84	24**	P0121	TPS Voltage Does Not Agree With MAP	TPS signal does not correlate to MAP sensor
87	14**	P1296	No 5 Volts To MAP Sensor	5 Volt output to MAP sensor open.
8A	25**	P1294	Target Idle Not Reached	Actual idle speed does not equal target idle speed.
8D	37	P1756	Governor Pressure Not Equal to Target @ 15-20 PSI	Governor sensor input not between 10 and 25 psi when requested.
		or		
8E		P1757	Governor Pressure Above 3 PSI In Gear With 0 MPH	Governor pressure greater than 3 psi when requested to be 0 psi.

DESCRIPTION AND OPERATION (Continued)

HEX CODE	MIL CODE	GENERIC SCAN TOOL CODE	DRB SCAN TOOL DISPLAY	DESCRIPTION OF DIAGNOSTIC TROUBLE CODE
94	37*	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	42*		Fuel Level Sending Unit Volts Too Low	Open circuit between PCM and fuel gauge sending unit.
		or		
96			Fuel Level Sending Unit Volts Too High	Circuit shorted to voltage between PCM and fuel gauge sending unit.
		or		
97			Fuel Level Unit No Change Over Miles	No movement of fuel level sender detected.
99	44**	P1493	Ambient/Batt Temp Sen VoltsToo Low	Battery temperature sensor input voltage below an acceptable range.
		or		
9A		P1492	Ambient/Batt Temp Sensor VoltsToo High	Battery temperature sensor input voltage above an acceptable range.
9B	21**	P0131	Left Bank and Upstream O2S Shorted to Ground	O2 sensor voltage too low, tested after cold start.
		or		
9C		P0137	Downstream, Left Bank Downstream and Pre-Catalyst O2S Shorted to Ground	O2 sensor voltage too low, tested after cold start.
9D	11**	P1391	Intermittent Loss of CMP or CKP	Intermittent loss of either camshaft or crankshaft position sensor
A0	31**	P0442	Evap Leak Monitor Small Leak Detected	A small leak has been detected by the leak detection monitor
		or		
A1		P0455	Evap Leak Monitor Large Leak Detected	The leak detection monitor is unable to pressurize Evap system, indicating a large leak.
A4	45	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	37**	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	15**	P0720	Low Ouput Spd Sensor RPM Above 15 mph	Output shaft speed is less than 60 rpm with vehicle speed above 15 mph.
A7	45**	P1764	Governor Pessure Sensor Volts Too Low	Voltage less than .10 volts.
		or		
A8		P1763	Governor Pressure Sensor Volts Too HI	Voltage greater than 4.89 volts.
		or		

DESCRIPTION AND OPERATION (Continued)

HEX CODE	MIL CODE	GENERIC SCAN TOOL CODE	DRB SCAN TOOL DISPLAY	DESCRIPTION OF DIAGNOSTIC TROUBLE CODE
A9		P1762	Governor Press Sen Offset Volts Too Lo or High	Sensor input greater or less than calibration for 3 consecutive Neutral/Park occurances.
AB	37**	P0748	Governor Pressure Sol Control/Trans Relay Circuits	Current state of solenoid output port is different than expected.
AD	37**	P1765	Trans 12 Volt Supply Relay Ctrl Circuit	Current state of solenoid output port is different than expeted.
AE AF B0 B1	43**	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.
B7 B8	31**	P1495 or P1494	Leak Detection Pump Solenoid Circuit Leak detection pump SW or mechanical fault	Leak detection pump solenoid circuit fault (open or short) Leak detection pump switch does not respond to input.
BA	11**	P1398	Mis-fire Adaptive Numerator at Limit	CKP sensor target windows have too much variation
BB	31**	P1486	Evap leak monitor pinched hose found	Plug or pinch detected between purge solenoid and fuel tank
BC	45		O/D Switch Pressed (LO) More Than 5 Min	Overdrive Off switch input too low for more than 5 minutes.
CO	21	P0133	CAT MON SLOW O2 1/1	A slow switching oxygen sensor has been detected in bank 1/1 during catalyst monitor test.

* Check Engine Lamp (MIL) will not illuminate if this Diagnostic Trouble Code was recorded. Cycle Ignition key as described in manual and observe code flashed by Check Engine lamp.

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

*** Generator Lamp illuminated

DESCRIPTION AND OPERATION (Continued)

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

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

Following is a description of each system monitor, and its DTC.

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

MIL 21—OXYGEN SENSOR (O2S) MONITOR

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 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.

MIL 21—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.

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.

MIL 31—LEAK DETECTION PUMP MONITOR

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

DESCRIPTION AND OPERATION (Continued)

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.

MIL 43—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.

MIL 51/52—FUEL SYSTEM 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. 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.

MIL 64—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 con-

DESCRIPTION AND OPERATION (Continued)

verter. 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.

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

DESCRIPTION AND OPERATION (Continued)

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.

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

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DESCRIPTION AND OPERATION

EVAPORATION 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 to a charcoal filled evaporative canister. The canister temporarily holds the vapors. The Powertrain Control Module (PCM) allows intake manifold vacuum to draw vapors into the combustion chambers during certain operating conditions.

All 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 in this section.

When equipped with the California Emissions Package, 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 evaporative system uses specially manufactured hoses. If replacement becomes necessary, only use fuel resistant hose.

ROLLOVER VALVE

The fuel tank is equipped with a rollover valve. The valve is located on the top of the fuel tank (Fig. 1). The valve will prevent fuel flow through the fuel tank vent (EVAP) hoses in the event of an accidental vehicle rollover. The EVAP canister draws fuel vapors from the fuel tank through this valve.

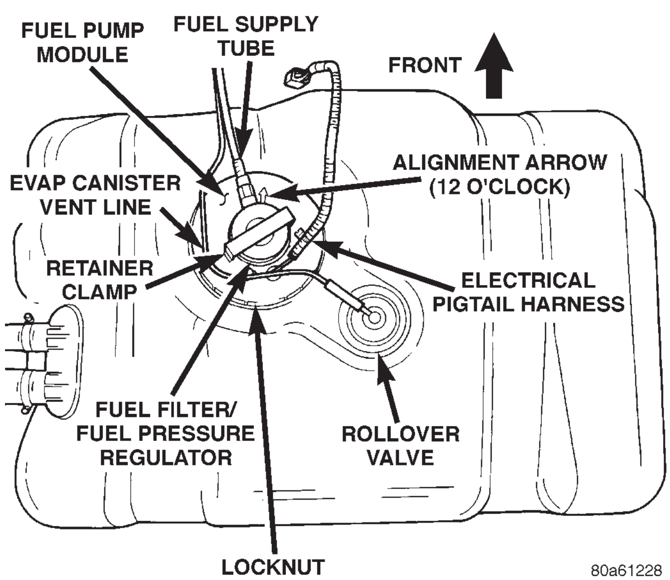

Fig. 1 Rollover Valve Location

The valve cannot be serviced separately. If replacement is necessary, the fuel tank must be replaced. Refer to Fuel Tank removal and installation in this group.

EVAPORATION (EVAP) CANISTER

A maintenance free, EVAP canister is used on all vehicles. The EVAP canister is located below the left front headlamp (Fig. 2). The EVAP canister is filled with granules of an activated carbon mixture. Fuel vapors entering the EVAP canister are absorbed by the charcoal granules.

DESCRIPTION AND OPERATION (Continued)

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

For vehicles equipped with the California Emission Package, also refer to Leak Detection Pump in this group for additional information.

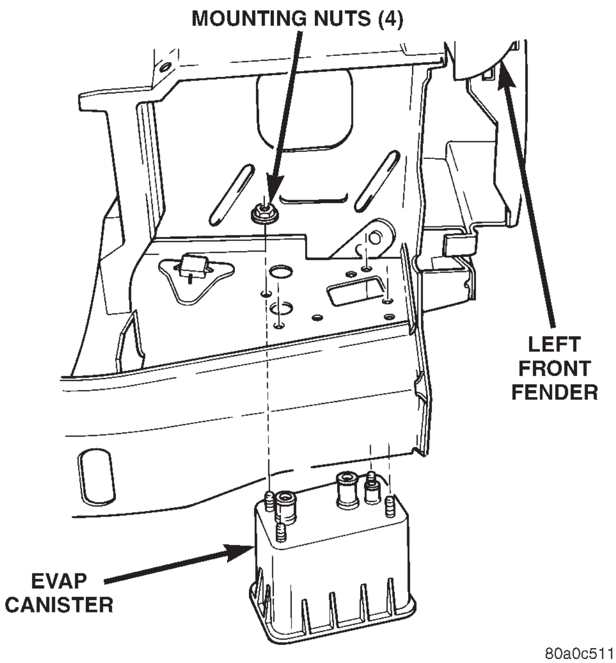

Fig. 2 EVAP Canister Location

DUTY CYCLE EVAP CANISTER PURGE SOLENOID

The 4.0L six-cylinder and 5.2L/5.9L V-8 engines are equipped with a duty cycle EVAP canister purge solenoid. The solenoid regulates the rate of vapor flow from the EVAP canister to the intake manifold. The Powertrain Control Module (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 cycles (energizes and de-energizes) the solenoid 5 or 10 times per second, depending upon operating conditions. The PCM varies the vapor flow rate by changing solenoid pulse width. Pulse width is the amount of time that the solenoid is energized. The PCM adjusts solenoid pulse width based on engine operating condition.

The solenoid attaches to a bracket located on the left/inner fender (Fig. 3).

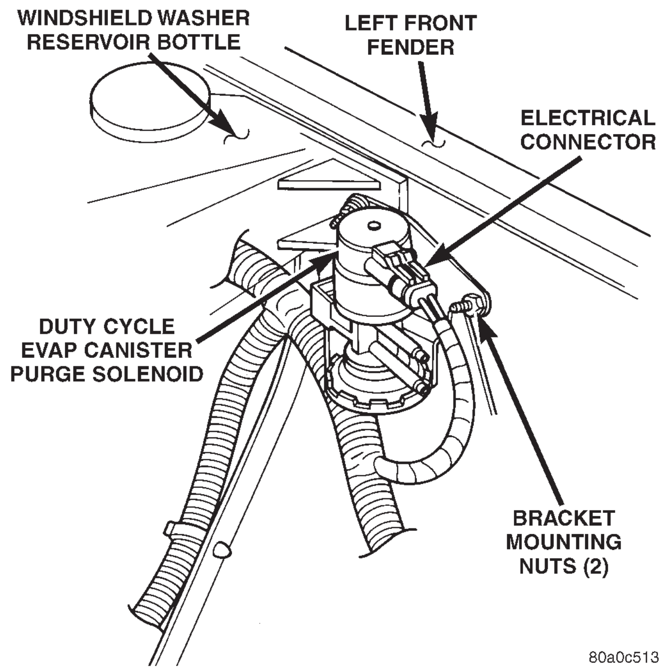

Fig. 3 Duty Cycle EVAP Purge Solenoid Location

LEAK DETECTION PUMP (LDP)—WITH CALIFORNIA EMISSIONS PACKAGE

The leak detection pump (LDP) is used with 4.0L 6–cylinder and 5.2L V-8 engines if equipped with the California Emission Package. It is not used with the 5.9L engine.

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:

DESCRIPTION AND OPERATION (Continued)

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—5.2L/5.9L ENGINE

The 5.2L/5.9L V-8 engine is equipped with a closed crankcase ventilation system and a positive crankcase ventilation (PCV) valve. The 4.0L 6–cylinder engine is not equipped with a PCV valve. Refer to Crankcase Ventilation System—4.0L Engine for information.

This system consists of a crankcase PCV valve mounted on the cylinder head (valve) cover with a hose extending from the valve to the intake manifold.

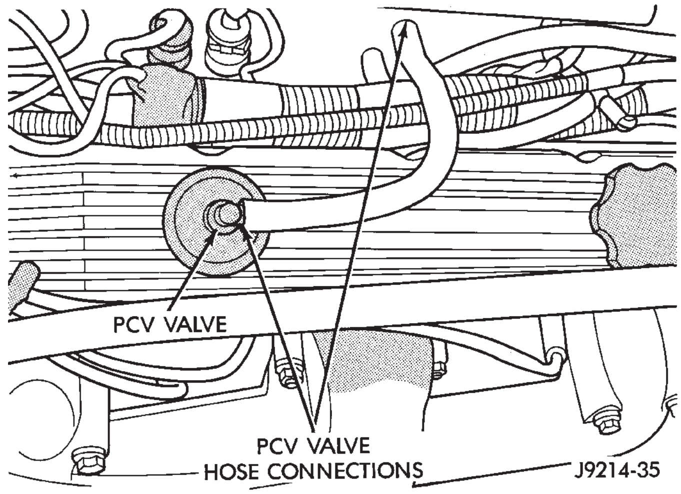

Fig. 5 PCV Valve/Hose—Typical

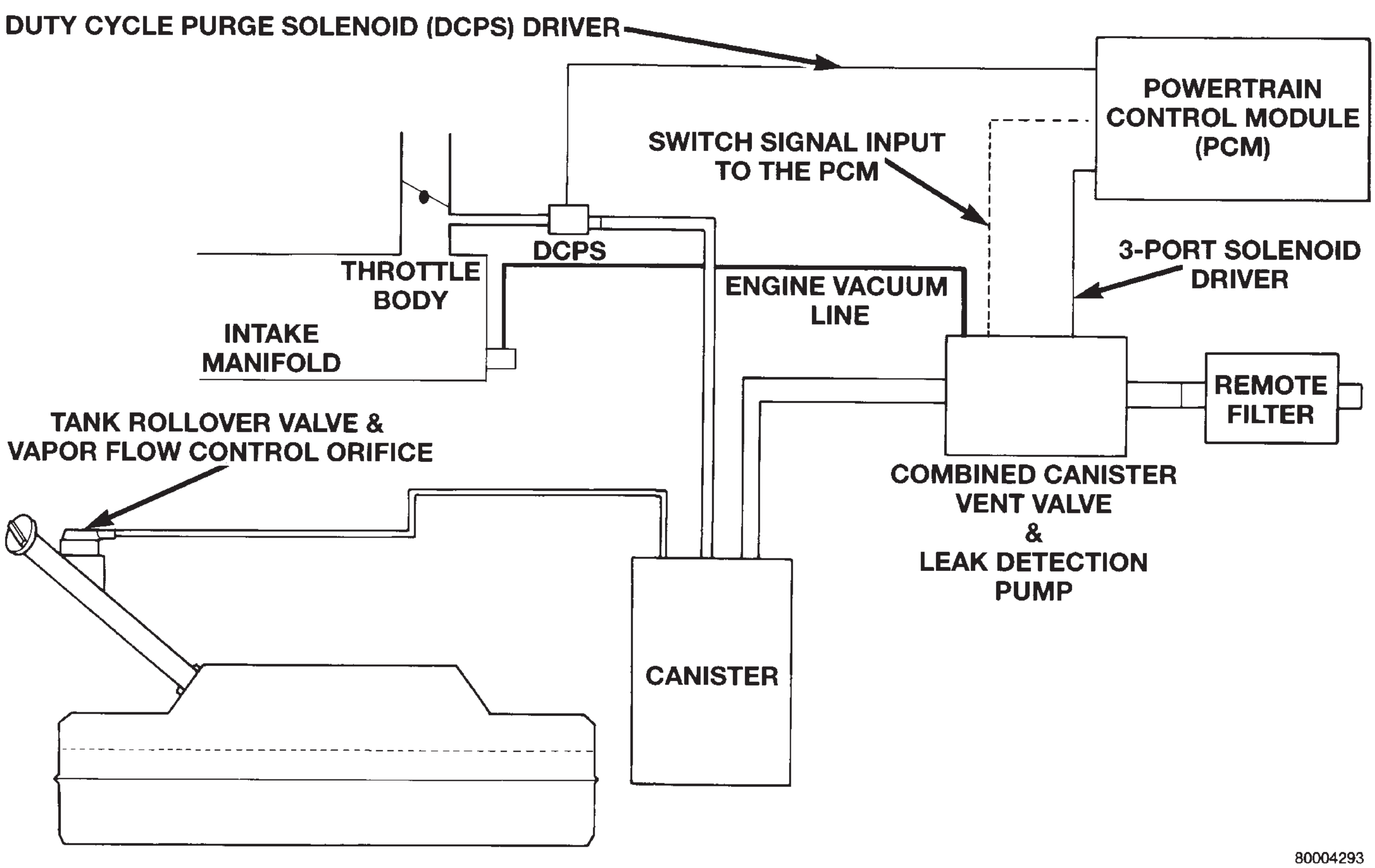

Fig. 4 Evaporative System Monitor Schematic—Typical

DESCRIPTION AND OPERATION (Continued)

A closed engine crankcase breather/filter, with a hose connecting it to the air cleaner housing, provides the source of air for system.

The PCV system operates by engine intake manifold vacuum (Fig. 6). Filtered air is routed into the crankcase through the air cleaner hose and crankcase breather/filter. 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.

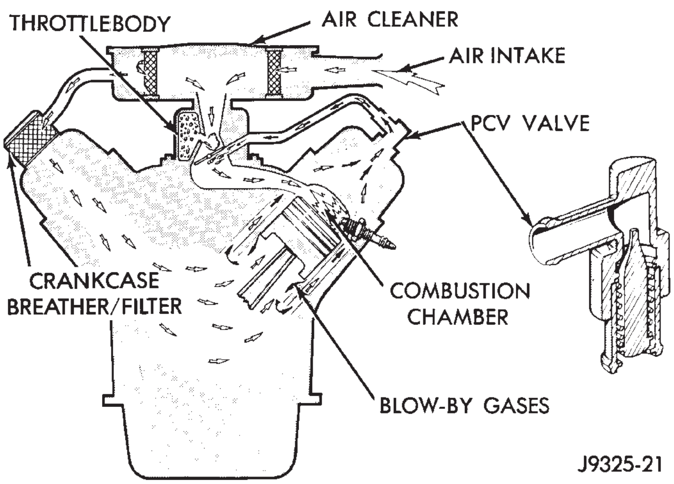

Fig. 6 Typical Closed Crankcase VentilationSystem

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.

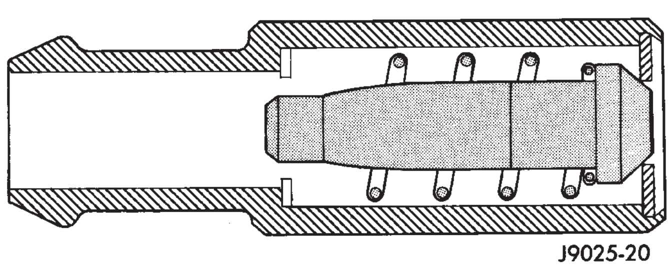

Fig. 7 Engine Off or Engine Pop-Back—NoVapor Flow

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. 8). In this position there is minimal vapor flow through the valve.

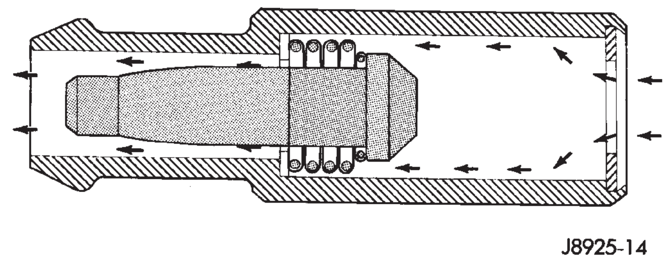

Fig. 8 High Intake Manifold Vacuum—MinimalVapor Flow

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. 9).

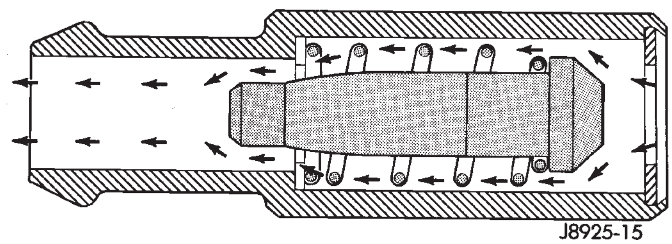

Fig. 9 Moderate Intake Manifold Vacuum—MaximumVapor Flow

CRANKCASE VENTILATION (CCV) SYSTEM—4.0L ENGINE

4.0L 6–cylinder engines are 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.

A molded vacuum tube connects a fitting on the intake manifold to a fixed orifice fitting of a calibrated size. This fitting meters the amount of crankcase vapors drawn out of the engine. The fixed orifice fitting is located on the top/rear of cylinder head (valve) cover (Fig. 10).

A fresh air supply hose is connected between a fitting on the air cleaner housing and the air inlet fitting at the top/front of cylinder head cover (Fig. 10).

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

CRANKCASE BREATHER/FILTER—5.2L/5.9L ENGINE

The crankcase breather/filter (Fig. 11) is located on the cylinder head (valve) cover. The filter may be cleaned by washing in kerosene or similar solvent. Filter must then be thoroughly drained. More frequent service may be necessary for vehicles operated

DESCRIPTION AND OPERATION (Continued)

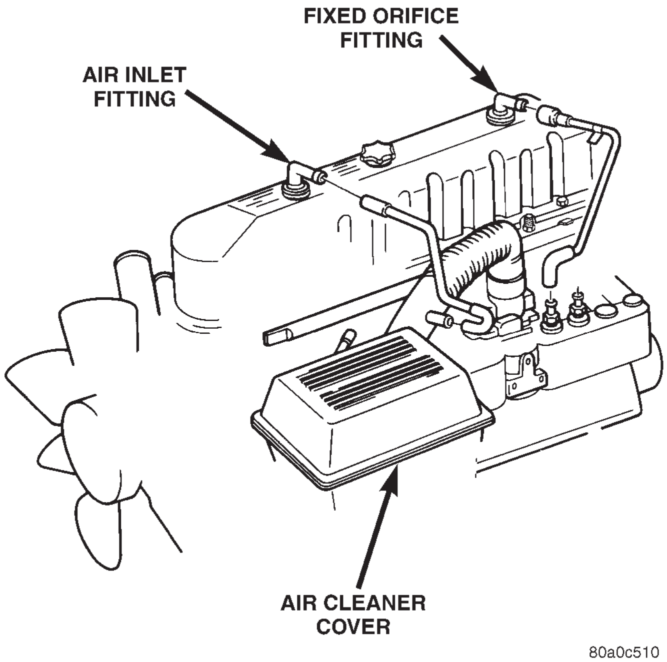

Fig. 10 CCV System—4.0L Engine

extensively on short run, stop and go or extended engine idle service, or extreme dust conditions.

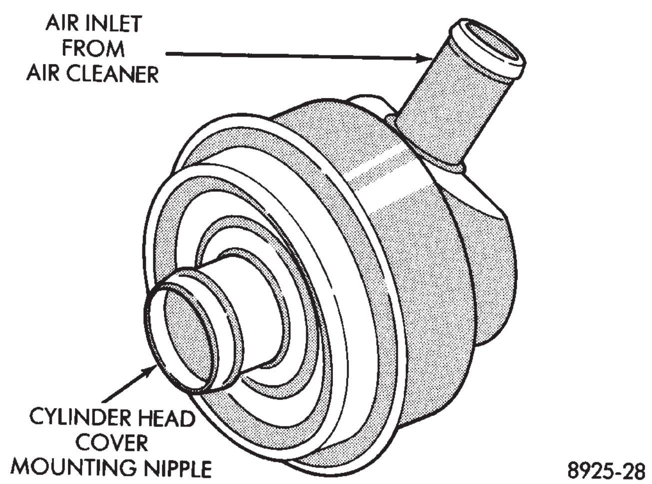

Fig. 11 Crankcase Breather/Filter—5.2L/5.9LEngine

VEHICLE EMISSION CONTROL INFORMATION (VECI) LABEL

All vehicles are equipped with a combined VECI label. This label is located in the engine compartment (Fig. 12) 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

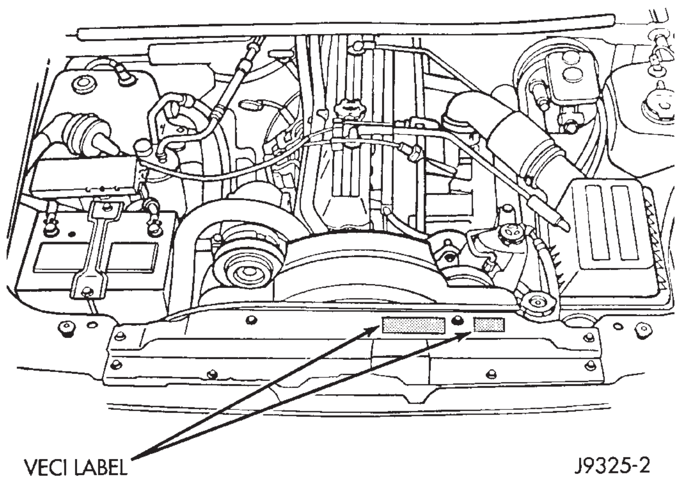

Fig. 12 VECI Label Location—Typical

The label also contains an engine vacuum schematic. There are unique labels for vehicles built for sale in the state of California and the country of Canada. Canadian labels are written in both the English and French languages. These labels are permanently attached and cannot be removed without defacing information and destroying label.

DIAGNOSIS AND TESTING

PCV VALVE TEST—5.2L/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. 13).

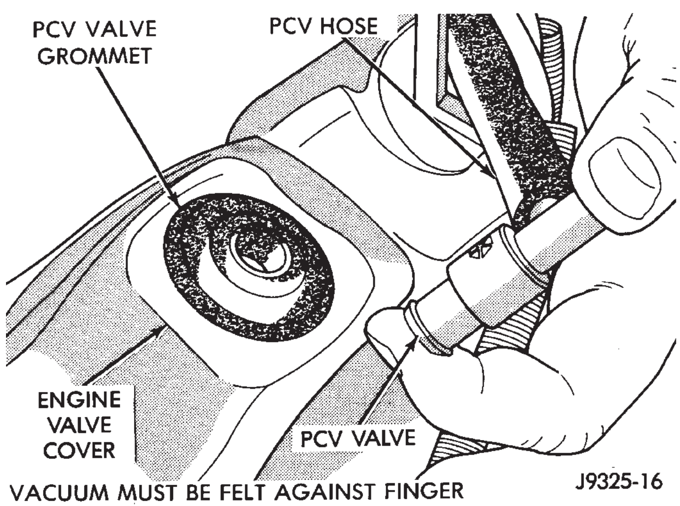

Fig. 13 Check Vacuum at PCV Valve—Typical

(2) Install the PCV valve. Remove the crankcase breather/filter. Hold a piece of stiff paper, such as a parts tag, loosely over the opening of crankcase

DIAGNOSIS AND TESTING (Continued)

breather/filter at the cylinder head (valve) cover (Fig. 14).

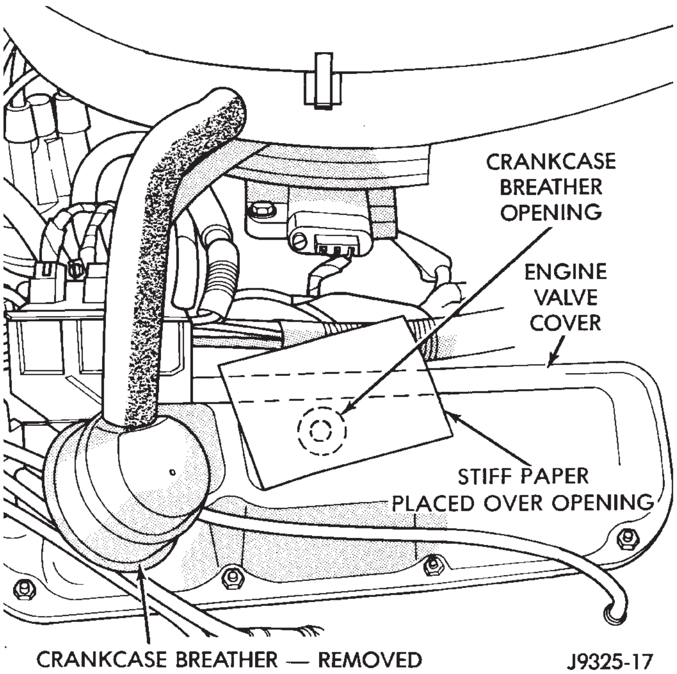

Fig. 14 Check Vacuum at Crankcase BreatherOpening—Typical

(3) The paper should be drawn against the opening in the cylinder head (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 cylinder head (valve) cover. The valve should rattle when shaken (Fig. 15).

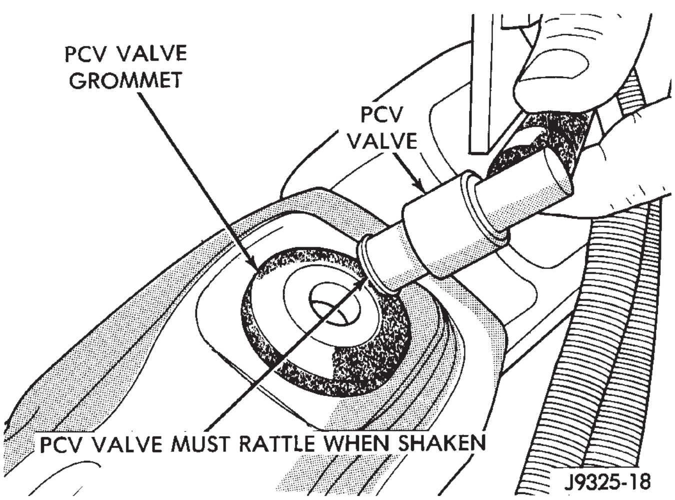

Fig. 15 Shake PCV Valve—Typical

(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 cylinder head (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 Vehicle Emission Control Information (VECI) Label. Refer to 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

The EVAP canister is located in the left front corner of vehicle below the left front headlamp (Fig. 16).

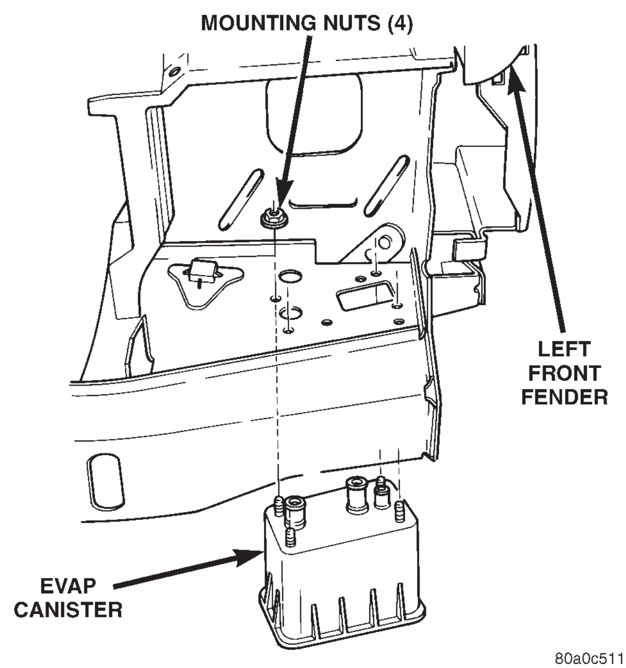

Fig. 16 EVAP Canister Location

REMOVAL

(1) Remove the grill. Refer to Group 23, Body.

(2) Remove the front bumper/fascia assembly. Refer to Group 23, Body.

(3) Disconnect vacuum lines at canister.

(4) Remove the canister mounting nuts.

(5) Lower the canister through bottom of vehicle.

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

(1) Position canister to body.

(2) Install canister mounting nuts. Tighten nuts to 9 N·m (80 in. lbs.) torque.

(3) Connect vacuum lines. Be sure vacuum lines are firmly connected and not leaking or damaged. If leaking, a Diagnostic Trouble Code (DTC) may be set with certain emission packages.

(4) Install the front bumper/fascia assembly and grill. Refer to Group 23, Body.

EVAPORATIVE CANISTER PURGE SOLENOID

REMOVAL

The duty cycle evaporative (EVAP) canister purge solenoid is located in the left/front corner of the engine compartment on all engine/emission packages (Fig. 17).

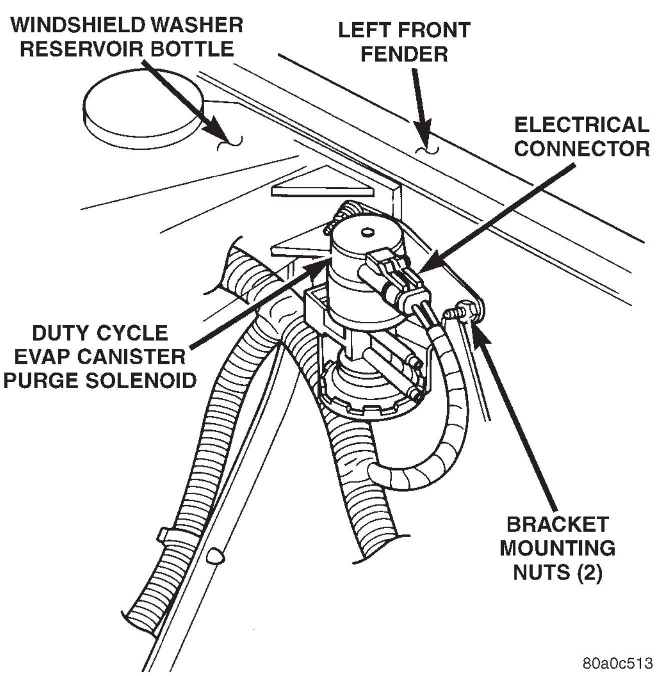

Fig. 17 EVAP Canister Purge Solenoid—Typical

(1) Disconnect the electrical connector at the solenoid.

(2) Disconnect the vacuum lines at the solenoid.

(3) Remove the two bracket mounting nuts and remove solenoid.

INSTALLATION

(1) Position the solenoid to vehicle.

(2) Install and tighten the two bracket mounting nuts to 5 N·m (45 in. lbs.) torque.

(3) Connect the vacuum lines to the solenoid. Be sure the vacuum lines are firmly connected and not leaking or damaged. If leaking, a Diagnostic Trouble Code (DTC) may be set with certain emission packages.

(4) Connect the electrical connector to the solenoid.

ROLLOVER VALVE(S)

The pressure relief/rollover valves(s) are/is molded into the fuel tank and are not serviced separately. If replacement is necessary, the fuel tank must be replaced. Refer to Fuel Tank Removal/Installation in Group 14, Fuel System for procedures.

LEAK DETECTION PUMP (LDP)

The LDP is located in the left/front corner of the engine compartment below the EVAP canister purge solenoid (Fig. 18).

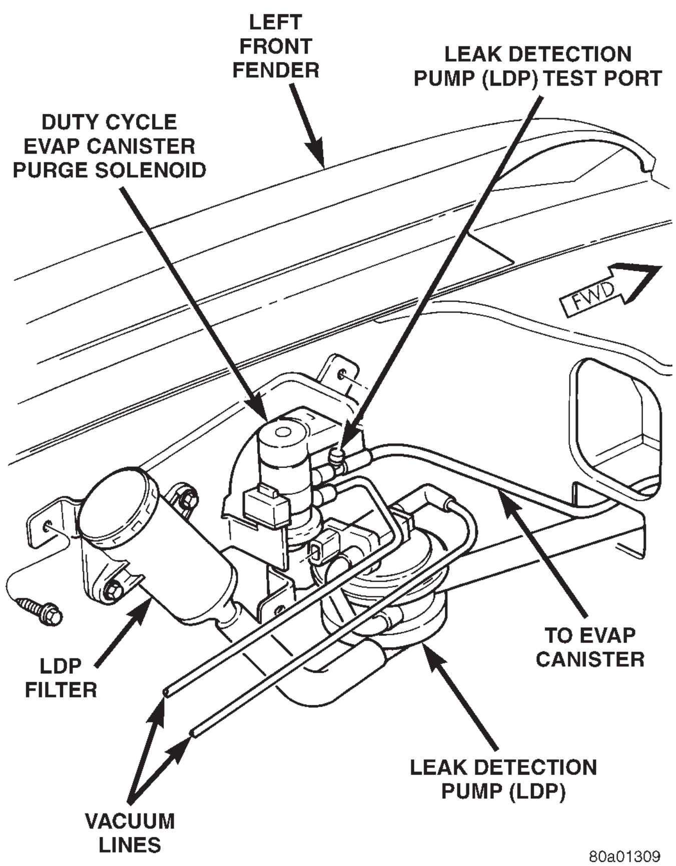

Fig. 18 Leak Detection Pump (LDP) Location

REMOVAL/INSTALLATION

(1) Remove air cleaner housing. Refer to Group 14, Fuel System for procedures.

(2) Carefully remove all vapor/vacuum lines at EVAP canister purge solenoid.

(3) Remove EVAP canister purge solenoid.

(4) Disconnect electrical connector at LDP.

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

(6) Remove LDP mounting nuts/bolts.

(7) Remove LDP from vehicle.

(8) Reverse the removal procedures for installation. The vapor/vacuum lines must be firmly connected. Check the vapor/vacuum lines at both the LDP and EVAP canister solenoid for damage or

REMOVAL AND INSTALLATION (Continued)

leaks. If a leak is present, a Diagnostic Trouble Code (DTC) may be set.

SPECIFICATIONS

TORQUE CHART

Description	Torque
EVAP Canister Mounting Nuts	9 N·m (80 in. lbs.)
EVAP Canister Purge Solenoid Mounting Nuts	5 N·m (45 in. lbs.)
LDP Pump Bracket Nuts	7 N·m (60 in. lbs.)

EMISSION CONTROL SYSTEM

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GENERAL INFORMATION

SYSTEM DESCRIPTION—2.5L DIESEL ENGINE

The 2.5L diesel MSA controller and Powertrain Control Module (PCM) monitor and control many different circuits in the fuel injection pump and engine systems. If the MSA senses a problem with a monitored circuit that indicates an actual problem, a Diagnostic Trouble Code (DTC) will be stored in the PCM's memory, and eventually may illuminate the Diesel Glow Plug lamp constantly while the key is on. If the problem is repaired, or is intermittent, the PCM will erase the DTC after 40 warm-up cycles. A warm-up cycle consists of starting the vehicle when the engine is cold, then the engine to warms up to a certain temperature, and finally, the engine temperature falls to a normal operating temperature, then the key is turned off.

Certain criteria must be met for a DTC to be entered into PCM memory. The criteria may be a specific range of engine rpm, engine or fuel temperature and/or input voltage to the PCM. A DTC indicates that the PCM has identified an abnormal signal in a circuit or the system. A DTC may indicate the result of a failure, but never identify the failed component directly.

There are several operating conditions that the MSA does not monitor and set a DTC for. Refer to the following Monitored Circuits and Non–Monitored Circuits in this section.

MONITORED CIRCUITS

The MSA can detect certain problems in the electrical system.

Open or Shorted Circuit – The MSA can determine if sensor output (which is the input to MSA is within proper range. It also determines if the circuit is open or shorted.

Output Device Current Flow – The MSA senses whether the output devices are electrically connected.

If there is a problem with the circuit, the MSA senses whether the circuit is open, shorted to ground (–), or shorted to (+) voltage.

NON–MONITORED CIRCUITS

The MSA does not monitor the following circuits, systems or conditions that could have malfunctions that result in driveability problems. A DTC will not be displayed for these conditions.

Fuel Pressure: Fuel pressure is controlled by the fuel injection pump. The PCM cannot detect problems in this component.

Cylinder Compression: The MSA cannot detect uneven, low, or high engine cylinder compression.

Exhaust System: The MSA cannot detect a plugged, restricted or leaking exhaust system.

Fuel Injector Malfunctions: The MSA cannot determine if the fuel injector is clogged, or the wrong injector is installed. The fuel injectors on the diesel engine are **not controlled** by the MSA, although a defective fuel injector sensor **is monitored** by the PCM.

GENERAL INFORMATION (Continued)

Vacuum Assist: Leaks or restrictions in the vacuum circuits of vacuum assisted engine control system devices are not monitored by the MSA.

MSA System Ground: The MSA cannot determine a poor system ground. However, a DTC may be generated as a result of this condition.

MSA/PCM Connector Engagement: The MSA cannot determine spread or damaged connector pins. However, a DTC may be generated as a result of this condition.

HIGH AND LOW LIMITS

The MSA compares input signal voltages from each input device. It will establish high and low limits that are programmed into it for that device. If the input voltage is not within specifications and other DTC criteria are met, a DTC will be stored in memory. Other DTC criteria might include engine rpm limits or input voltages from other sensors or switches. The other inputs might have to be sensed by the MSA when it senses a high or low input voltage from the control system device in question.

DESCRIPTION AND OPERATION

DIAGNOSTIC TROUBLE CODES

On the following pages, a list of DTC's is provided for the 2.5L diesel engine. A DTC indicates that the PCM has recognized an abnormal signal in a circuit or the system. A DTC may indicate the result of a failure, but most likely will not identify the failed component directly.

ACCESSING DIAGNOSTIC TROUBLE CODES

A stored DTC can be displayed through the use of the DRB III scan tool. The DRB III connects to the data link connector. The data link connector is located under the instrument panel near bottom of the steering column (Fig. 1).

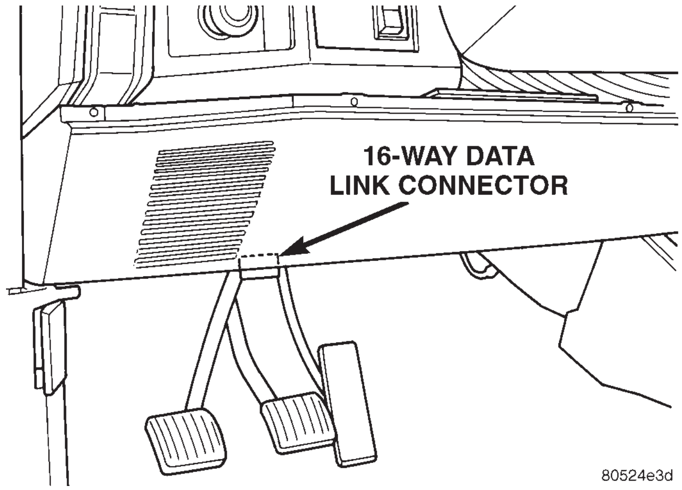

Fig. 1 Data Link Connector Location—Typical

ERASING TROUBLE CODES

After the problem has been repaired, use the DRB III scan tool to erase a DTC.

DESCRIPTION AND OPERATION (Continued)

MSA CONTROLLER DRBIII CODES

Generic Scan Tool Code	DRB III Scan Tool Display
P0100	Mass of Volumes of Air Flow Plausibility Mass of Volumes of Air Flow Signal High Exceeded Mass of Volumes of Air Flow Signal Low Exceeded
P0115	Temperature of Engine Coolant SRC High Exceeded Temperature of Engine Coolant SRC Low Exceeded
P0180	Fuel Temperature Sensor SRC High Exceeded Fuel Temperature Sensor SRC Low Exceeded
P0400	EGR Open Circuit EGR Short Circuit
P0500	Vehicle Speed Sensor PEC Frequency Too High Vehicle Speed Sensor Signal High Exceeded Vehcle Speed Sensor Plausibility
P0725	Engine Speed Sensor Dynamic Plausibility Engine Speed Sensor Over Speed Recognition Engine Speed Sensor Static Plausibilty
P1105	Atmospheric Pressure Sensor SRC High Exceeded Atmospheric Pressure Sensor SRC Low Exceeded
P1201	Needle Movement Sensor High Exceeded Needle Movement Sensor Low Exceeded
P1220	Fuel Quantity Actuator Neg. Gov. Deviation Cold Fuel Quantity Actuator Neg. Gov. Deviation Warm Fuel Quantity Actuator Pos. Gov. Deviation Cold Fuel Quantity Actuator Pos. Gov. Deviation Warm
P1225	Control Sleeve Sensor Signal High Exceeded Control Sleeve Sensor Start End Pos. Not Attained Control Sleeve Sensor Stop End Pos. Not Attained
P1230	Timing Control Negative Governing Governor Deviation Timing Control Positive Governing Governor Deviation
P1515	Accelerator Pedal Postion Sensor Signal High Exceeded Accelerator Pedal Sensor Signal Low Exceeded Accelerator Pedal Sensor Signal PWG Plaus With Low Idle Switch Accelerator Pedal Sensor Signal PWG Plaus With Potentiometer
P1600	Battery Voltage SRC High Exceeded
P1605	Terminal #15 Plausibility After Startup
P1610	Regulator Lower Regulator Limit Regulator Upper Regulator Limit
P1615	Microcontroller Gate-Array Monitoring Microcontroller Gate-Array Watchdog Microcontroller Prepare Fuel Quantity Stop Microcontroller Recovery Was Occurred Microcontrller Redundant Overrun Monitoring
P1630	Solenoid Valve Controller Open Circuit Solenoid Valve Controller Short Circuit

DESCRIPTION AND OPERATION (Continued)

Generic Scan Tool Code	DRB III Scan Tool Display
P1635	Glow Relay Controller Open Circuit Glow Relay Controller Short Circuit
P1650	Diagnostic Lamp Open Circuit Diagnostic Lamp Short Circuit
P1660	Redundant Emer. Stop Plausibility In After-Run Redundant Emer Stop Powerstage Defective
P1665	Cruise Status Indicator Lamp Short Circuit
P1680	EEPROM Plausibility Checksum Error for Adj. EEPROM Plausibility Checksum Error in CC212 EEPROM Plausibility Communication With EEPROM EEPROM Plausibility Func. Switch Wrong or Missing EEPROM Plausibility Ver Number Not Corresponding
P1685	Vehicle Theft Alarm Code Line Breakdown
P1703	Brake Signal Plaus With Redundant Contact
P1740	Clutch Signal Plausibilty
P1725	Inductive Aux. Speed Sensor Dynamic Plausibilty Inductive Aux. Speed Sensor Overspeed Recognition Inductive Aux Speed Sensor Plausibilty Inductive Aux. Speed Sensor Static Plausibilty

PCM DRBIII CODES

Generic Scan Tool Code	DRBIII Scan Tool Display
P0117	Engine Coolant Volts Lo
P0118	Engine Coolant Volts Hi
P0500	Vehicle Speed Signal
P0601	Internal Self Test
P1296	5 VDC Output
P1391	Loss of Cam or Crank

EXHAUST EMISSION CONTROLS—2.5L DIESEL ENGINE

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DESCRIPTION AND OPERATION

VACUUM HOSE ROUTING SCHEMATIC

Vacuum for the EGR system is supplied by the internal engine mounted vacuum pump. Refer to EGR System Operation for vacuum pump information. Vacuum harness routing for emission related components is displayed in (Fig. 1).

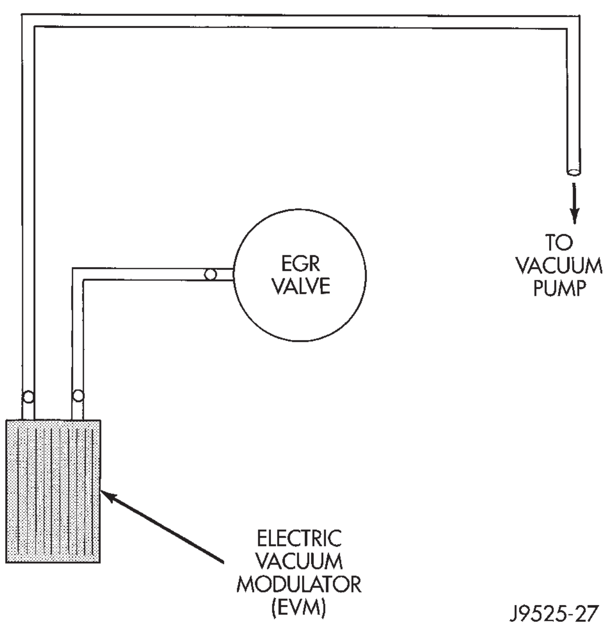

Fig. 1 Typical Hose Routing

EXHAUST GAS RECIRCULATION (EGR) SYSTEM

GENERAL INFORMATION

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.

A malfunctioning EGR system can cause engine stumble, sags or hesitation, rough idle, engine stalling and poor driveability.

EGR SYSTEM OPERATION

The system consists of:

- An EGR valve assembly. The valve is located behind the intake manifold (Fig. 2).

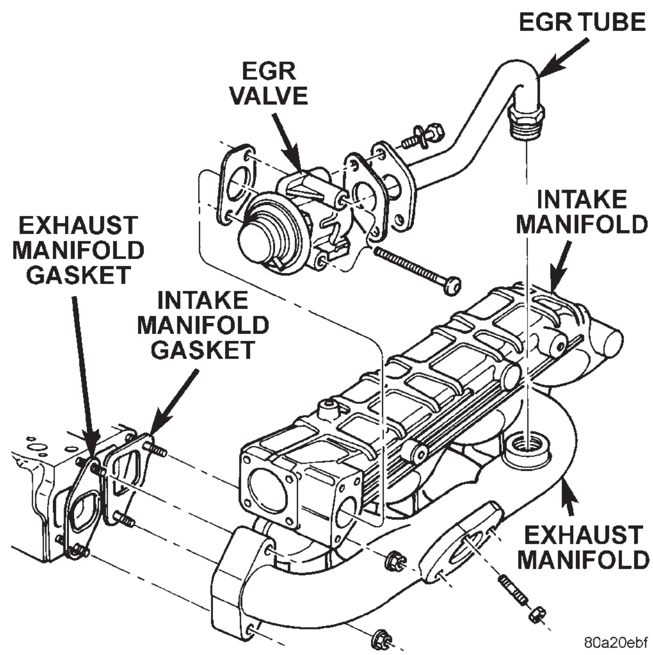

Fig. 2 EGR Valve and Tube Location

- An Electric Vacuum Modulator (EVM). The EVM is sometimes referred to as the EGR control solenoid or EGR duty cycle solenoid. The EVM serves two different functions. One is to control vacuum bleed–off of the EGR valve. The other is to control the “on time” of the EGR valve.
- The MSA operates the EVM. The MSA is located is located inside the vehicle in the center consule.
- An EGR tube (Fig. 2) connecting a passage in the EGR valve to the rear of the exhaust manifold.

DESCRIPTION AND OPERATION (Continued)

• The vacuum pump supplies vacuum for the EVM and the EGR valve. This pump also supplies vacuum for operation of the power brake booster. The pump is located internally in the front of the engine block (Fig. 3) and is driven by the crankshaft gear.

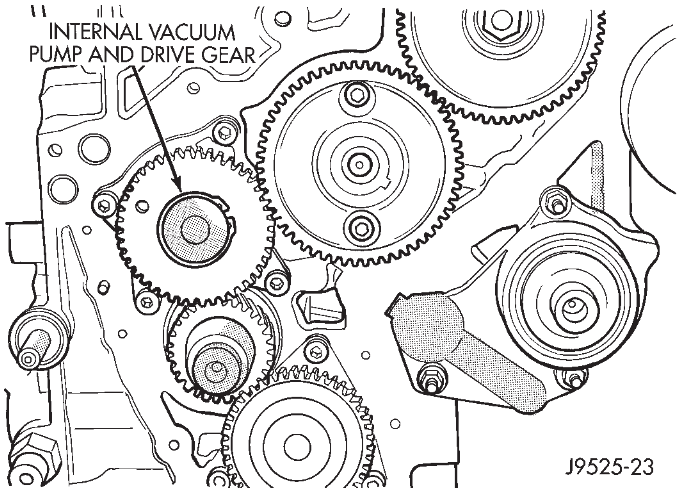

Fig. 3 Internal Vacuum Pump

• Vacuum lines and hoses to connect the various components.

When the MSA supplies a variable ground signal to the EVM, EGR system operation starts to occur. The MSA will monitor and determine when to supply and remove this variable ground signal. This will depend on inputs from the engine coolant temperature, throttle position and engine speed sensors.

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

Exhaust gas recirculation will begin in this order when:

• The MSA determines that EGR system operation is necessary.
• The engine is running to operate the vacuum pump.
• A variable ground signal is supplied to the EVM.
• Variable vacuum passes through the EVM to the EGR valve.
• 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 shut down by the MSA after 60 seconds of continuous engine idling to improve idle quality.

DIAGNOSIS AND TESTING

EGR GAS FLOW 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.

The engine must be started, running and warmed to operating temperature for this test.

(1) All EGR valves are equipped with a vacuum supply fitting located on the EGR valve vacuum motor (Fig. 2).

(2) Disconnect the rubber hose from the vacuum supply fitting (Fig. 2).

(3) Connect a hand–held vacuum pump to this fitting.

(4) Start the engine.

(5) Slowly apply 10 inches of vacuum to the fitting on the EGR valve motor. Vacuum should hold steady at 10 inches. If not, replace the EGR valve. If vacuum holds steady at 10 inches, proceed to next step.

(6) While applying vacuum, and with the engine running at idle speed, the idle speed should drop, a rough idle may occur, or the engine may even stall. This is indicating that exhaust gas is flowing through the EGR tube between the intake and exhaust manifolds.

(7) If the engine speed did not change, the EGR valve may be defective, the EGR tube may be plugged with carbon, or the passages in the intake and exhaust manifolds may be plugged with carbon.

(a) Remove EGR valve from engine. Refer to EGR Valve Removal in this group.

(b) Apply vacuum to the vacuum motor fitting and observe the stem on the EGR valve. If the stem is moving, it can be assumed that the EGR valve is functioning correctly. The problem is in either a plugged EGR tube or plugged passages at the intake or exhaust manifolds. Refer to step (c). If the stem will not move, replace the EGR valve.

(c) 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 in this group for procedures.

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

ELECTRIC VACUUM MODULATOR (EVM) TEST

VACUUM TEST

With the engine running, disconnect the vacuum supply line at the fitting on the EVM. Minimum vacuum should be no less than 20 inches. If vacuum is lower, check for leaks in vacuum supply line. If leaks cannot be found, check for low vacuum at vacuum pump. Refer to Group 5, Brake System for procedures.

REMOVAL AND INSTALLATION

EGR VALVE

REMOVAL

(1) Remove the rubber hose from turbocharger to metal tube.

(2) Disconnect vacuum line at EGR valve vacuum supply fitting (Fig. 2).

(3) Loosen the tube fitting at exhaust manifold end of EGR tube (Fig. 2).

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

(5) Remove the two EGR valve mounting bolts (Fig. 2) and remove EGR valve.

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

INSTALLATION

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

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

(3) Position the EGR valve and new gasket to the intake manifold.

(4) Install two EGR valve mounting bolts. Do not tighten bolts at this time.

(5) Position new gasket between EGR valve and EGR tube.

(6) Install two EGR tube bolts. Tighten all four mounting bolts to 23 N·m (204 in. lbs.).

(7) Tighten EGR tube fitting at exhaust manifold.

(8) Connect vacuum line to EGR valve.

(9) Install the rubber hose from turbocharger to metal tube.

EGR TUBE

The EGR tube connects the EGR valve to the rear of the exhaust manifold (Fig. 2).

REMOVAL

(1) Remove rubber hose from turbocharger to metal tube.

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

(3) Loosen fitting at exhaust manifold end of tube (Fig. 2).

(4) Remove EGR tube and discard old gasket.

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

(6) 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) Position EGR tube to engine.

(3) Loosely tighten fitting at exhaust manifold end of tube.

(4) Install 2 mounting bolts at EGR valve end of tube. Tighten bolts to 23 N·m (204 in. lbs.) torque.

(5) Tighten fitting at exhaust manifold end of tube.

(6) Install hose from turbocharger to metal tube.

ELECTRIC VACUUM MODULATOR (EVM)

The EVM (EGR Duty Cycle Purge Solenoid) is mounted to the side of the PDC.

REMOVAL

(1) Disconnect both cables from battery, negative cable first.

(2) Remove 2 screws holding PDC to bracket, swing out of way.

(3) Remove nut and clamp holding battery to battery tray (Fig. 4).

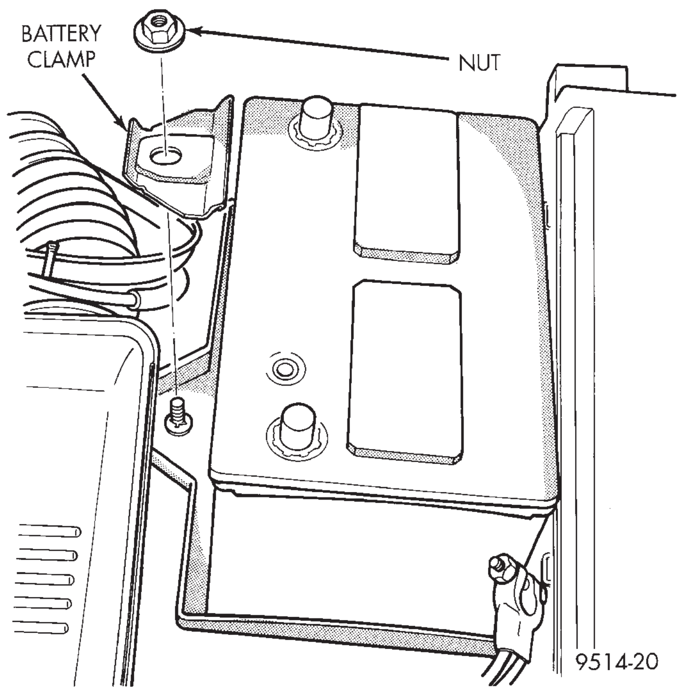

Fig. 4 Battery Clamp

(4) Remove battery from vehicle.

(5) Disconnect two vacuum hoses at EVM.

(6) Remove mounting screws of EVM.

(7) Remove the EVM to gain access to the EVM electrical connector.

(8) Remove electrical connector at EVM.

INSTALLATION

(1) Install electrical connector to EVM.

(2) Install EVM and tighten mounting screws.

(3) Connect vacuum hoses.

(4) Install PDC to bracket and tighten mounting screws.

(5) Install battery.

(6) Connect battery cables positive first.

SPECIFICATIONS

TORQUE CHART—2.5L DIESEL

Description	Torque
EGR Valve Mounting Bolts	23 N·m (204 in. lbs.)
EGR Tube Mounting Bolts	23 N·m (204 in. lbs.)
EVM (Electric Vacuum Modulator) Mounting Bolt	2 N·m (20 in. lbs.)