Emission Control System

Description

Emissions Control System consists of three major systems.

- Crankcase Emission Control System prevents blow-by gas from releasing into the atmosphere. This system recycles gas back into the intake manifold (Closed Crankcase Ventilation Type).
- Evaporative Emission Control System prevents evaporative gas from releasing into the atmosphere. This system burns gas at appropriate engine operating condition after gathering it in the canister.
- Exhaust Emission Control System converts the three pollutants [hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx)] into harmless substances by using the 3-way catalytic converter.

Emission Control System

Tightening Torques

Item	kgf.m	N.m	lb-ft
Positive Crankcase Ventilation (PCV) Valve installation	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
Fuel tank pressure sensor installation bolt	0.4 ~ 0.6	3.9 ~ 5.9	2.9 ~ 4.3
Canister close valve installation bolt	0.4 ~ 0.6	3.9 ~ 5.9	2.9 ~ 4.3
Canister installation bolt	0.4 ~ 0.6	3.9 ~ 5.9	2.9 ~ 4.3
Canister service cover installation bolt	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
Ventilation hose connector assembly installation bolt	0.4 ~ 0.6	3.9 ~ 5.9	2.9 ~ 4.3
Canister protector installation bolt	2.0 ~ 3.0	19.6 ~ 29.4	14.5 ~ 21.7

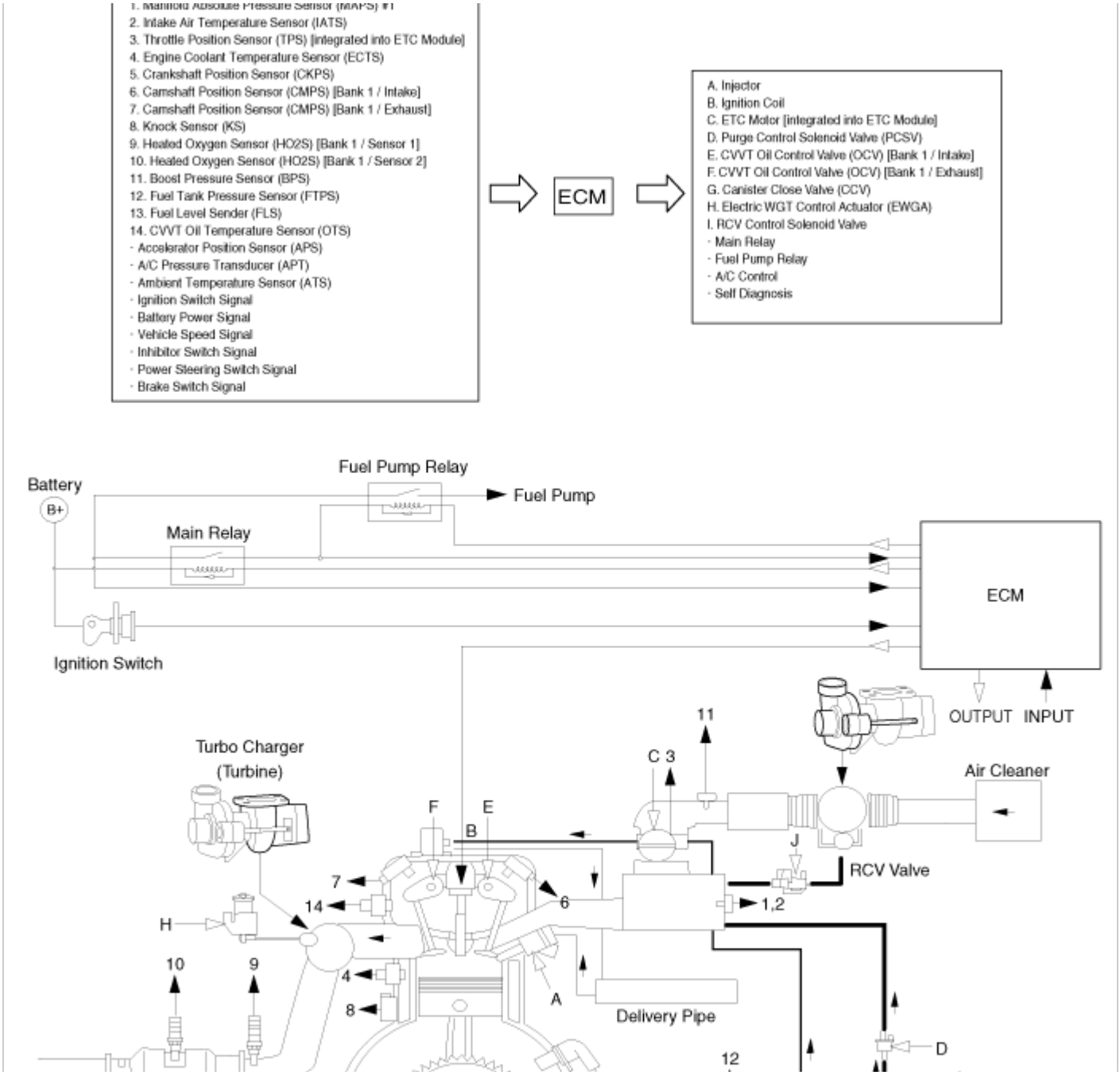
Emission Control System

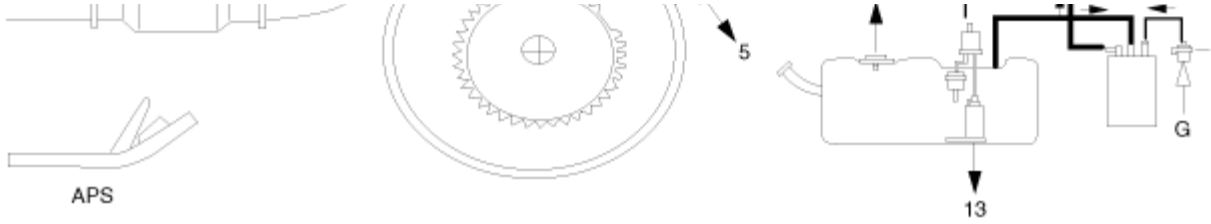
Troubleshooting

Symptom	Suspect area
Engine will not start or hard to start	Vapor hose damaged or disconnected
Engine hard to start	Malfunction of the Purge Control Solenoid Valve
Rough idle or engine stalls	Vapor hose damaged or disconnected
	Malfunction of the PCV valve
Rough idle	Malfunction of the Evaporative Emission Control System
Excessive oil consumption	Positive crankcase ventilation line clogged

Emission Control System

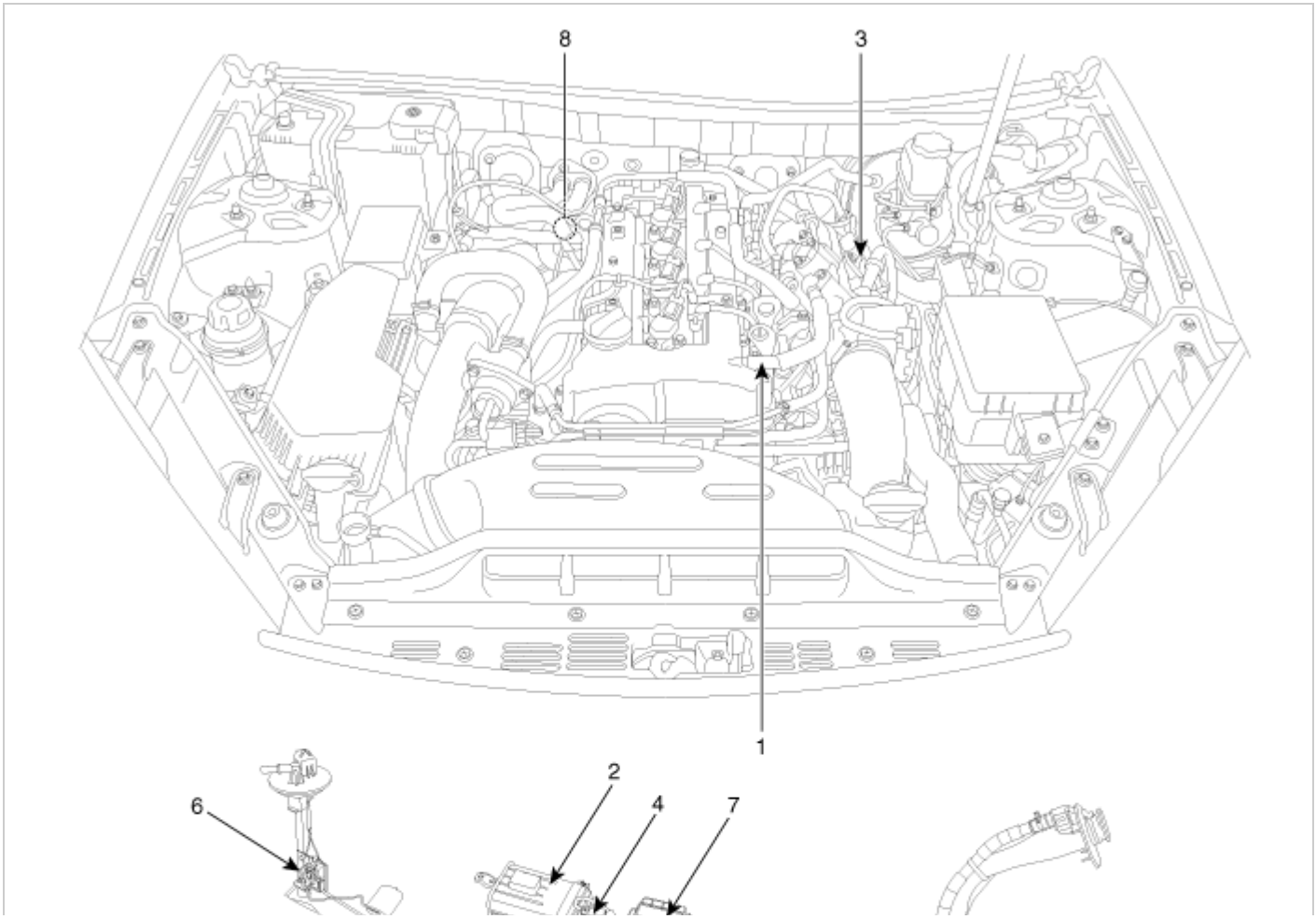
Schematic Diagram

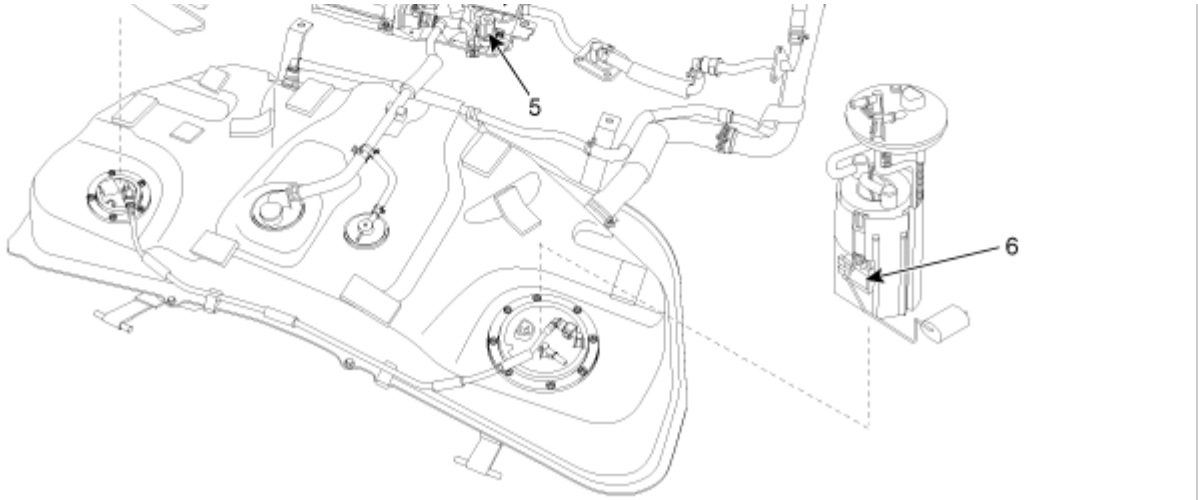

1. Manifold Absolute Pressure Sensor (MAPS) #1
2. Intake Air Temperature Sensor (IATS)
3. Throttle Position Sensor (TPS) [integrated into ETC Module]
4. Engine Coolant Temperature Sensor (ECTS)
5. Crankshaft Position Sensor (CKPS)
6. Camshaft Position Sensor (CMPS) [Bank 1 / Intake]
7. Camshaft Position Sensor (CMPS) [Bank 1 / Exhaust]
8. Knock Sensor (KS)
9. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 1]
10. Heated Oxygen Sensor (HO2S) [Bank 1 / Sensor 2]
11. Boost Pressure Sensor (BPS)
12. Fuel Tank Pressure Sensor (FTPS)
13. Fuel Level Sender (FLS)
14. CVVT Oil Temperature Sensor (OTS)
- Accelerator Position Sensor (APS)
- A/C Pressure Transducer (APT)
- Ambient Temperature Sensor (ATS)
- Ignition Switch Signal
- Battery Power Signal
- Vehicle Speed Signal
- Inhibitor Switch Signal
- Power Steering Switch Signal
- Brake Switch Signal
ECM
A. Injector
B. Ignition Coil
C. ETC Motor [integrated into ETC Module]
D. Purge Control Solenoid Valve (PCSV)
E. CVVT Oil Control Valve (OCV) [Bank 1 / Intake]
F. CVVT Oil Control Valve (OCV) [Bank 1 / Exhaust]
G. Canister Close Valve (CCV)
H. Electric WGT Control Actuator (EWGA)
I. RCV Control Solenoid Valve
- Main Relay
- Fuel Pump Relay
- A/C Control
- Self Diagnosis
Battery
B+
Fuel Pump Relay
Fuel Pump
Main Relay
Ignition Switch
ECM
OUTPUT
INPUT
Turbo Charger
(Turbine)
11
C 3
Air Cleaner
F
E
B
J
RCV Valve
7
14
6
1,2
H
10
9
4
8
A
Delivery Pipe
12
D



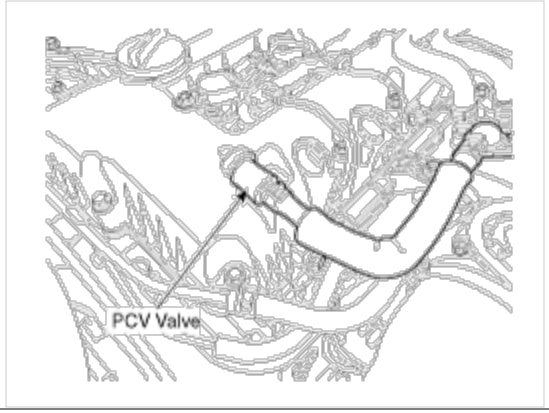
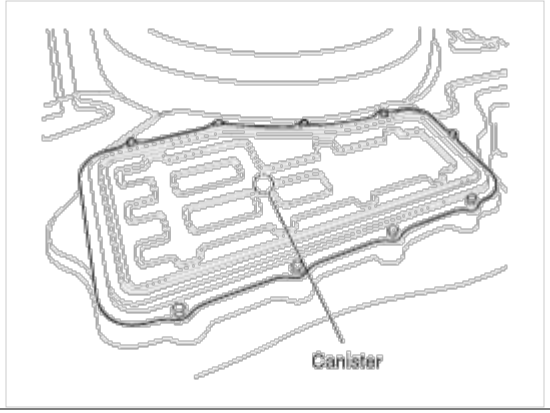
Emission Control System

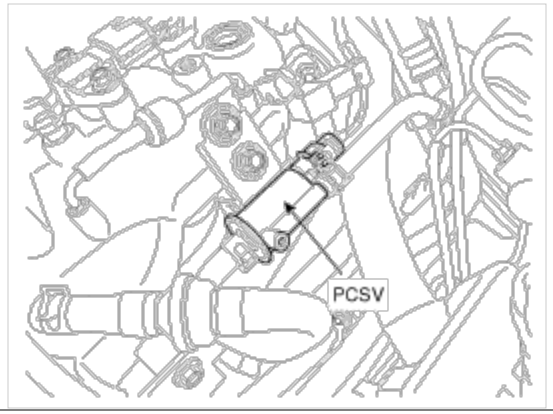
Components Location



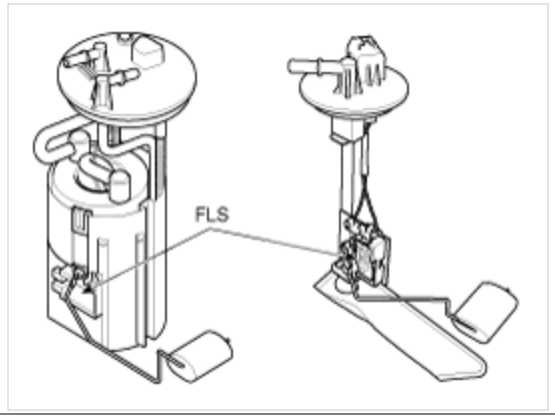


1. PCV Valve 2. Canister 3. Purge Control Solenoid Valve (PCSV) 4. Fuel Tank Pressure Sensor (FTPS)	5. Canister Close Valve (CCV) 6. Fuel Level Sender (FLS) 7. Fuel Tank Air Filter 8. Catalytic Converter (WCC+UCC)

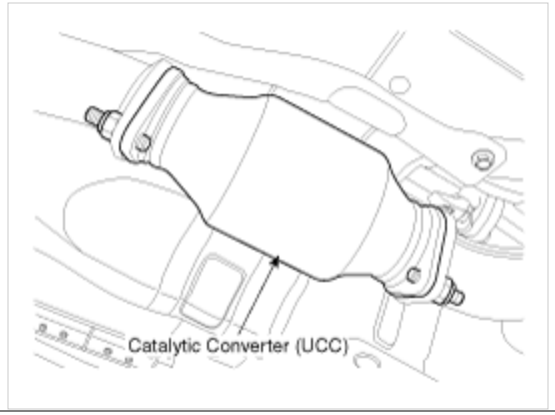
1. PCV Valve	2. Canister
	
3. Purge Control Solenoid Valve (PCSV)	4. Fuel Tank Pressure Sensor (FTPS) 5. Canister Close Valve (CCV) 7. Fuel Tank Air Filter

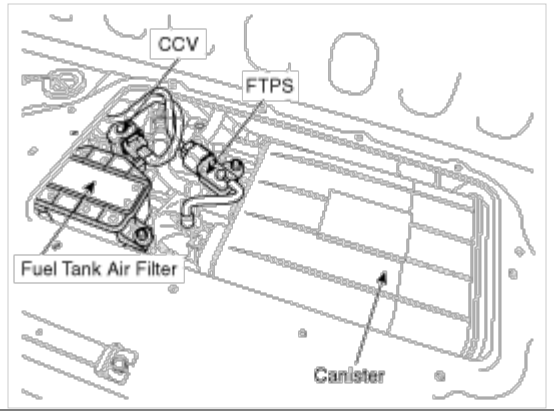


6. Fuel Level Sender (FLS)

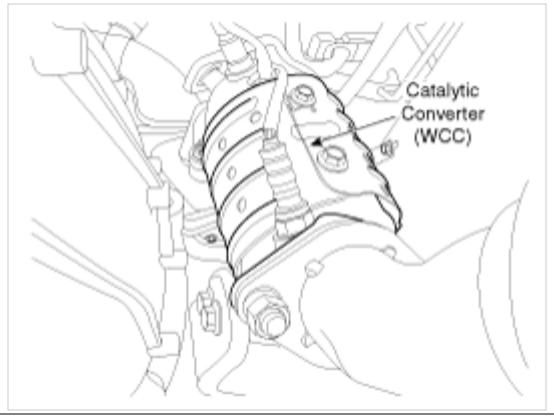


8. Catalytic Converter (UCC)

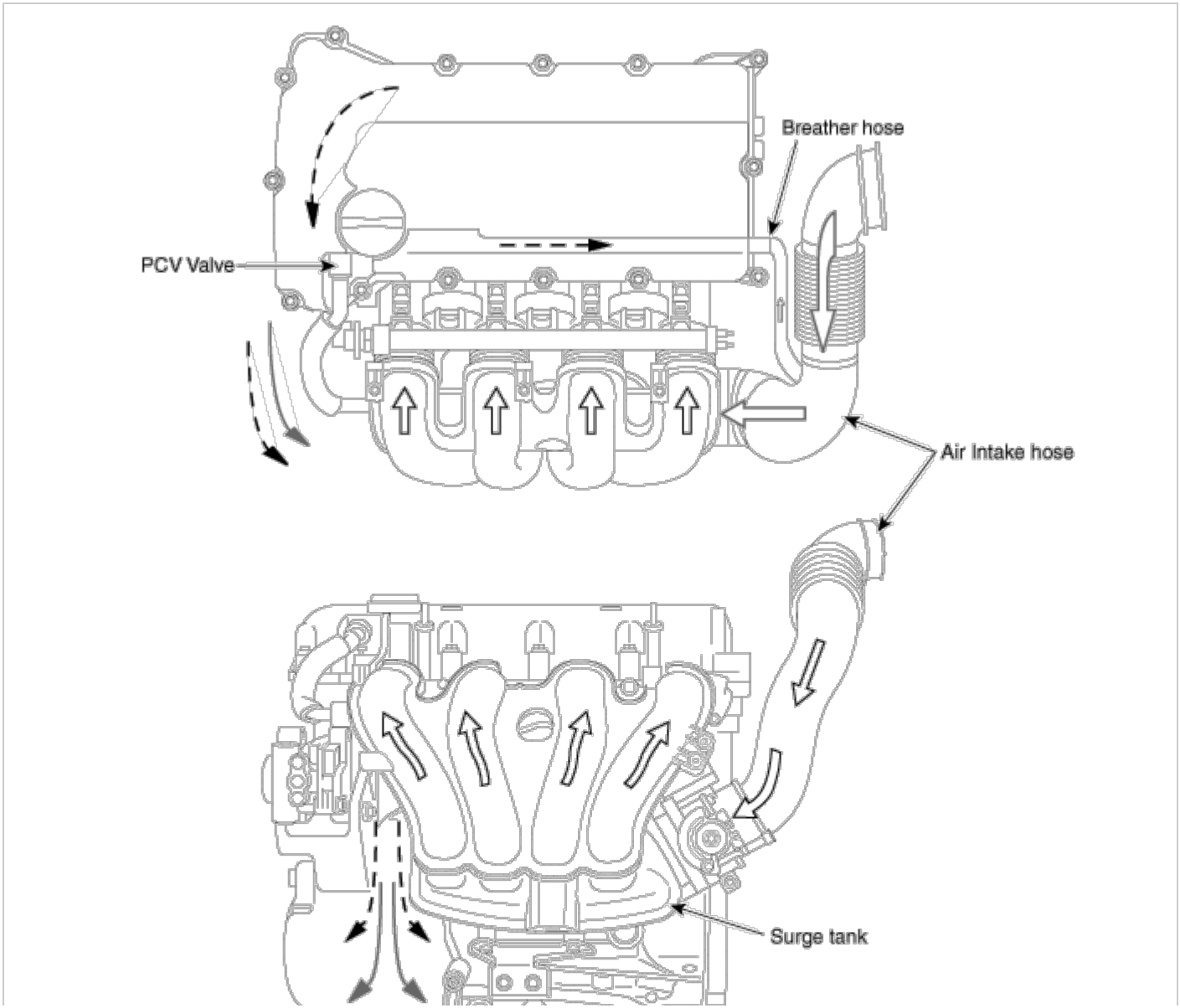


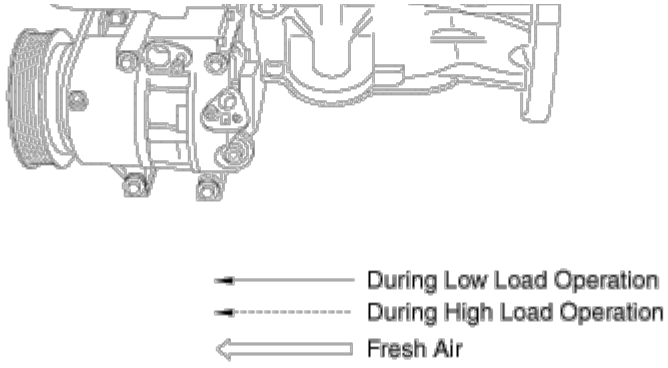


8. Catalytic Converter (WCC)



Schematic Diagram





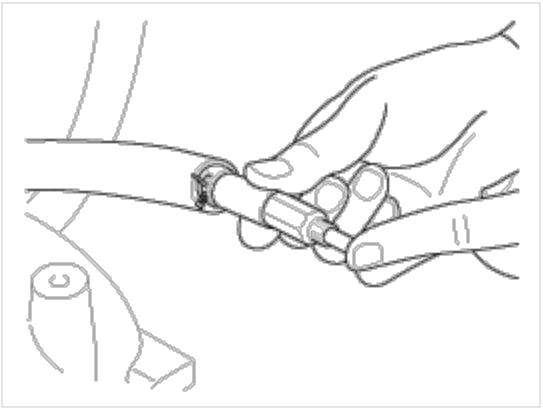
Emission Control System

Inspection

1. After disconnecting the vapor hose from the PCV valve, remove the PCV valve.
2. Reconnect the PCV valve to the vapor hose.
3. Run the engine at idle, and put a finger on the open end of the PCV valve and make sure that intake manifold vacuum can be felt.

NOTICE

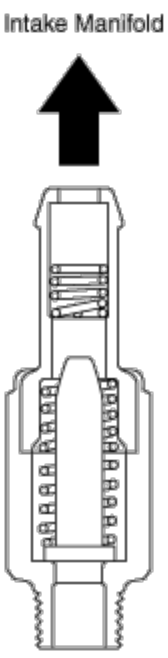
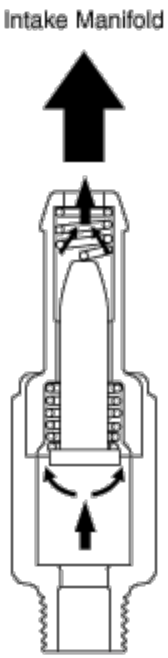
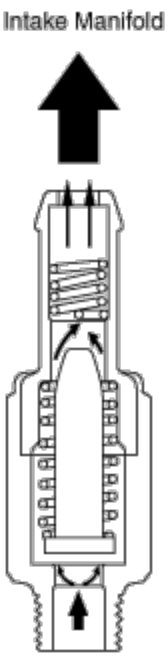
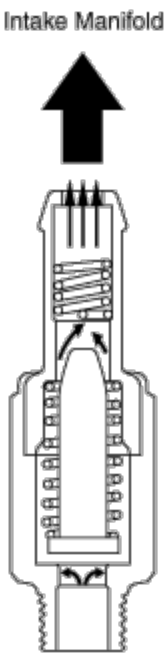
The plunger inside the PCV valve will move back and forth at vacuum.



4. If the vacuum is not felt, clean or replace the vapor hose.

Emission Control System

Operation Principle

Engine Condition	Not Running	Idling or Decelerating	Normal Operation	Accelerating and High Load
Vacuum in Intake Manifold	0	High	Moderate	Low
PCV Valve	Close	Slightly Open	Properly Open	Fully Open
Blow-by Gas Flow	0	Small	Medium	Large
Schematic Diagram				

Emission Control System

Installation

1. Installation is reverse of removal.

PCV Valve installation:

7.8 ~ 11.8 N.m (0.8 ~ 1.2 kgf.m, 5.8 ~ 8.7 lb-ft)

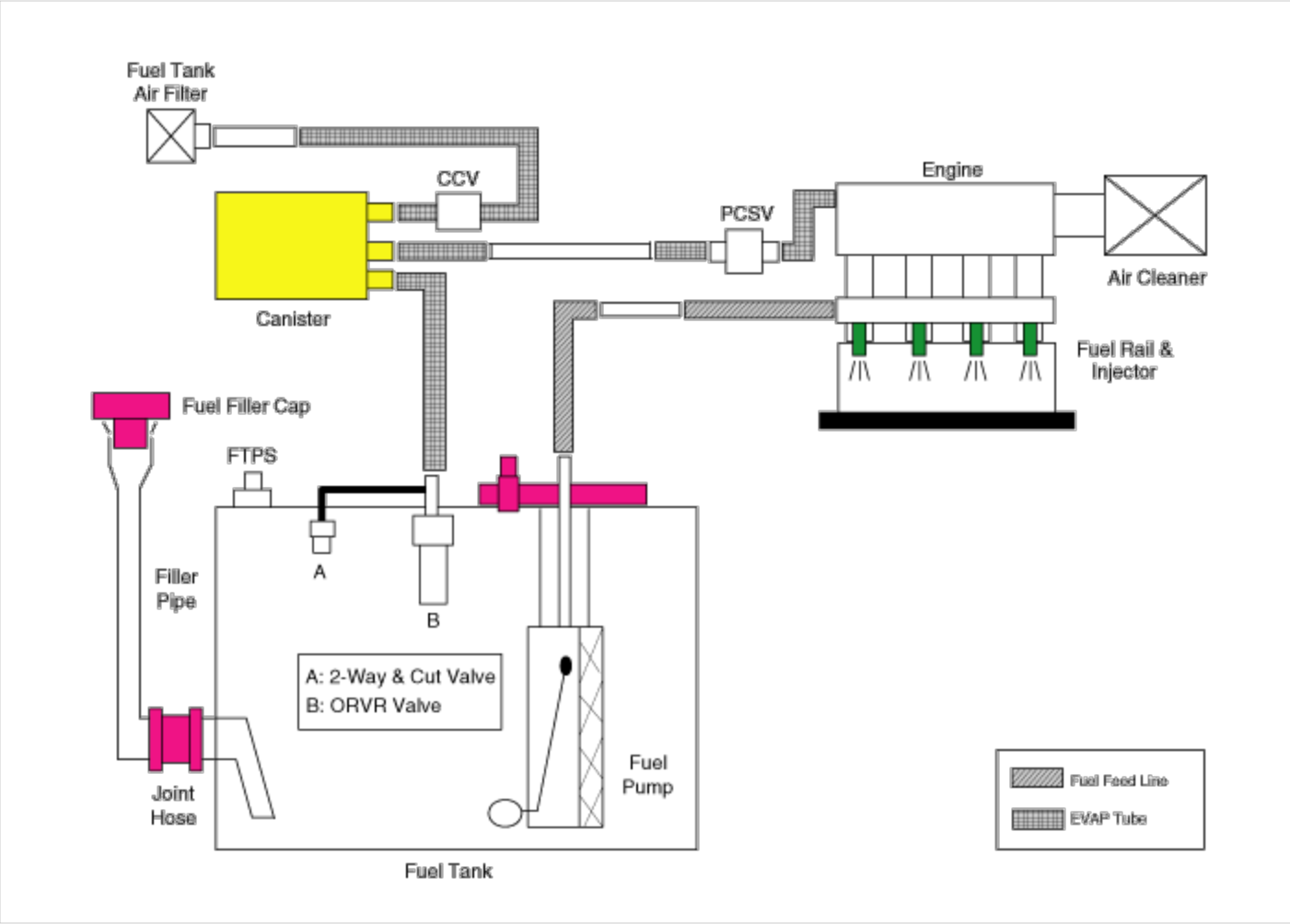
Emission Control System

Description

Evaporative Emission Control System prevents fuel vapor stored in fuel tank from vaporizing into the atmosphere. When the fuel evaporates in the fuel tank, the vapor passes through vent hoses or tubes to canister filled with charcoal. The canister temporarily holds the vapor in the charcoal. If ECM determines to draw the gathered vapor into the combustion chambers during certain operating conditions, it will vacuum into intake manifold.

Emission Control System

Schematic Diagram



Canister

Canister is filled with charcoal and absorbs evaporated vapor in fuel tank. The gathered fuel vapor in canister is drawn into the intake manifold by the ECM/PCM when appropriate conditions are set.

Purge Control Solenoid Valve (PCSV)

Purge Control Solenoid Valve (PCSV) is installed in the passage connecting canister and intake manifold. It is a duty type solenoid valve and is operated by ECM/PCM signal.

To draw the absorbed vapor into the intake manifold, the ECM/PCM will open the PCSV, otherwise the passage remains closed.

Fuel Filler Cap

A ratchet tightening device on the threaded fuel filler cap reduces the chances of incorrect installation, seals the fuel filler. After the gasket on the fuel filler cap and the fill neck flange make contact, the ratchet produces a loud clicking noise indicating the seal has been set.

Fuel Tank Pressure Sensor (FTPS)

The Fuel Tank Pressure Sensor (FTPS) is an integral part of the monitoring system. The FTPS checks Purge Control Solenoid Valve (PCSV) operation and leaks in the Evaporative Emission Control System by monitoring pressure and vacuum level in the fuel tank during PCSV operating cycles.

Canister Close Valve (CCV)

The Canister Close Valve (CCV) is located between the canister and the fuel tank air filter. It closes off the air inlet to the canister for the Evaporative Emissions System and also prevents fuel vapors from escaping from the Canister when the vehicle is not operating.

Evaporative System Monitoring

Evaporative Emission Control Monitoring System consists of fuel vapor generation, evacuation, and leakage check step. At first, the OBD-II system checks if vapor generation due to fuel temperature is small enough to start monitoring. Then it evacuates the evaporative system by means of PCSV with ramp in order to maintain a certain vacuum level. The final step is to check if there is vacuum loss by any leakage of the system.

Vapor Generation Checking

During stabilization period, the PCSV and the CCV are closed. The system pressure is measured as starting pressure (DP_A). After a certain defined period (T1), the system pressure (DP_B) is measured again and the difference from the starting pressure is calculated. If this difference (DP_B - DP_A) is bigger than a threshold, there should be excessive vapor and the monitor is aborted for next checking. On the contrary, if the difference is lower than another negative threshold, PCSV is regarded as malfunction such as clogged at open position.

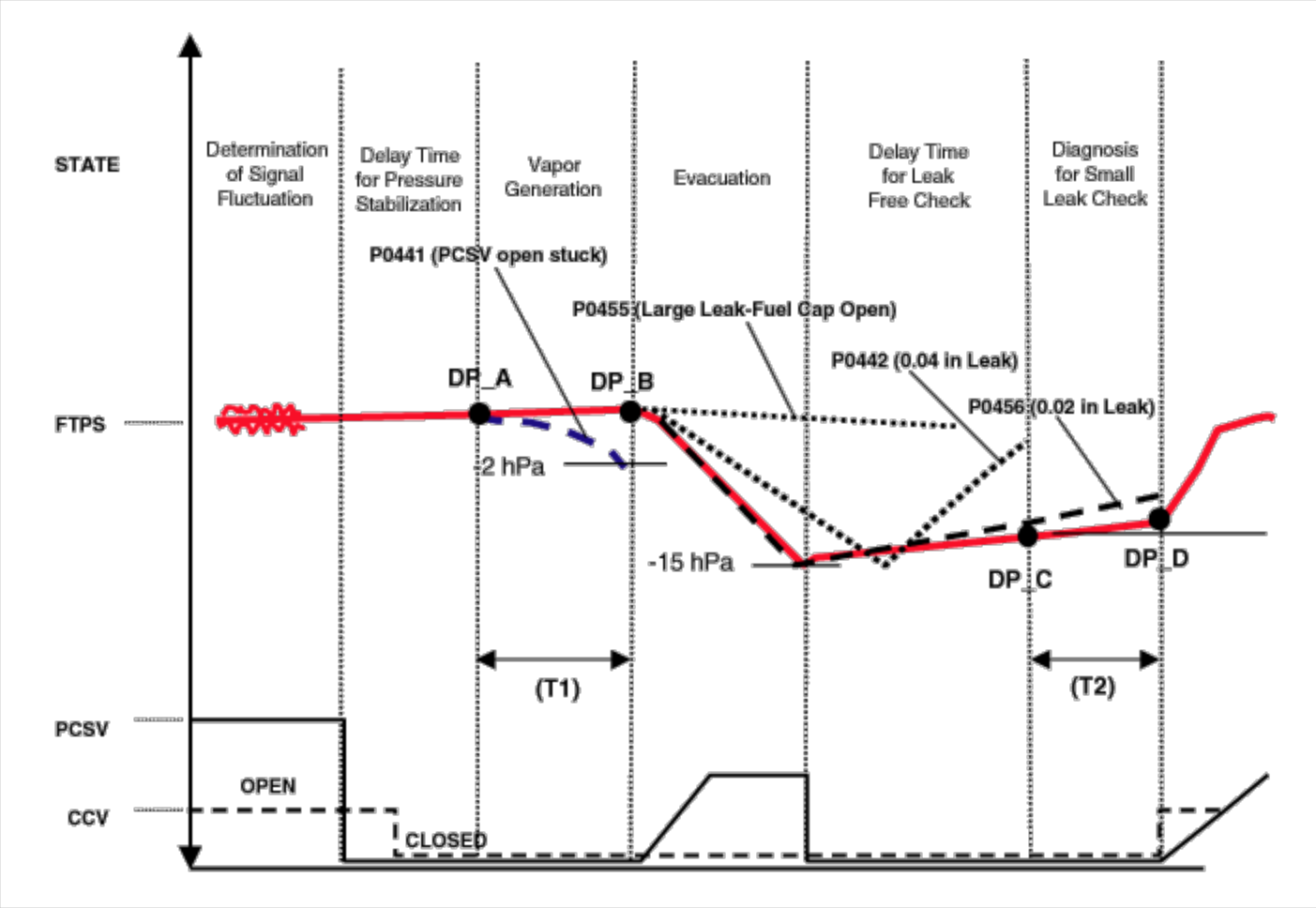
Evacuation

PCSV is opened with a certain ramp for the pressure to reach down to a certain level. If pressure can’t be lowered below a threshold, the system is regarded as fuel cap-opened or having a large leakage.

Leaking Checking

PCSV is closed and the system waits for a period to get stabilized pressure. During checking period (T2), the system measures the beginning and the end of the system pressure (DP_C, DP_D). The diagnosis value is the pressure difference corrected by natural vapor generation (DP_B - DP_A) rate from the vapor generation checking step.

Evaporative System Monitoring

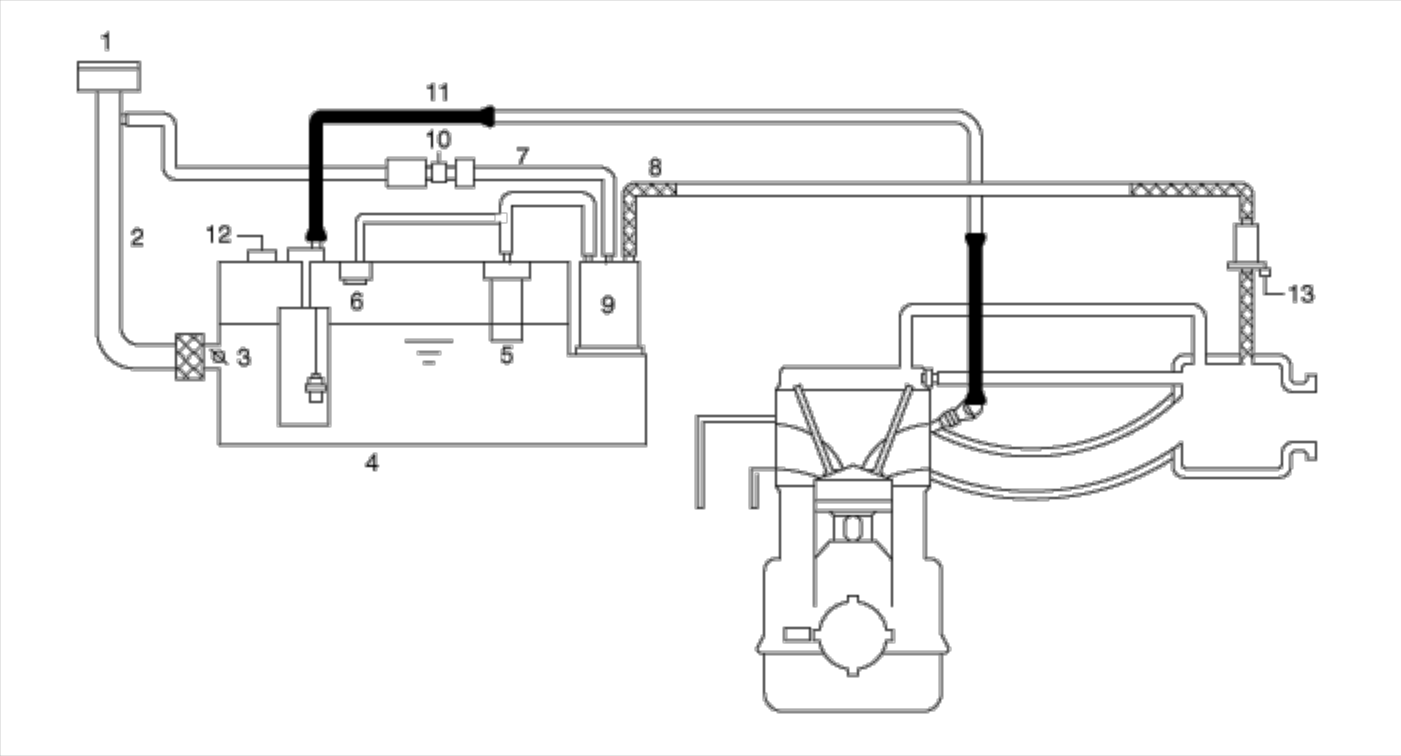


Evaporative And ORVR Emission Control System

This system consists of a fill vent valve, fuel shut-off valve, fuel cut valve (for roll over), two way valve (pressure/vacuum relief), fuel liquid/vapor separator which is installed beside the filler pipe, charcoal canister which is mounted under the rear floor LH side member and protector, tubes and miscellaneous connections.

While refueling, ambient air is drawn into the filler pipe so as not to emit fuel vapors in the air. The fuel vapor in the tank is then forced to flow into the canister via the fill vent valve. The fuel liquid/vapor separator isolates liquid fuel and passes the pure vapor to the charcoal canister.

While the engine is operating, the trapped vapor in the canister is drawn into the intake manifold and then into the engine combustion chamber. According to this purge process, the charcoal canister is purged and recovers its absorbing capability.



1. Fuel Filler Cap	8. Evaporative Hose
2. Fuel Filler Pipe	9. Canister
3. Fuel Shut-OFF Valve	10. Canister Close Valve (CCV)
4. Fuel Tank	11. Fuel Feed Line
5. ORVR Valve	12. Fuel Tank Pressure Sensor (FTPS)
6. 2-Way & Cut Valve	13. Purge Control Solenoid Valve (PCSV)
7. Evaporative Hose	

Inspection

[System Inspection]

1. Disconnect the vapor hose from the throttle body and connect a vacuum pump to the nipple on the throttle body.
2. Check the following points with applying vacuum using the vacuum pump.
   · At Cold Engine [Engine Coolant Temperature < 60°C(140°F)]

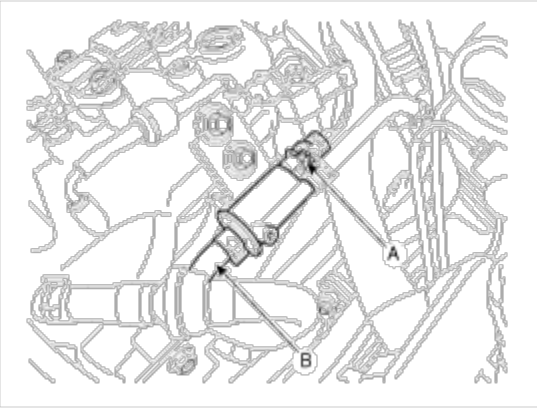
Engine Operating Condition	Applied Vacuum	Result
Idle	0.5kgf/cm² (50kPa,7.3psi)	Vacuum is held
3,000rpm		

· At Warmed Engine [Engine Coolant Temperature > 80°C(176°F)]

Engine Operating Condition	Applied Vacuum	Result
Idle	0.5kgf/cm² (50kPa,7.3psi)	Vacuum is held
Within 3 minutes after engine start at 3,000 rpm	Try to apply vacuum	Vacuum is released
In 3 minutes after engine start at 3,000 rpm	0.5kgf/cm² (50kPa,7.3psi)	Vacuum will be held momentarily, after which, it will be released

[PCSV Inspection]

1. Turn ignition switch OFF and disconnect the negative (-) battery cable.
2. Disconnect the PCSV connector (A).
3. Disconnect the vapor hose (B) which is connected with the intake manifold from the PCSV.



4. After connecting a vacuum pump to the nipple, apply vacuum.
5. With the PCSV control line grounded, check valve operation when applying battery voltage to the PCSV or not.

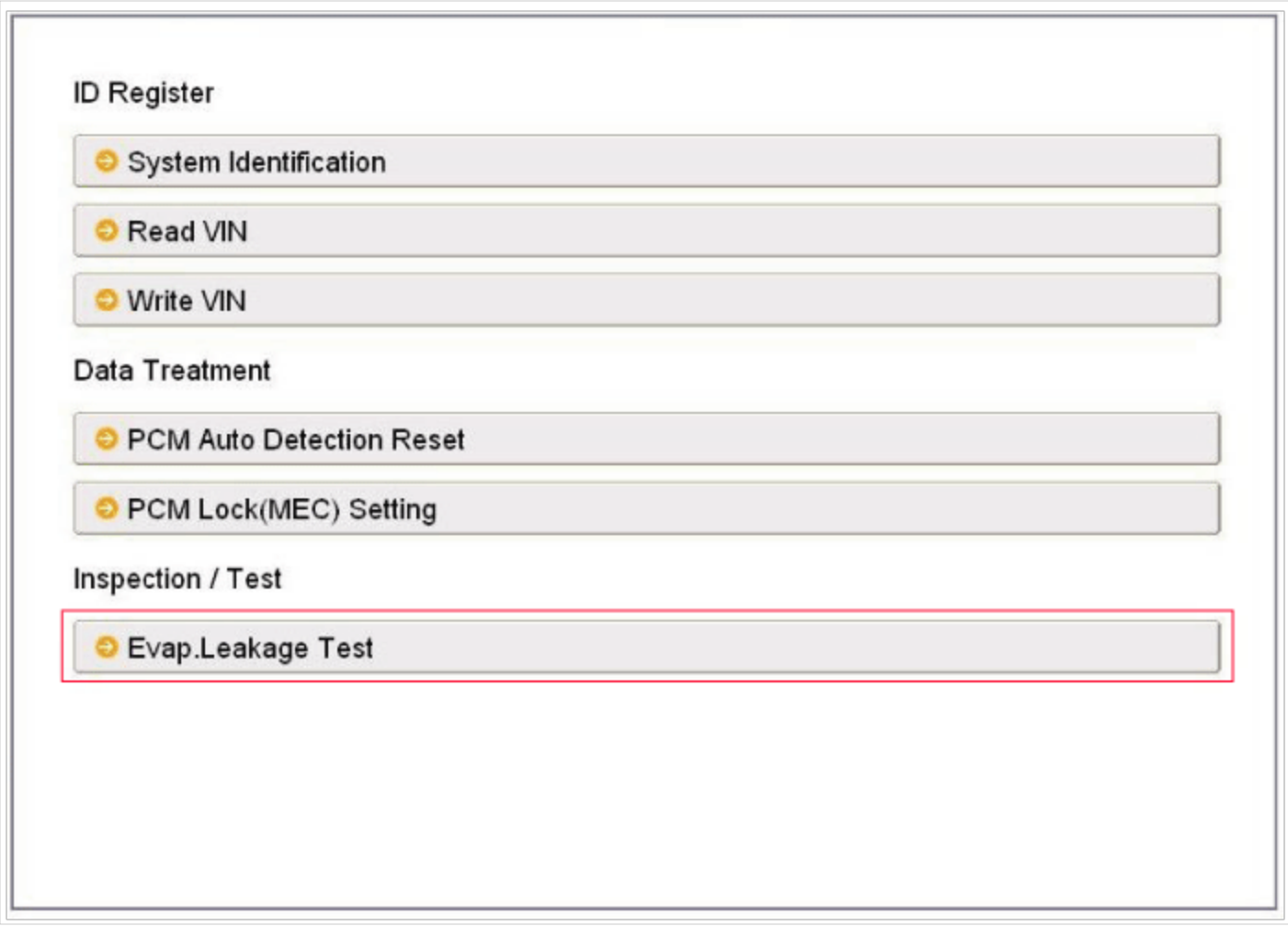
Battery Voltage	Valve	Vacuum
Connected	Open	Released
Disconnected	Close	Maintained

6. Measure the coil resistance of the PCSV.

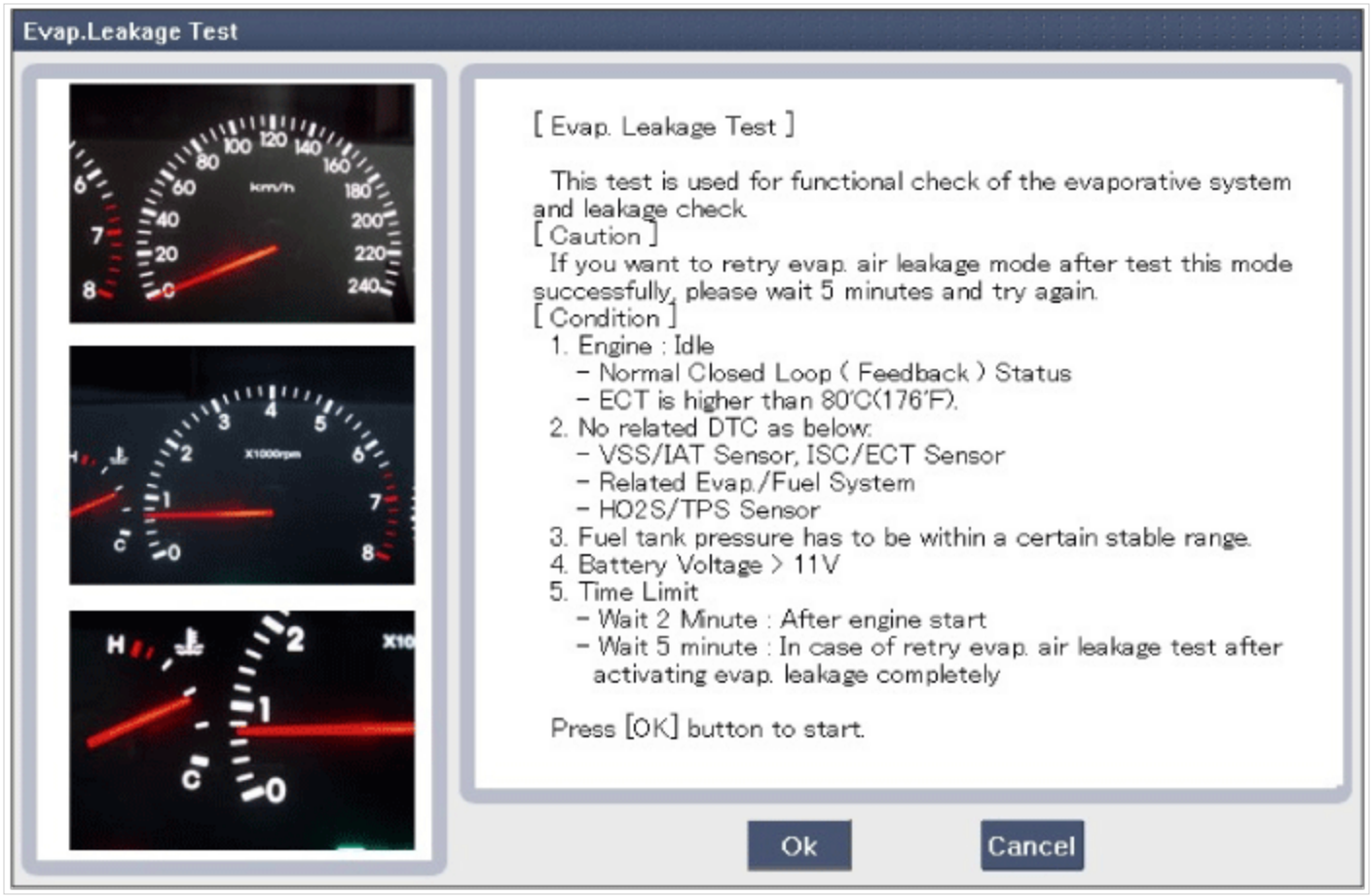
Specification:19.0 ~ 22.0Ω [20°C(68°F)]

[EVAP. Leakage Test]

1. Select "Evap. Leakage Test".



2. Proceed test in a accordance with the screen introduction.



Installation

Installation is reverse of removal.

Canister installation bolt :

3.9 ~ 5.9 N.m (0.4 ~ 0.6 kgf.m, 2.9 ~ 4.3 lb-ft)

Canister cover installation bolt :

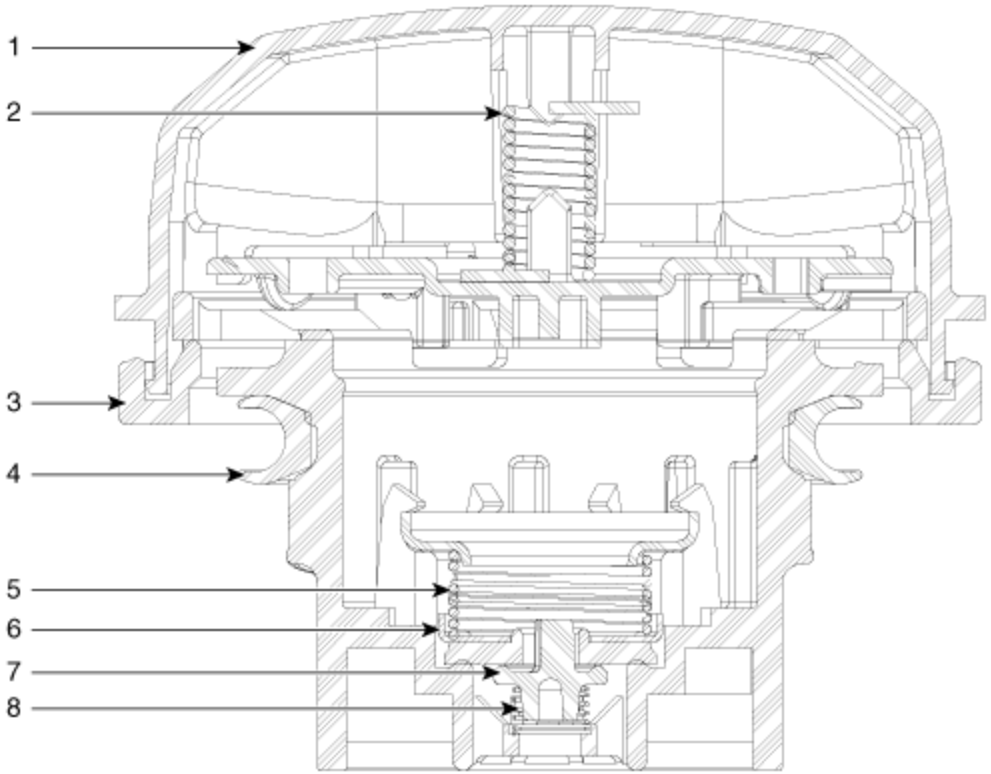
7.8 ~ 11.8 N.m (0.8 ~ 1.2 kgf.m, 5.8 ~ 8.7 lb-ft)

Canister protector installation bolt :

19.6 ~ 29.4 N.m (2.0 ~ 3.0 kgf.m, 14.5 ~ 21.7 lb-ft)

Description

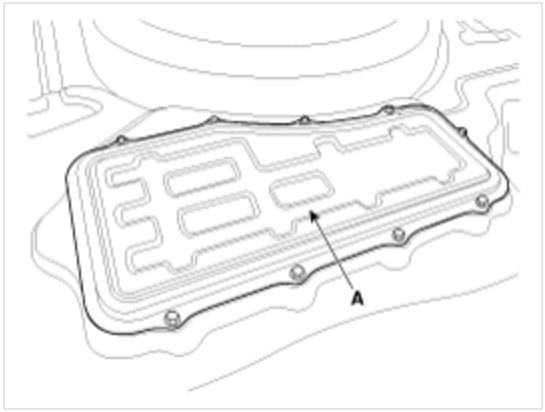
A ratchet tightening device on the threaded fuel filler cap reduces the chances of incorrect installation, which would seal the fuel filler. After the gasket on the fuel filler cap and the filler neck flange contact each other, the ratchet produces a loud clicking noise indicating the seal has been set.



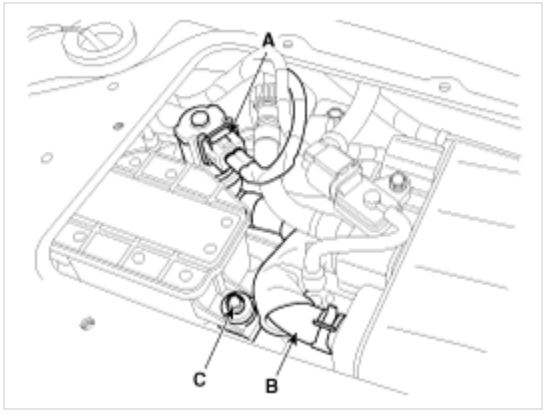
1. Cover	5. Spring
2. Torsion spring	6. Plate seal
3. Retainer	7. Vacuum valve
4. Gasket seal	8. Spring

Replacement

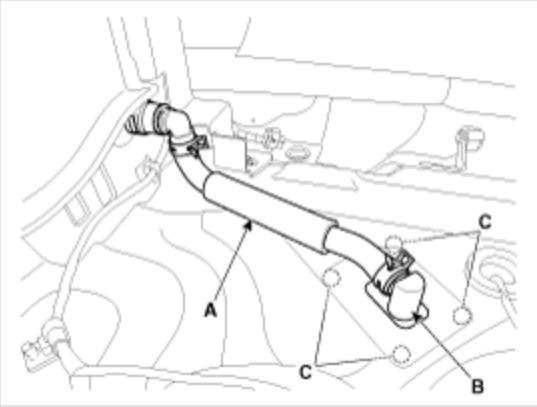
1. Turn the ignition switch OFF and disconnect the negative (-) battery cable.
2. Remove the service cover (A).



3. Disconnect the canister close valve connector (A).
4. Disconnect the vapor hose (B) from the canister.
5. Remove the insatallation bolt (C).



6. Disconnect the ventilation hose (A) from the connector assembly (B).
7. Remove the fuel tank air filter after removing the connector assembly installation bolts (C).



8. Install a new fuel tank assembly.

Ventilation hose connector assembly installation :

3.9 ~ 5.9 N.m (0.4 ~ 0.6 kgf.m, 2.9 ~4.3 lb-ft)

Emission Control System

Description

Exhaust emissions (CO, HC, NOx) are controlled by a combination of engine modifications and the addition of special control components.

Modifications to the combustion chamber, intake manifold, camshaft and ignition system form the basic control system.

These items have been integrated into a highly effective system which controls exhaust emissions while maintaining good drivability and fuel economy.

Air/Fuel Mixture Control System [Multiport Fuel Injection (MFI) System]

The MFI system uses signals from the heated oxygen sensor to activate and control the injector installed in the manifold for each cylinder, thus precisely regulating the air/fuel mixture ratio and reducing emissions.

This in turn allows the engine to produce exhaust gas of the proper composition to permit the use of a three way catalyst. The three way catalyst is designed to convert the three pollutants [hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx)] into harmless substances. There are two operating modes in the MFI system.

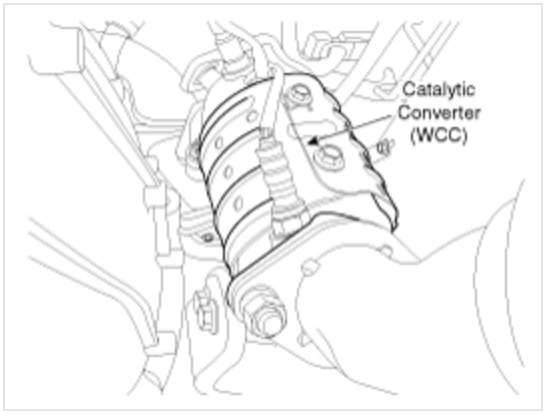
1. Open Loop air/fuel ratio is controlled by information programmed into the ECM.
2. Closed Loop air/fuel ratio is adjusted by the ECM based on information supplied by the oxygen sensor.

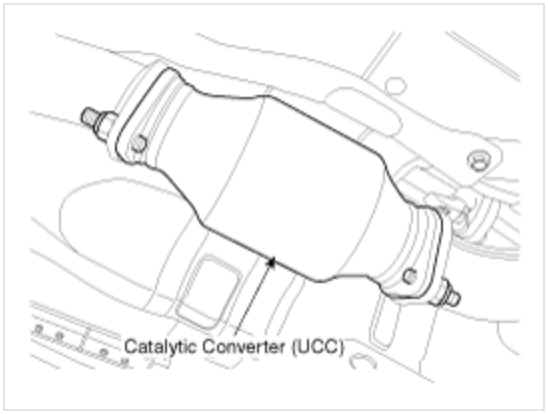
Emission Control System

Description

The catalytic converter of the gasoline engine is a three way catalyst. It oxidizes carbon monoxide and hydrocarbons (HC), and separates oxygen from the oxides of nitrogen (NOx).

There are two types of three-way catalyst; Palette type and Monolith type.

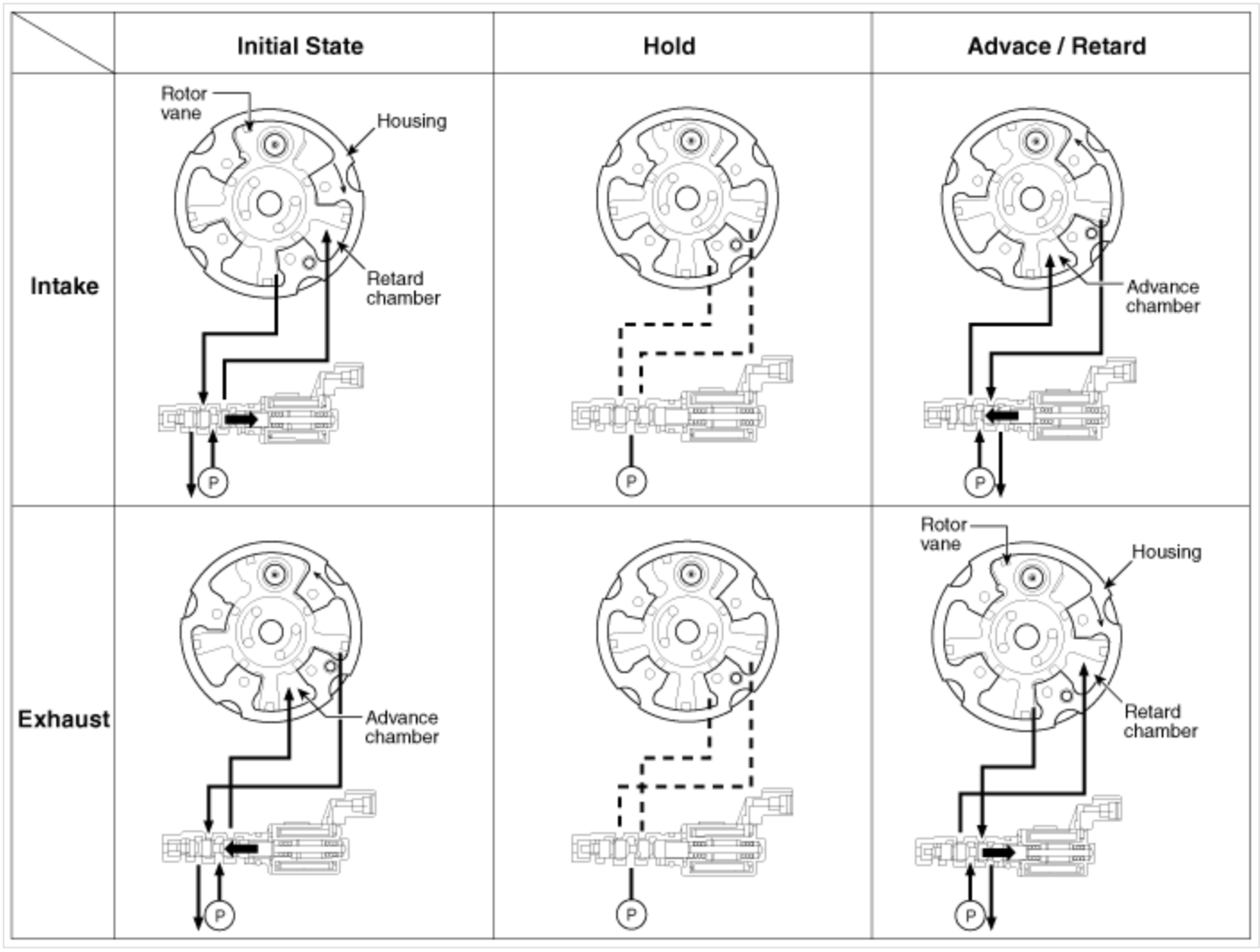




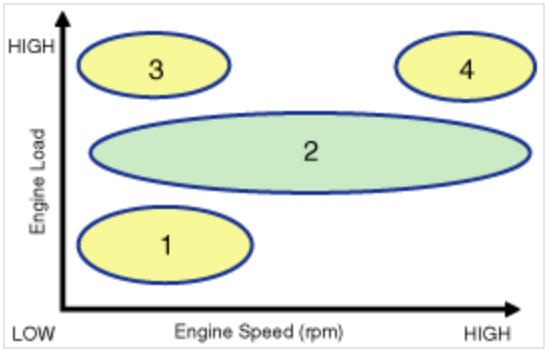
Emission Control System

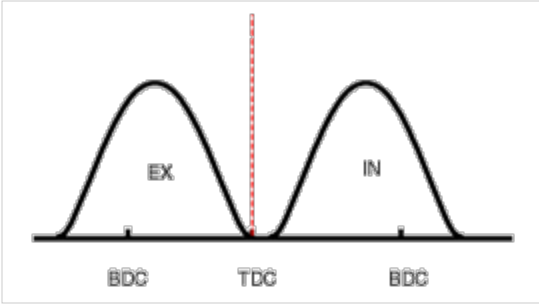
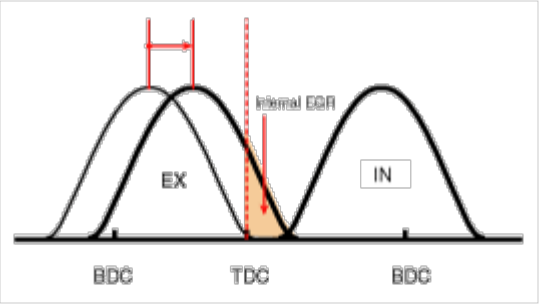
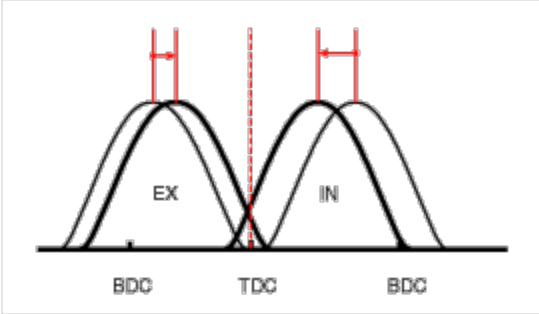
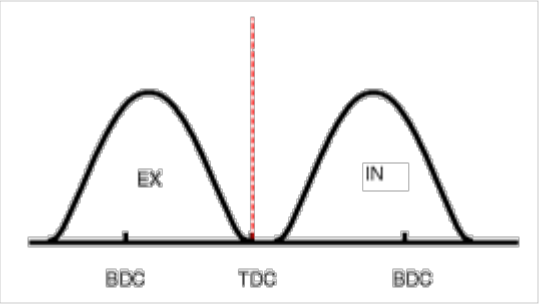
Operation Principle

The CVVT has the mechanism rotating the rotor vane with hydraulic force generated by the engine oil supplied to the advance or retard chamber in accordance with the CVVT oil control valve control.



[CVVT System Mode]



(1) Low Speed / Low Load	(2) Part Load
	
(3) Low Speed / High Load	(4) High Speed / High Load
	

Driving Condition	Exhaust Valve		Intake Valve	
	Valve Timing	Effect	Valve Timing	Effect

(1) Low Speed /Low Load	Completely Advance	* Valve Under-lap * Improvement of combustion stability	Completely Retard	* Valve Under-lap * Improvement of combustion stability
(2) Part Load	Retard	* Increase of expansion work * Reduction of pumping loss * Reduction of HC	Retard	* Reduction of pumping loss
(3) Low Speed /High Load	Retard	* Increase of expansion work	Advance	* Prevention of intake back flow (Improvement of volumetric efficiency)
(4) High Speed /High Load	Advance	* Reduction of pumping loss	Retard	* Improvement of volumetric efficiency