Chapter 6
Emissions and engine control systems

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Specifications

Air flow sensor voltages	
Engine stopped, ignition ON	0.5 volts or less
Idling, warm	1.0 to 1.3 volts, approximately
ATC vacuum motor operating points	
3.0 litre engine	
Start to open	4.7 to 8.7 kPa
Opens fully	10.0 to 16.6 kPa
4.2 litre engine	
Start to open	9.6 kPa
opens fully	19.5 kPa
BCDD set level	
4.2 litre engine	
Manual	75 to 78 kPa
Automatic	78 to 80 kPa
3.0 litre engine	76 to 78 kPa
Engine temperature sensor values	
At 20 degrees C	2,100 to 2,900 ohms
At 50 degrees C	680 to 1,000 ohms
At 80 degrees C	300 to 330 ohms
EGR gas temperature sensor resistance	
44.4 degrees C	69 to 89 K-ohms
100 degrees C	11 to 15 K-ohms
150 degrees C	2 to 4 K-ohms
Exhaust gas temperature sensor resistance at 100 degrees C	77 to 94 ohms

1 General information

Note: *The systems discussed in this Chapter pertain to petrol engines only.*

To prevent pollution of the atmosphere from burned and evaporating gases, a number of major and auxiliary emission control systems are incorporated on Nissan Patrol/Ford Maverick petrol vehicles. The combination of systems used depends on the year in which the vehicle was manufactured, the locality to which it was originally delivered and the engine type. Check the Vehicle Emissions Control Information (VECI) label in your engine compartment to determine which systems are used on your vehicle. The major systems incorporated on these vehicles include:

Boost Controlled Deceleration Device (BCDD) system
Catalytic Converter (CAT) system
Evaporative Emission Control (EVAP) system
Exhaust Gas Recirculation (EGR) system
Intake air temperature control system
Positive Crankcase Ventilation (PCV) system
Spark Control (SC) system
The auxiliary systems incorporated include:
Hot Idle Compensation (HIC) system
Positive temperature coefficient (PTC) heater system

The Sections in this Chapter include general descriptions, checking procedures (where possible) and component renewal procedures (where applicable) for each of the systems listed above.

Before assuming that an emission control system is malfunctioning, check the fuel and ignition systems carefully. In many cases, special tools and equipment, as well as specialised training, are required to accurately diagnose the causes of a rough running or difficult to start engine. If checking and servicing become too difficult or if a procedure is beyond the scope of the home mechanic, consult a dealer service department. This does not necessarily mean however, that the emission control systems are particularly difficult to maintain and repair. You can quickly and easily perform many checks and do most (if not all) of the regular maintenance at home with common tune-up and hand tools. **Note:** *The most frequent cause of emission system problems is simply a loose or broken vacuum hose or wiring connection. Therefore, always check hose and wiring connections first.*

Pay close attention to any special precautions outlined in this Chapter (particularly those concerning the catalytic converter). It should be noted that the illustrations of the various systems may not exactly match the systems refitted in your particular vehicle, due to changes made by the manufacturer during production or from year to year.

2 Spark Control (SC) system

General description

1 The spark control system is designed to reduce HC and NOX emissions by delaying the ignition timing only when the engine is cold. By delaying the vacuum advance, combustion temperatures are not increased. This system is fitted on 3.0 litre engines only.

2 The SC system includes the conventional distributor-mounted vacuum unit, and a thermal vacuum switch.

3 At cold engine temperatures, the thermal vacuum switch does not allow engine vacuum to reach the diaphragm in the distributor vacuum unit and the ignition timing is thereby retarded to reduce emissions.

Check

4 Refit a T-fitting between the vacuum gauge and the main vacuum advance control unit and the thermal vacuum switch and observe that, with the engine cold (coolant temperature 30 degrees C or less), there is no vacuum to the distributor.

5 Warm the engine to normal operating temperature and observe that vacuum is allowed past the TVS and on to the vacuum advance. If no vacuum is available, remove the thermal vacuum switch and check it.

6 If vacuum is correct, check the operation of the vacuum advance (see Chapter 5).

Component renewal

Vacuum advance unit

7 See Chapter 5.

Thermal vacuum switch

8 Drain the coolant from the engine block (see Chapter 1), remove the vacuum hoses from the TVS, then remove the TVS and renew it. Refitting is the reverse of the removal procedures. **Note:** *Be sure to apply liquid sealer to the threads of the new TVS before refitting it.*

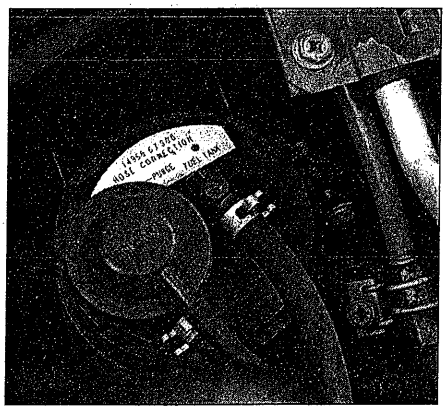
3 Evaporative Emission Control (EVAP) system

General description

1 This system is designed to trap and store fuel that evaporates from the fuel tank, throttle body and inlet manifold that would normally enter the atmosphere in the form of hydrocarbon (HC) emissions.

2 The Evaporative Emission Control (EVAP) system consists of a charcoal-filled canister, the lines connecting the canister to the fuel tank and a check valve. On some models, there is also a thermal vacuum switch.

3 Fuel vapours are transferred from the fuel tank and throttle body/carburettor to a canister where they are stored when the engine isn't running. When the engine is running, the fuel vapours are purged from the canister by intake airflow and consumed in the normal combustion process.



3.8 Inspect the EVAP canister for damage or leaks - if there is a fuel odour in the engine compartment, check the canister first. The purge control valve is located on top of the canister

4 There is a purge control valve on the canister which is activated by engine vacuum. When vacuum increases, the valve opens and allows the engine to draw in vapours. The thermal vacuum switch prevents the canister from receiving this vacuum signal vacuum at low engine temperatures.

Check

Refer to illustration 3.8

5 Poor idle, stalling and poor driveability can be caused by an inoperative purge control valve, a damaged canister, split or cracked hoses or hoses connected to the wrong fittings. Check the fuel filler cap for a damaged or deformed gasket (see Chapter 1).

6 Evidence of fuel loss or fuel odour can be caused by liquid fuel leaking from fuel lines, a cracked or damaged canister, an inoperative purge control valve, disconnected, misrouted, kinked, deteriorated or damaged vapour or control hoses.

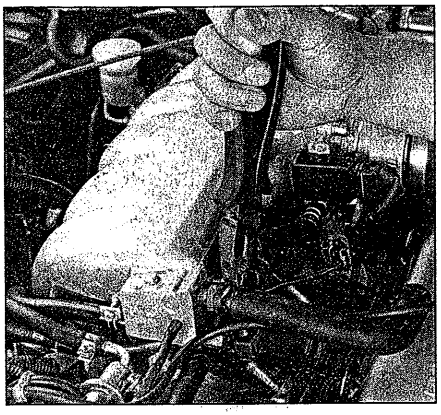
7 Inspect each hose attached to the canister for kinks, leaks and cracks along its entire length. Repair or renew as necessary.

8 Look for fuel leaking from the bottom of the canister **(see illustration)**. If fuel is leaking, renew the canister and check the hoses and hose routing.

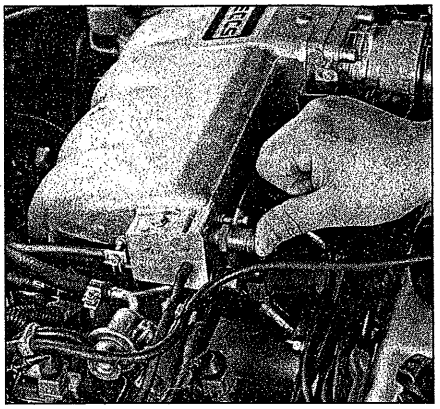
9 Inspect the canister. If it's cracked or damaged, renew it.

10 Check for a clogged filter or a stuck purge control valve. Blow into the canister at the upper of the paired tubes. There should be no leakage. Now blow into the other two tubes. There should be leakage. If a problem is found, renew the canister.

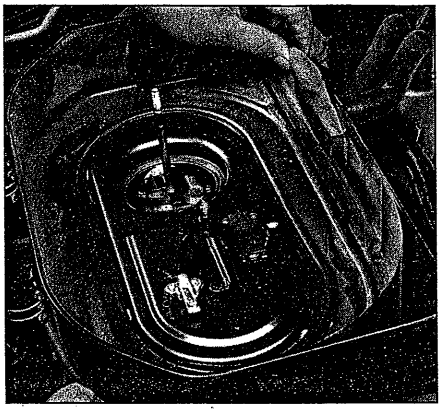
11 Check the operation of the thermal vacuum switch. With the engine completely cold, use a hand-held pump and direct air into the thermal vacuum switch from the manifold side. Air should not pass through the thermal vacuum switch. Now warm the engine to operating temperature (above 54 degrees C) and observe that air passes through the thermal vacuum switch. Renew the valve if the test results are incorrect.



5.5 Loosen the hose clamp and remove the hose from the PCV valve



5.6 With the engine running there should be a strong vacuum present at the PCV valve - if there is not, renew the valve



5.10 The PCV system draws air through this filter (carburetted engines) - if it is missing or dirty, contaminated air will flow throughout the engine

Fuel check valve

12 The fuel check valve is in the fuel vapour vent line between the canister and the fuel tank.

13 Remove the valve and blow air through it from the canister side. There should be little resistance.

14 Blow through it from the fuel tank side. There should be substantial resistance, although some air should go through. If it doesn't perform properly, renew it.

Fuel tank cap

15 Remove the fuel tank cap and clean it with soap and water.

16 Apply vacuum to the bottom of the cap. There should be some resistance which decrease and some clicking. If there is no resistance or no flow, renew the cap.

Charcoal canister renewal

17 Clearly label, then detach the vacuum hoses from the canister.

18 Remove the mounting clamp bolts, lower the canister with the bracket, disconnect the hoses from the check valve and remove it from the vehicle.

19 Refitting is the reverse of removal.

4 Exhaust Gas Recirculation (EGR) system

General description

1 To reduce NOX emissions, part of the exhaust gases are recirculated through the EGR valve into the inlet manifold to lower the maximum combustion temperature.

2 The main component of the system is the EGR valve. It operates in conjunction with the thermal vacuum switch and the Back Pressure Transducer (BPT) valve.

3 At low engine temperatures, the thermal vacuum switch and EGR valve are shut and the exhaust gas is not being recirculated. At higher engine temperatures, the thermal vacuum switch allows vacuum to reach the BPT valve.

4 The BPT valve senses exhaust pressure and adjusts the amount of vacuum going to the EGR valve. When exhaust pressure is high, full vacuum flow is permitted and full exhaust gas recirculation takes place.

Check

5 If the engine runs roughly at idle, hesitates under acceleration, accelerates poorly or has poor fuel economy, the EGR system is probably not shutting off.

6 Before checking the EGR valve, always inspect the condition of all vacuum hoses in the system. Make sure they're all properly attached and are in good condition. If any of the hoses are cracked or otherwise damaged, renew them.

7 Also inspect the BPT valve filter for contamination or damage. If it's dirty, clean it with compressed air.

8 Disconnect the vacuum hose from the EGR valve and connect a vacuum pump to it.

9 Apply vacuum directly to the EGR valve. The engine should run roughly or die. If it doesn't, renew the EGR valve.

Component renewal

10 Disconnect the vacuum hose, remove the retaining bolts and the valve, renew the faulty valve with a new one, refit the bolts and reconnect the vacuum hoses.

5 Positive Crankcase Ventilation (PCV) system

General information

1 The Positive Crankcase Ventilation (PCV) system reduces hydrocarbon emissions by scavenging crankcase vapours. It does this by circulating fresh air from the air cleaner through the crankcase, where it mixes with blow-by gases and is then rerouted through a PCV valve to the inlet manifold.

2 The main components of the PCV system are the PCV valve, a fresh air intake filter and the hoses connecting these components to the engine.

3 To maintain idle quality, the PCV valve restricts the flow when the inlet manifold vacuum is high. If abnormal operating conditions (such as piston ring problems) arise, the system is designed to allow excessive amounts of blow-by gases to flow back through the crankcase vent tube into the air cleaner to be consumed by normal combustion.

4 This system directs the blow-by into the throttle body which, over time, can cause an oily residue build up in the area near the throttle plate. Consequently, it's a good idea to periodically clean this residue from the throttle body. Refer to Chapter 4B for this cleaning procedure.

Check

Refer to illustrations 5.5 and 5.6

5 To check the valve, first remove it and shake the valve **(see illustration)**. It should rattle, indicating that it's not clogged with deposits. If the valve does not rattle, renew it.

6 Start the engine and allow it to idle, then place your finger over the valve opening **(see illustration)**. If strong vacuum is felt, the PCV valve is working properly. Also, check for vacuum leaks at the valve, filler cap and all the hoses.

Renewal

Refer to illustration 5.10

7 Unscrew the valve to remove it.

8 If necessary, refit a new PCV valve.

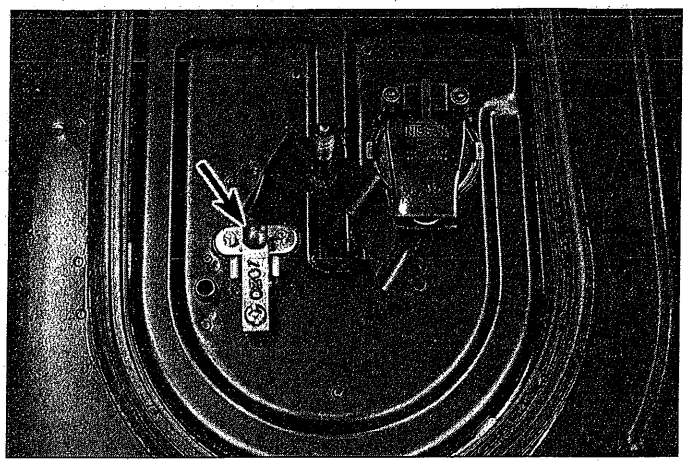
9 Clean and refit the PCV hoses. Make sure that the PCV valve and hoses are secure.

10 Check the condition of the filter used on some carburetted models. It is located in the air cleaner housing **(see illustration)**.

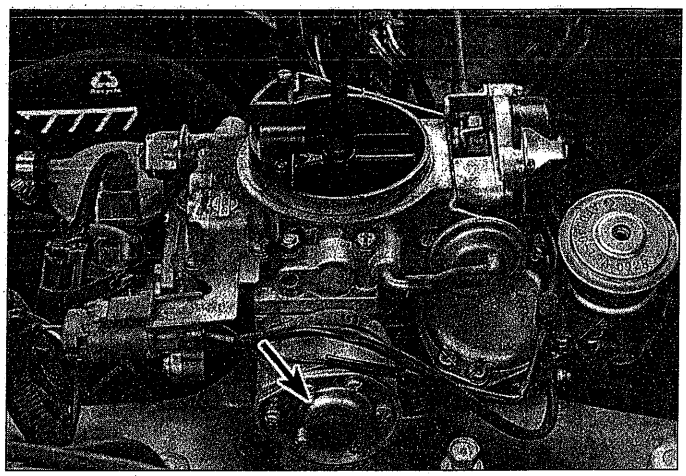
6 Hot Idle Compensation (HIC) system

General information

1 The HIC system allows controlled air to enter the inlet manifold to maintain proper air/fuel mixture during high temperatures at idle.



6.6 The Hot Idle Compensation valve (arrow) is located in the air cleaner housing - the temperature sensor for the hot air intake system is adjacent to the HIC valve



7.1 The BCCD valve is mounted on the side of the carburettor - the rubber cap (arrow) covers the adjusting screw

2 The HIC valve opening will vary as the temperature of the air changes from cold (27 to 60 degrees C) to hot (above 75 degrees C). The HIC valve starts out closed (cold) then gradually opens (hot) as the heated air is passed over the valve.

Check

3 Disconnect the HIC hose from the inlet manifold and attempt suck through it. At temperatures below 60 degrees C, the HIC valve should be closed.

4 Remove the HIC valve, turn it upside down and place the top section in a pan of heated water with a thermometer. With the valve temperature above 75 degrees C, air should be able to pass through it.

5 If the test results are incorrect, renew the HIC valve.

Renewal

Refer to illustration 6.6

6 Remove the mounting clip and lift the HIC valve from the air cleaner housing **(see illustration)**.

7 Boost Controlled Deceleration Device (BCDD) system

General information

Refer to illustration 7.1

1 The BCDD valve is mounted on the carburettor **(see illustration)**. Its purpose is to open a small fuel passage in the carburettor under heavy deceleration conditions in order to prevent HC emissions caused by excessive inlet vacuum.

2 The device is controlled by a control solenoid valve. This valve stops operation of the BCDD when vehicle speed is low, when the clutch pedal is depressed or when the inlet manifold vacuum is below 80 kPa.

Check and adjustment

3 Disconnect the wiring from the control solenoid, if equipped.

4 Loosen the dashpot adjustment screw completely. **Note:** *After checking the BCDD valve, readjust the dashpot* (refer to Chapter 4A).

5 Connect a hand vacuum gauge to inlet manifold vacuum.

6 Start the engine. Quickly rev it and then fully release the throttle. The vacuum should rise quickly and then drop to a predetermined level and hold briefly. It should then drop off to the normal idle level. Refer to the Specifications in this Chapter for the correct vacuum level.

7 If the unit requires adjustment, remove the cap from the BCDD unit and turn the screw gently in small increments.

8 If there is no valve action, remove the valve and check for a stuck plunger.

9 To test the control solenoid, disconnect the wiring from the solenoid.

10 Connect fused jumper wires from the battery to the solenoid. There should be a click heard at the carburettor. If not, renew the solenoid. **Note:** *The solenoid receives inputs from the clutch switch (if equipped) and the speed detecting switch. If it tests good yet still refuses to operate under driving conditions, check these components.*

Renewal

11 Remove the three large screws retaining the cover and remove the BCDD.

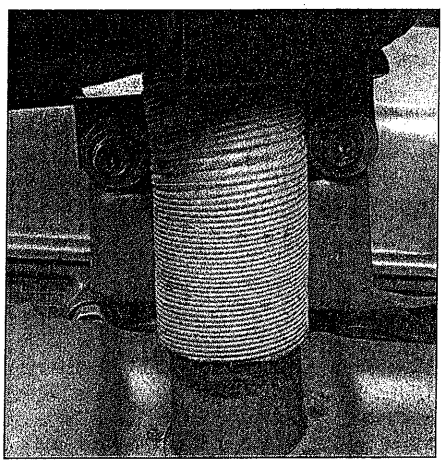
12 Refitting is the reverse of removal.

8 Automatic Temperature Control (ATC) system

General information

Refer to illustration 8.2

1 The automatic temperature control system is used on carburetted engines to control the temperature of the air inducted to the carburettor. This improves warm-up and drivability as well as permitting leaner calibration



8.2 The hot air duct which connects the air cleaner to the exhaust manifold heat source must be kept in good condition in order for the vehicle to perform properly during warm-up

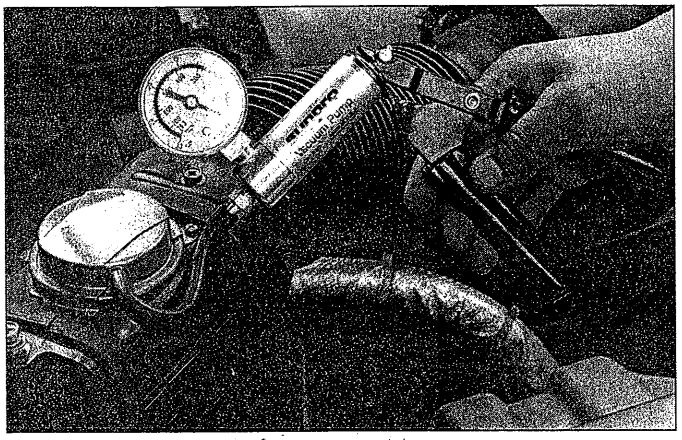
of the carburettor.

2 Under cold inlet air conditions, the air temperature sensor does not permit engine vacuum to reach the vacuum motor. The motor keeps the air door in the closed position and the engine draws in air that has been heated by the exhaust manifold heat stove by way of a hot air duct **(see illustration)**.

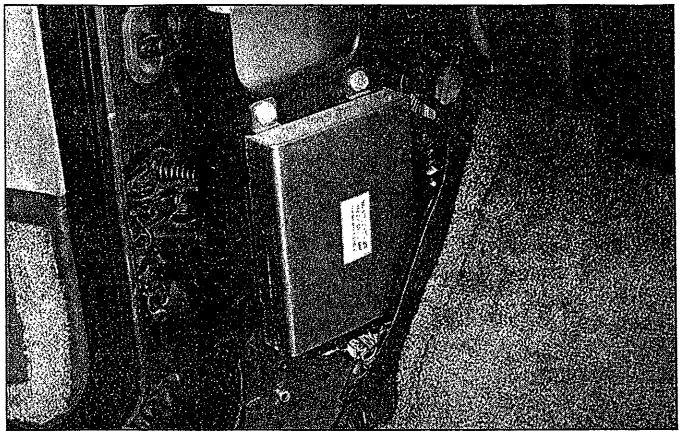
3 When the inlet air has warmed sufficiently, the air temperature sensor allows vacuum to reach the vacuum motor. This operates the air door and it then opens the normal inlet path so that the engine draws in unheated air.

4 The components of this system include the vacuum motor and air door, the temperature sensor and the hoses.

5 On 3.0 litre engines , there is also a Positive Temperature Coefficient (PTC) heater refitted beneath the carburettor. This is an electrically heated grid which warms the incoming air. It is controlled by a mixture heater relay.



8.10 Check the operation of the vacuum motor on the hot air intake system with a hand vacuum pump



9.8 The ECU is located behind the left kick panel

Check

Refer to illustration 8.10

6 With the engine completely cool, look into the air snorkel and observe the position of the air door. It should be positioned to allow cool air to enter the carburettor.

7 Start the engine. The door should move to block cool air from entering and expose the duct to the exhaust.

8 Warm the engine completely. The door should move to allow cool air to enter the carburettor.

9 If the door does not act as described, proceed with the test.

10 Connect a hand vacuum pump to the vacuum motor **(see illustration)**. The door should begin to open at the vacuum level listed in this Chapter's Specifications. It should be fully open at the full open specification. If not renew it.

11 With the engine cool, disconnect the vacuum hose from the vacuum motor. There should be vacuum present at the hose. If not, check the hoses for cracks and other damage.

12 With the engine warm, there should be no vacuum to the motor. If either of the above conditions are not met, renew the temperature sensor.

13 To check the PTC heater, connect an ohmmeter between the terminals of the heater unit. Continuity should be present, if there is infinite resistance, renew it.

14 Check for battery voltage at the wiring to the heater wit the ignition ON. If there is no voltage, check the heater relay and the wiring.

Renewal

15 To renew the vacuum motor, remove the screws which secure the retention strap over it.

16 Refit the new vacuum motor and fasten the strap back into position.

17 To renew the temperature sensor, unclip it from its retainer and clip in the new unit.

18 To renew the PTC heater, remove the carburettor (refer to Chapter 4A). Disconnect the wiring to the heater and remove it.

19 Refitting is the reverse of removal.

9 Electronic Combustion Control System (ECCS) - general information and ECU removal and refitting

General information

1 The fuel injection system is controlled by means of a microcomputer known as the Electronic Control Unit (ECU).

2 The ECU receives signals from various sensors which monitor changing engine operating conditions such as intake air volume, coolant temperature, engine rpm, exhaust oxygen content, etc. These signals are utilised by the ECU to determine the correct fuel injection duration and ignition timing.

3 The system is analogous to the central nervous system in the human body: The sensors (nerve endings) constantly relay signals to the ECU (brain), which processes the data and, if necessary, sends out a command to change the operating parameters of the engine (body).

4 Here's a specific example of how one portion of this system operates: An oxygen sensor, located in the exhaust manifold, constantly monitors the oxygen content of the exhaust gas. If the percentage of oxygen in the exhaust gas is incorrect, an electrical signal is sent to the ECU. The ECU takes this information, processes it and then sends a command to the fuel injection system telling it to change the air/fuel mixture. This happens in a fraction of a second and it goes on continuously when the engine is running. The end result is an air/fuel mixture ratio which is constantly maintained at a proper ratio, regardless of driving conditions.

5 In the event of a sensor malfunction, a backup circuit will take over to provide driveability until the problem is identified and fixed.

Precautions

6 Follow these steps:

a) Always disconnect the power by either turning off the ignition switch or disconnecting the battery terminals before unplugging any electrical connectors. **Caution:** *If the stereo in your vehicle is equipped with an anti-theft system, make sure you have the correct activation code before disconnecting the battery.*

b) When refitting a battery, be particularly careful to avoid reversing the positive and negative battery cables.

c) Do not subject EFI components, emissions-related components or the ECU to severe impact during removal or refitting.

d) Do not be careless during troubleshooting. Even slight terminal contact can invalidate a testing procedure and damage one of the numerous transistor circuits.

e) Never attempt to work on the ECU or open the ECU cover. The ECU is protected by a government-mandated extended warranty that will be nullified if you tamper with or damage the ECU.

f) If you are inspecting electronic control system components during rainy weather, make sure that water does not enter any part. When washing the engine compartment, do not spray these parts or their electrical connectors with water.

ECU removal and refitting

Refer to illustration 9.8

7 Disconnect the negative cable from the battery (see Chapter 5).

8 Remove the passenger side kick panel **(see illustration)**.

9 Remove the bolt from the ECU wiring harness connector. **Note:** *If necessary, remove the ECU and then disconnect the harness connector to ease removal.*

10 Remove the bolts from the ECU brackets and remove the ECU from the vehicle.

11 Refitting is the reverse of removal. Be very careful to not bend any of the pins as you connect the harness. When tightening the wiring harness connector bolt, only tighten it until the red protrusion lines up with the connector side.

10 On Board Diagnosis (OBD) system - description and trouble code access

General information

1 The ECU contains a built-in self-diagnosis system which detects and identifies malfunctions occurring in the network. The system has two levels at which it will communicate with the technician. Mode I is the normal operation mode of the vehicle. When the ignition switch is turned ON, the CHECK ENGINE lamp is illuminated in order for you to make sure that the bulb is working (bulb check).

2 When the engine is started, the warning light should go out. When the engine is running, the CHECK ENGINE light will illuminate in the case of a detected malfunction to inform you that there is a problem.

3 When mode II has been activated and the engine is stopped with the ignition switch turned ON, the ECU will display the trouble codes of all detected faults.

4 When mode II is activated and the engine is running, the CHECK ENGINE light will monitor the performance of the oxygen sensor.

5 When the ECU detects a problem, three things happen: the CHECK ENGINE light comes on, the trouble is identified and a diagnostic code is recorded and stored. The ECU stores the failure code assigned to the specific problem area until the diagnosis system is canceled by switching from self-diagnostic mode II (code retrieval) to mode I.

Note: *It is a good idea to check for any trouble codes when the engine exhibits driveability problems.*

Obtaining diagnostic code output

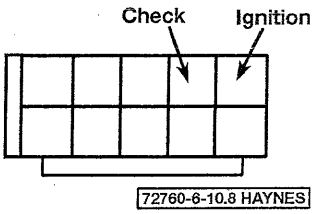
Refer to illustration 10.8

6 To obtain an output of diagnostic codes, verify first that the battery voltage is above 11 volts, the throttle is fully closed, the transmission is in Neutral, the accessory switches are off and the engine is at normal operating temperature.

7 Turn the ignition switch to ON (engine not running). Do not start the engine. Locate the test connector harness under the dash at the extreme right side.

8 Use a jumper wire to bridge the CHECK and IGNITION terminals of the test connector **(see illustration)**. Wait at least two seconds. Disconnect the wire.

9 Read the diagnosis code as indicated by the number of flashes of the "CHECK ENGINE" light on the dash. Normal system operation is indicated by Code No. 55 (no malfunctions) for all models. The "CHECK ENGINE" light displays a Code No. 55 by blinking five times for 0.6 seconds and then five times for 0.3 seconds. Each code will be displayed by first blinking the first digit of the code, then pause, and blink the second digit of the code. For example; Code 13 (engine temperature sensor circuit) will flash one long flash, pause, and then flash three quick flashes.



10.8 To activate the diagnostic modes, bridge the CHECK and IGNITION terminals of the diagnostic connector - it's located behind the right side of the dash

10 If there are any malfunctions in the system, their corresponding trouble codes are stored in computer memory and the light will blink the requisite number of times for the indicated trouble codes. If there's more than one trouble code in the memory, they'll be displayed in numerical order (from lowest to highest) with a pause between each one. Should it become necessary to work on engine components requiring removal of the battery terminal, always check to see if a diagnostic code has been recorded before disconnecting the battery.

11 To exit diagnostic mode II, reconnect the CHECK and IGNITION terminals for at least two seconds.

Diagnostic Trouble Codes

Code	Circuit or system	Diagnosis
Code 11	Crank angle sensor circuit.	Check the wiring connectors and the harness before renewing the sensor.
Code 12	Air flow meter circuit.	Check the wiring connectors and the Harness before renewing the sensor.
Code 13	Engine temperature sensor circuit.	Check the wiring connectors and the Harness before renewing the sensor.
Code 21	Ignition signal circuit.	Check the wiring connectors and the Harness before renewing the power transistor.
Code 43	Throttle sensor circuit.	Check the wiring connectors and the Harness before renewing the sensor.
Code 55	System functioning properly	No trouble codes present.

Note: *If codes 11 and 21 are both displayed, check the crank angle sensor circuit first.*

11 Information sensors

Note 1: *Most of the components described in this Section are protected by a Federally mandated extended warranty. See your dealer for the details regarding your vehicle.*

Note 2: *Refer to Chapters 4B and 5 for additional information on the location and the diagnostic procedures for the sensors that are not directly covered in this Section.*

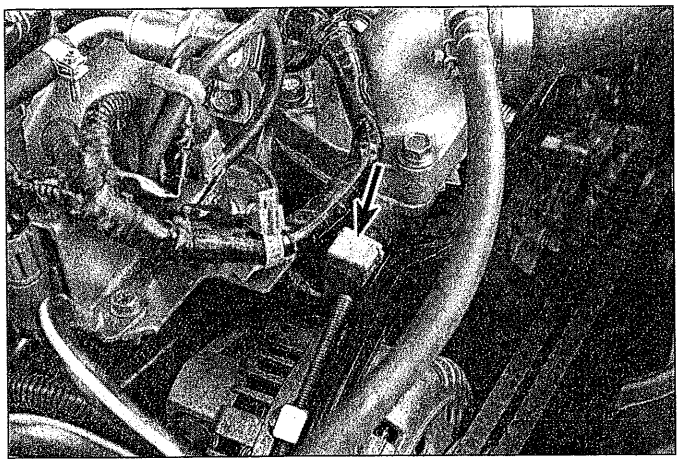
Engine temperature sensor

General description

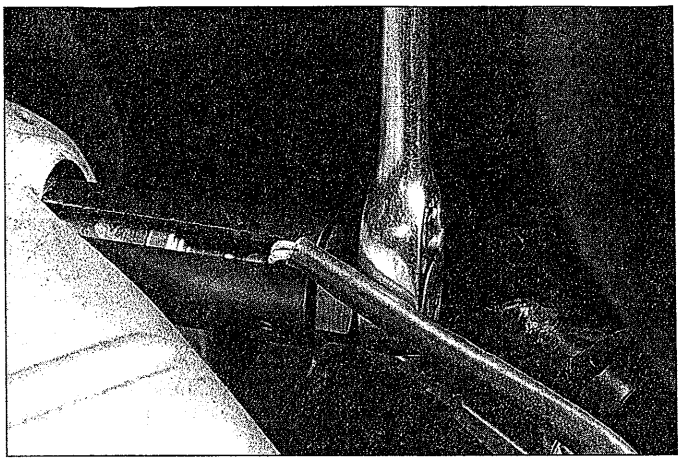
1 The engine temperature sensor is a thermistor (a resistor which varies the value of its voltage output in accordance with temperature changes). As the sensor temperature DECREASES, the resistance values will INCREASE. As the sensor temperature INCREASES, the resistance values will DECREASE. A failure in this sensor circuit should set a Code 13. This code indicates a failure in the engine temperature sensor circuit, so in most cases the appropriate solution to the problem will be either repair of a connector or wire, or renewal of the sensor.

Check

2 To check the sensor, disconnect the electrical connector and measure the resistance across the sensor terminals. With the engine completely cold (20 degrees C) the



11.4 The engine temperature sensor is located in the thermostat housing



11.19 Slotted sockets are available to ease oxygen sensor removal

resistance should be as listed in this Chapter's Specifications. Next, start the engine and warm it up until it reaches operating temperature (82 degrees C) - check the resistance again and compare it to the specifications. **Note:** *If necessary, remove the sensor and perform the tests in a pan of heated water to simulate the conditions.*

Renewal

Refer to illustration 11.4

3 Make sure that the engine is completely cool, then place the new sensor at hand so that it can be refitted quickly and with a minimum of coolant loss.

4 Before refitting the new sensor, wrap the threads with Teflon sealing tape to prevent leakage and thread corrosion.

5 To remove the sensor, unplug the electrical connector, then carefully unscrew the sensor **(see illustration)**.

6 Refit the new sensor. **Caution:** *Handle the coolant sensor with care. Damage to this sensor will affect the operation of the entire fuel injection system.*

Oxygen sensor

General description

7 The oxygen sensor is located in the exhaust manifold. The oxygen content in the exhaust reacts with the oxygen sensor to produce a voltage output which varies from 0.1-volt (high oxygen, lean mixture) to 0.9-volts (low oxygen, rich mixture). The ECU constantly monitors this variable voltage output to determine the ratio of oxygen to fuel in the mixture. The ECU alters the air/fuel mixture ratio by controlling the pulse width (open time) of the fuel injectors. A mixture ratio of 14.7 parts air to 1 part fuel is the ideal mixture ratio for minimising exhaust emissions, thus allowing the catalytic converter to operate at maximum efficiency. It is this ratio of 14.7 to 1 which the ECU and the oxygen sensor attempt to maintain under normal driving conditions.

8 The oxygen sensor produces no voltage when it is below its normal operating temperature of about 293-degrees C. During this initial period before warm-up, the ECU operates in open loop mode.

9 When there is a problem with the oxygen sensor or its circuit, the ECU operates in the open loop mode - that is, it controls fuel delivery in accordance with a programmed default value instead of feedback information from the oxygen sensor.

10 The proper operation of the oxygen sensor depends on four conditions:

a) ***Electrical*** *- The low voltages generated by the sensor depend upon good, clean connections which should be checked whenever a malfunction of the sensor is suspected or indicated.*

b) ***Outside air supply*** *- The sensor is designed to allow air circulation to the internal portion of the sensor. Whenever the sensor is removed and refitted or renewed, make sure the air passages are not restricted.*

c) ***Proper operating temperature*** *- The ECU will not react to the sensor signal until the sensor reaches approximately 296-degrees C. This factor must be taken into consideration when evaluating the performance of the sensor.*

d) ***Unleaded fuel*** *- The use of unleaded fuel is essential for proper operation of the sensor. Make sure the fuel you are using is of this type.*

11 In addition to observing the above conditions, special care must be taken whenever the sensor is serviced.

a) *The oxygen sensor has a permanently attached pigtail and electrical connector which should not be removed from the sensor. Damage to or removal of the pigtail or electrical connector can adversely affect operation of the sensor.*

b) *Grease, dirt and other contaminants should be kept away from the electrical connector and the louvred end of the sensor.*

c) *Do not use cleaning solvents of any kind on the oxygen sensor.*

d) *Do not drop or roughly handle the sensor.*

e) *The silicone boot must be refitted in the correct position to prevent the boot from being melted and to allow the sensor to operate properly.*

Check

12 Checking the operation of the oxygen sensor is done very easily and accurately using the capabilities of the on-board ECU in self-diagnostic mode II. Warm the engine to the normal operating temperature.

13 Locate the computer diagnostic wiring connector under the dash at the extreme right side. Use a jumper wire to bridge the CHECK and the IGNITION terminals of the connector for at least two seconds **(see illustration 10.8)**. Disconnect the jumper.

14 Start the engine. The check engine lamp will now display oxygen sensor performance. Run the engine under no load at 2,000 RPM for two minutes.

15 Hold the engine at 2,000 RPM. Count the number of times the check engine lamp flashes during a ten second interval. If the number of flashes is less than five, then the oxygen sensor must be renewed.

16 To exit diagnostic mode II, turn the ignition off and disconnect the negative terminal from the battery.

Renewal

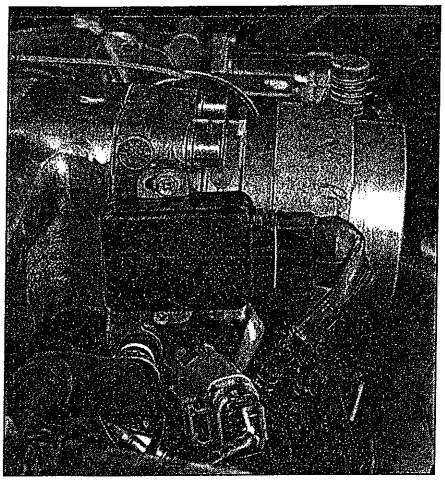
Refer to illustration 11.19

Note: *Because it is refitted in the exhaust manifold or pipe, which contracts when cool, the oxygen sensor may be very difficult to loosen when the engine is cold. Rather than risk damage to the sensor (assuming you are planning to reuse it in another manifold or pipe), start and run the engine for a minute or two, then shut it off. Be careful not to burn yourself during the following procedure.*

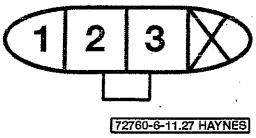
17 Disconnect the cable from the negative terminal of the battery. Raise the vehicle and place it securely on jackstands.

18 Carefully disconnect the electrical connector from the sensor pigtail lead.

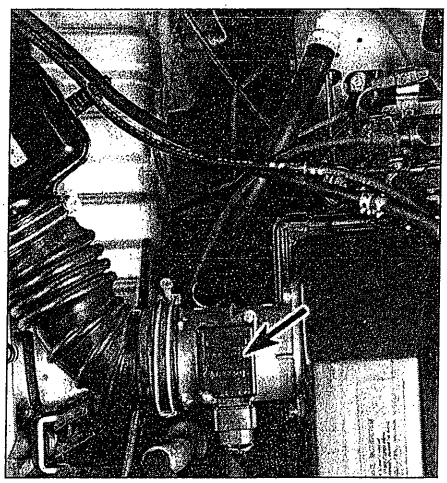
19 Remove the oxygen sensor from the exhaust system **(see illustration)**. **Caution:** *Excessive force may damage the threads.*



11.24 The throttle sensor is located on the side of the throttle body



11.27 Backprobe the air flow meter electrical connector with a voltmeter - connect the positive lead to terminal 2 and the negative lead to earth



11.30 The air flow sensor (arrow) is located in the inlet duct - inspect the entire air inlet assembly for loose clamps or damage

Note: *Some oxygen sensors are threaded directly into the exhaust manifold while others are mounted in the exhaust manifold or pipe.*

20 Anti-seize compound must be used on the threads of the sensor to facilitate future removal. The threads of new sensors will already be coated with this compound, but if an old sensor is removed and refitted, re-coat the threads.

21 Refit the sensor and tighten it securely.

22 Reconnect the electrical connector of the pigtail lead to the main engine wiring harness.

23 Lower the vehicle and reconnect the cable to the negative terminal of the battery.

Throttle sensor

General description

Refer to illustration 11.24

24 The throttle sensor is located on the end of the throttle shaft on the throttle body **(see illustration)**. By monitoring the output voltage from the throttle sensor, the ECU can alter fuel delivery based on throttle valve angle (driver demand). A broken or loose sensor can cause intermittent bursts of fuel from the injector and an unstable idle because the ECU thinks the throttle is moving. See Chapter 4B for the check and renewal procedures.

Airflow sensor

General Information

25 The Airflow sensor measures the volume of air that enters the intake system using a heated film principle. The sensor measures the amount of heat lost by a film placed in the air stream. This information is relayed to the computer to inject the correct amount of the fuel into the combustion chambers for the volume of air (load) that is demanded.

Check

Refer to illustration 11.27

26 With the engine idling, tap softly on the sensor with you knuckles or a screwdriver handle. If the engine stumbles when tapped, the sensor is bad.

27 Without disconnecting the wiring connector from the sensor, peel back the rubber and using a suitable probe, connect a voltmeter to the sensor connector as shown **(see illustration)**. Refer to the Specifications in this Chapter for the correct voltage readings under the various conditions.

28 If the sensor doesn't meet the required specifications, renew it.

29 If the voltage readings are correct, yet there is still a diagnostic trouble code for this item, check the wiring harness for open circuits or a damaged harness (see Chapter 12).

Renewal

Refer to illustration 11.30

30 Disconnect the electrical connector from the airflow sensor **(see illustration)**. Disconnect the air duct from the sensor.

31 Remove the air cleaner lid with air flow sensor attached.

32 Disconnect the air flow sensor from the lid by removing the bolts and the retainer late inside the air cleaner housing.

33 Refitting is the reverse of removal.

Exhaust gas temperature sensor

General Description

34 The exhaust gas temperature sensor is mounted near the EGR valve. This sensor detects the temperature of the exhaust as it moves through the EGR valve. The information is sent to the ECU and in turn the EGR on/off time is regulated precisely and more efficiently.

Check

35 Remove the sensor and place it in a pan of water which can be heated.

36 Connect an ohmmeter to the terminals of the sensor. Observe the change in resistance as the water is heated.

37 The resistance should decrease evenly as the temperature rises. When the water boils, read the resistance. If the resistance is not as listed in the Specifications in this Chapter or if the response is not smooth, renew it.

Renewal

38 Disconnect the harness connector for the temperature sensor and using an open-end spanner, remove the sensor from the manifold.

39 Refitting is the reverse of removal. Apply anti-seize to the threads before refitting.

Vehicle speed sensor

General description

40 The Vehicle Speed Sensor (VSS) is located in the speedometer. The sensor is electronically controlled and sends a pulsing voltage signal to the ECU, which the ECU converts to kilometres per hour.

41 Checking the VSS involves tapping into the ECU main wiring harness. Have the vehicle speed sensor, circuit and the ECU diagnosed by a dealership service department or other qualified repair shop.

Knock sensor

General Description

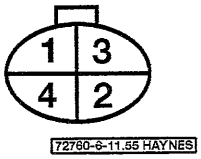
42 Irregular octane levels in modern petrol can cause detonation in an engine. Detonation is sometimes referred to as "spark knock". The knock sensor sends a voltage signal to the ECU when no spark knock is occurring and the ECU provides normal ignition advance. When the knock sensor detects abnormal shock waves (spark knock), it turns off the circuit to the ECU, and distributor timing is retarded until the knock is eliminated.

43 When the knock sensor circuit fails, the ECU reverts to a retarded timing setting for all driving conditions. Have the knock sensor, circuit and the ECU diagnosed by a dealership service department or other qualified repair shop.

Power steering pressure switch

General description

44 The power steering pressure switch is located on the steering pump. It senses when



11.55 Backprobe the distributor connector and connect a voltmeter between terminal 3 and earth, then between terminal 4 and earth. When the shaft is rotated, the voltmeter should register every time a slot in the rotor passes the sensor

the front wheels are turning and sends a signal to the ECU. The ECU then instructs the Auxiliary Air Control valve to increase the idle speed.

Check

45 Disconnect the switch wiring. Connect an ohmmeter to the terminals of the switch.
46 Start the engine and allow it to idle.
47 There should be infinite resistance with the wheels straight ahead.
48 When the wheels are turned, there should be zero resistance. If the switch fails either test, renew it.

Renewal

49 Place a rag beneath the power steering pump and remove the switch.
50 Refitting is the reverse of removal. Check the fluid level before starting the vehicle.

Crank angle sensor

General description

51 The crank angle sensor is a fundamental component in the ignition system. It informs the ECU of crankshaft position, which stroke the number one piston is on and also engine speed. The crank angle sensor is located in the distributor.
52 The sensor uses a flat rotor plate with two sets of slits in it. One array consists of 360 slits, the other of 6. As he rotor rotates, an L.E.D. passes light through the slits to a photo diode. This signal is then passed to the ECU.

Check

Refer to illustration 11.55

53 Remove the distributor (refer to Chapter 5). Leave the wiring harness connected to the distributor and the engine harness.
54 Turn the ignition ON.
55 Using suitable probes, backprobe the connector and connect an analog voltmeter as shown **(see illustration)**. Slowly turn the distributor shaft.
56 As it is turned, the reading should vary from 0 and 5 volts, six times per revolution at terminal 3 and 360 times per revolution at terminal 4.
57 Disassemble the distributor and inspect the signal plate for dirt or damage (refer to Chapter 5). Clean it if necessary.

Renewal

58 The crank angle sensor is an integral part of the distributor and is not serviced separately. Refer to Chapter 5 for distributor renewal.

12 Catalytic converter system

Note: *Because of a federally mandated extended warranty which covers emissions-related components such as the catalytic converter, check with a dealer service department before renewing the converter at your own expense.*

General description

1 To reduce hydrocarbon, carbon monoxide and oxides of nitrogen emissions, vehicles are equipped with a three-way catalyst system which oxidises and reduces these chemicals, converting them into harmless nitrogen, carbon dioxide and water.
2 The catalytic converter is mounted in the exhaust system much like a muffler.

Check

3 Periodically inspect the catalytic converter-to-exhaust pipe mating flanges and bolts. Make sure that there are no loose bolts and no leaks between the flanges.
4 Look for dents in or damage to the catalytic converter protector. If any part of the protector is damaged or dented enough to touch the converter, repair or renew it.
5 Inspect the heat insulator for damage. Make sure that there is adequate clearance between the heat insulator and the catalytic converter.

Renewal

6 To renew the catalytic converter, refer to Chapter 4A.

Notes