SECTION 1

ENGINE CIELO EURO III

SECTION 1A

GENERAL ENGINE INFORMATION

TABLE OF CONTENTS

DIAGNOSIS

COMPRESSION TEST

Important: Disconnect the Crankshaft Position (CKP) Sensor connector to disable the fuel and the ignition systems.

Test the compression pressure for each cylinder. Low compression pressure may be the fault of the valves or the pistons. The following conditions should be considered when you check the cylinder compression:

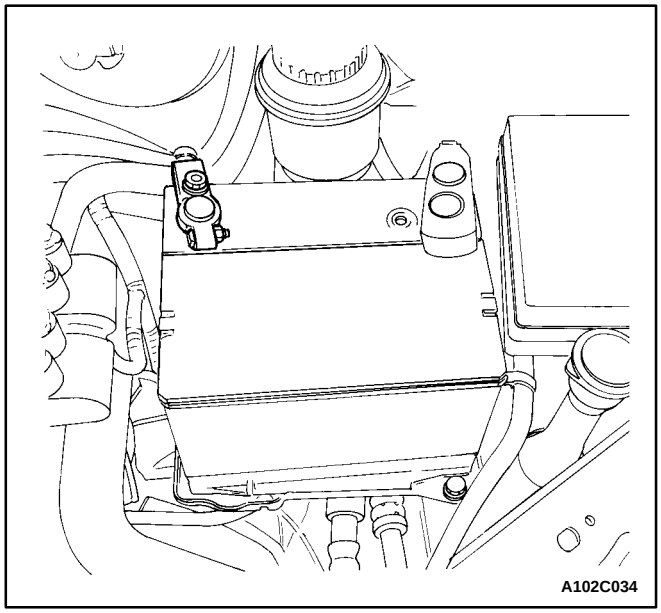
- The engine should be at normal operating temperature.
- The throttle must be wide open.
- All the spark plugs should be removed.
- The battery must be at or near full charge.

1. Place approximately three squirts of oil from a plunger-type oiler into each spark plug port.
2. Insert the engine compression gauge into each spark plug port.
3. Crank test each cylinder with four to five compression strokes using the starter motor.
4. The lowest reading should not be less than 70% of the highest reading. The compression gauge reading should not be less than 689 kPa (100 psi) for any of the cylinders.
5. Examine the gauge readings obtained after the four “puffs” per cylinder are obtained from cranking the starter motor. The readings are explained in the following descriptions:

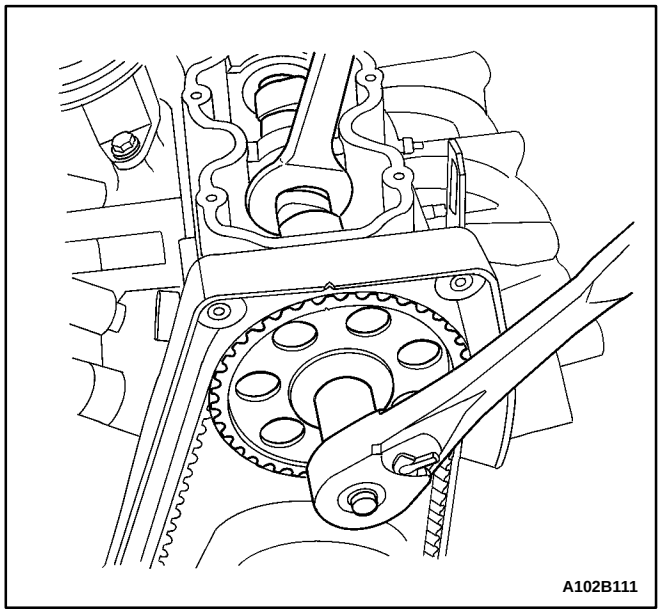
- Normal Condition – Compression builds up quickly and evenly to the specified compression on each cylinder.
- Piston Rings Faulty – Compression is low on the first stroke and tends to build up on following strokes, but the compression pressure does not reach normal. The compression pressure improves considerably with the addition of oil into the cylinder.
- Valves Faulty – Low compression pressure on the first stroke. The compression pressure does not tend to build up on the following strokes. The compression pressure does not improve much with the addition of oil into the cylinder.

OIL PRESSURE TEST

Step	Action	Value(s)	Yes	No
1	Is low or no oil pressure indicated?	–	Go to *Step 2*	System OK
2	Check the oil level in the crankcase. Is the level low?	–	Go to *Step 3*	Go to *Step 4*
3	Add oil so that the oil level is up to the full mark on the indicator. Is the repair complete?	–	Go to *Step 1*	–
4	Check the idle speed. Is the idle speed below the specified value?	825 rpm	Go to *Step 5*	Go to *Step 6*
5	Increase the idle speed. Is the speed increased?	–	Go to *Step 1*	–
6	Inspect the oil pressure switch. Is the oil pressure switch incorrect or malfunctioning?	–	Go to *Step 7*	Go to *Step 8*
7	Install a new oil pressure switch. Is the repair complete?	–	Go to *Step 1*	–
8	Inspect the oil pressure gauge. Is the oil pressure gauge incorrect or malfunctioning?	–	Go to *Step 9*	Go to *Step 10*
9	Install a new oil pressure gauge. Is the repair complete?	–	Go to *Step 1*	–
10	Inspect the engine oil. Is the engine oil in the crankcase diluted or of the improper viscosity?	–	Go to *Step 11*	Go to *Step 12*
11	Install new engine oil of the proper viscosity for the expected temperatures. Is the repair complete?	–	Go to *Step 1*	–
12	Inspect the oil pump. Is the pump worn or dirty?	–	Go to *Step 13*	Go to *Step 14*
13	Replace the oil pump. Is the repair complete?	–	Go to *Step 1*	–
14	Inspect the oil filter. Is the oil filter plugged?	–	Go to *Step 15*	Go to *Step 16*
15	Install a new oil filter. Is the repair complete?	–	Go to *Step 1*	–
16	Inspect the oil pickup screen. Is the oil pickup screen loose or plugged?	–	Go to *Step 17*	Go to *Step 18*
17	Tighten or replace the oil pickup screen, as necessary. Is the repair complete?	–	Go to *Step 1*	–
18	Inspect the oil pickup tube. Are there any holes in the oil pickup tube?	–	Go to *Step 19*	Go to *Step 20*
19	Replace the oil pickup tube. Is the repair complete?	–	Go to *Step 1*	–


A102C034

11. Install the battery and the battery tray. Refer to *Section 1E, Engine Electrical.*
12. Connect the positive battery cable to the battery.

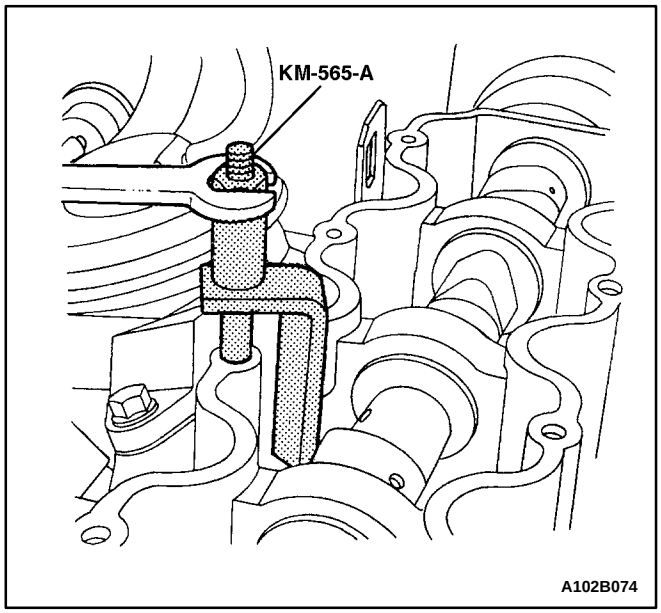

A102B111

Notice: Take extreme care to prevent any scratches, nicks, or damage to the camshaft. Such damage can impair vehicle operation.

13. Install the camshaft gear.
14. While holding the camshaft firmly in place, install the camshaft gear bolt.

Tighten

Tighten the camshaft gear bolt to 45 N m (33 lb-ft).



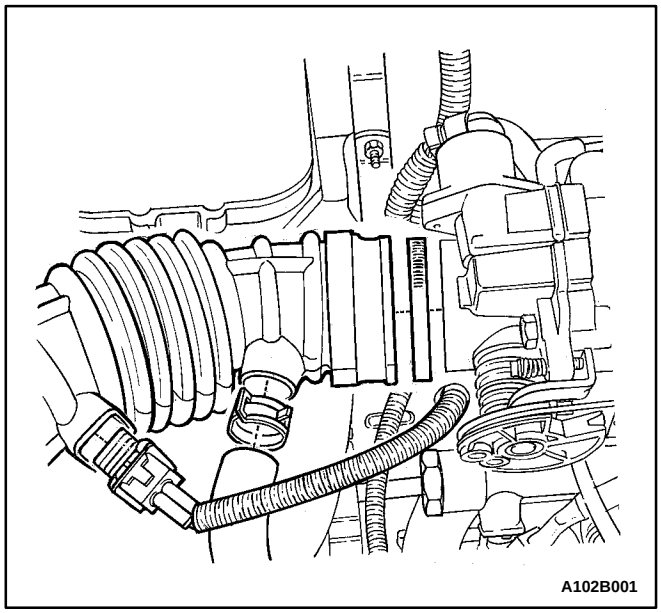
A102B074

15. Install the camshaft followers using the valve spring compressor KM-565-A.
16. Remove the tool KM-565-A.

INTAKE MANIFOLD

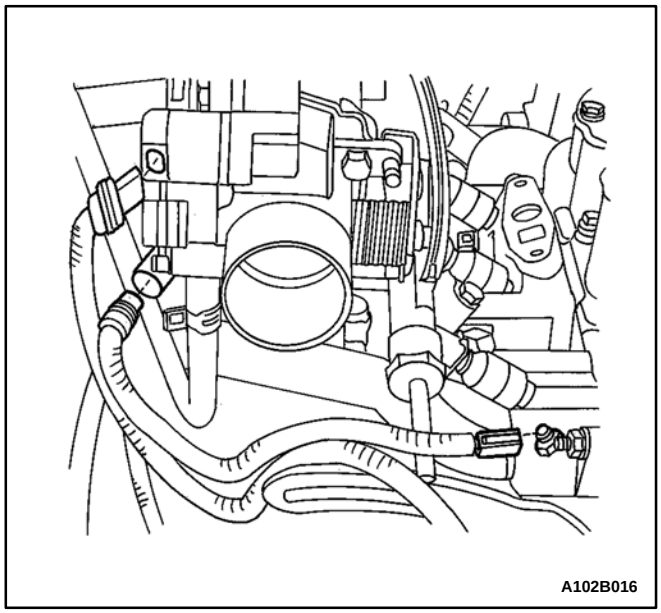
Removal Procedure

1. Remove the fuel pump fuse.
2. Start the engine. After it stalls, crank the engine for 10 seconds to rid the fuel system of fuel pressure.
3. Disconnect the negative battery cable.
4. Disconnect the engine control module (ECM) ground terminal from the intake manifold.



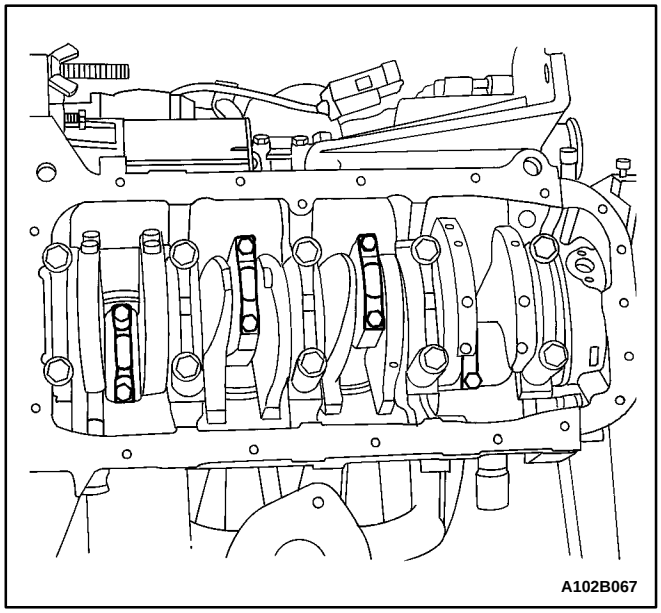
A102B001

5. Drain the engine coolant. Refer to *Section 1D, Engine Cooling.*
6. Disconnect the intake air temperature (IAT) sensor connector.
7. Disconnect the air intake tube from the throttle body.

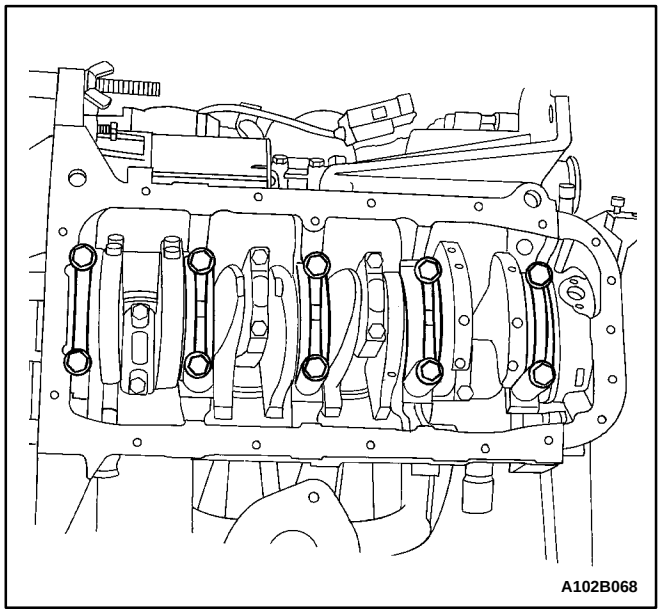


A102B016

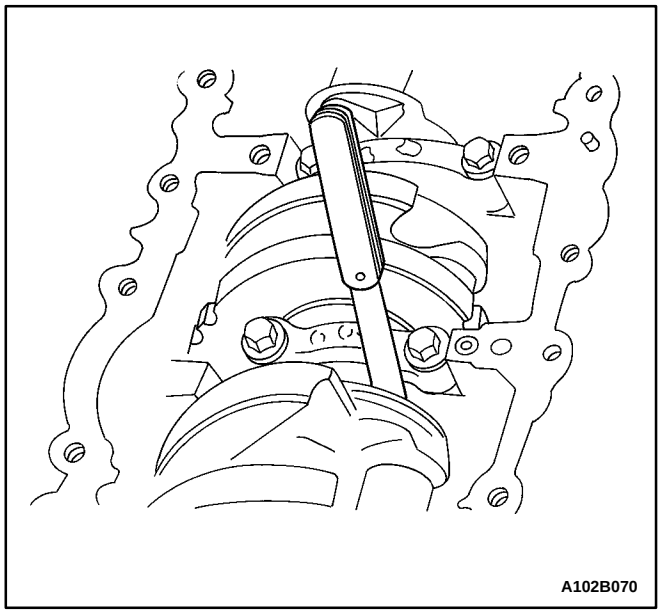
8. Disconnect the idle air control valve (IAC) connector.
9. Disconnect the throttle position (TP) sensor connector.
10. Disconnect the engine coolant temperature (ECT) sensor connector.


A102B067

31. Mark the order of the rod bearing caps.
32. Remove the connecting rod cap bolts for all of the pistons.
33. Remove the connecting rod bearing caps and the lower connecting rod bearings.
34. Remove the upper connecting rod bearings.


A102B068

35. Mark the order of the crankshaft bearing caps.
36. Remove the crankshaft bearing cap bolts.
37. Remove the crankshaft bearing caps.
38. Remove the crankshaft bearings from the crankshaft bearing caps.
39. Remove the crankshaft.
40. Remove the crankshaft bearings from the engine block.
41. Clean the parts, as necessary.


A102B070

Assembly Procedure

1. With crankshaft and bearings in place, plastic gauge all bearing clearances. Refer to “Crankshaft Bearings and Connecting Rod Bearings – Gauging Plastic” in this section.
2. Inspect the crankshaft end play with the crankshaft bearings installed.
3. Check for permissible crankshaft end play. Refer to “Engine Specifications” in this section.

GENERATOR SPECIFICATIONS

Application	Description
Types	CS-121D

BATTERY SPECIFICATIONS

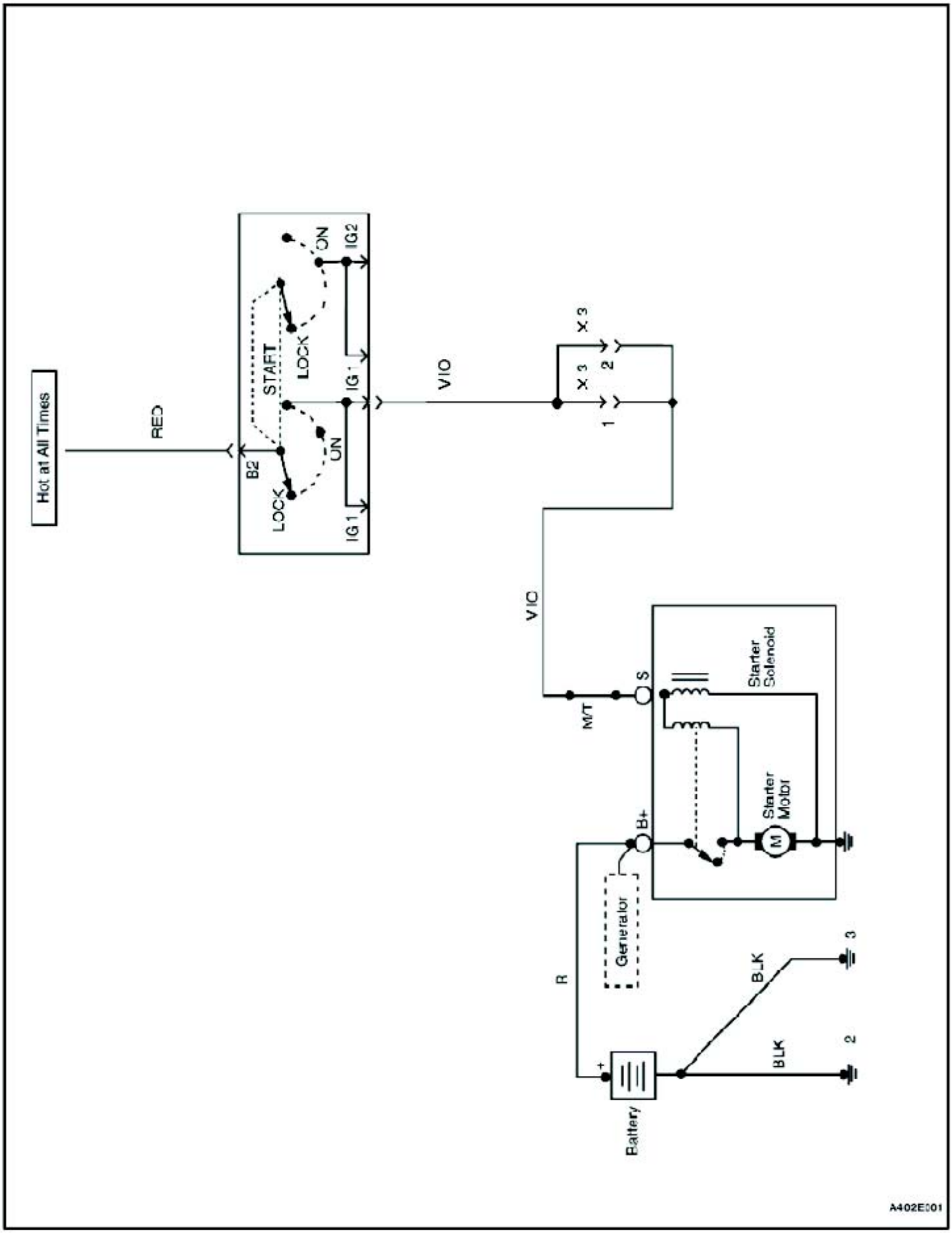
Application	Description
L4 Engine	
Cold Cranking Amps	550 amps
RC (Minimum)	90 minutes
Load Test	270 amps
Replacement	85B-60
Minimum Voltage: 9.6 9.4 9.1 8.8 8.5 8.0	Estimated Temperature: 21°C (70°F) 20°C (68°F) 0°C (32°F) – 10°C (14°F) – 18°C (0°F) Below – 18°C (Below 0°F)

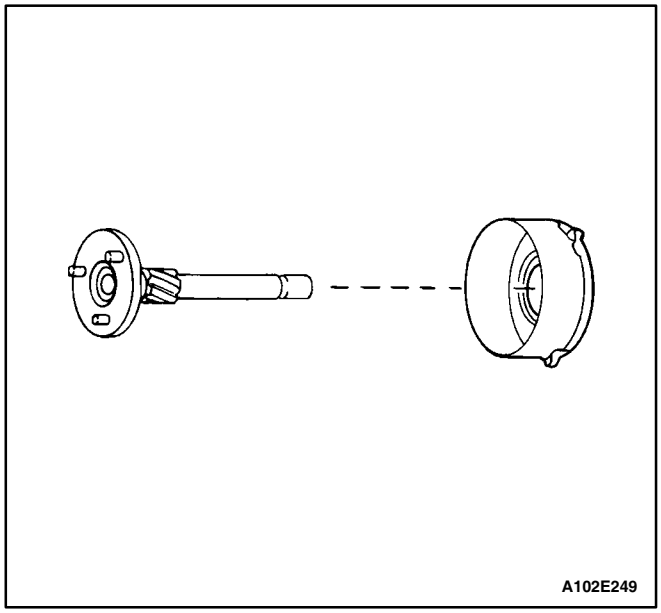
FASTENER TIGHTENING SPECIFICATIONS

Application	N•m	Lb-Ft	Lb-In
Battery Cable Nuts	4.5	–	40
Battery Carrier Tray Lower Bolts	20	15	–
Battery Carrier Tray Upper Bolts	20	15	–
Battery Retainer Clamp-to-Battery Rod Nuts	4	–	35
Fuel Rail Retaining Bolts	20	15	–
Generator Battery Lead Nut	15	11	–
Generator Drive End Bearing Nut	81	60	–
Generator Lower Bracket-to-Generator Nuts	20	15	–
Generator Shackle Bracket Bolt	20	15	–
Generator Through-Bolts	10	–	89
Starter Field Coil Connector Nut	8	–	71
Starter Mounting Bolts	43	32	–
Starter Solenoid Assembly Screws	8	–	71
Starter Solenoid Nuts	15	11	–
Starter Through-Bolts	6	–	53

SCHEMATIC AND ROUTING DIAGRAMS

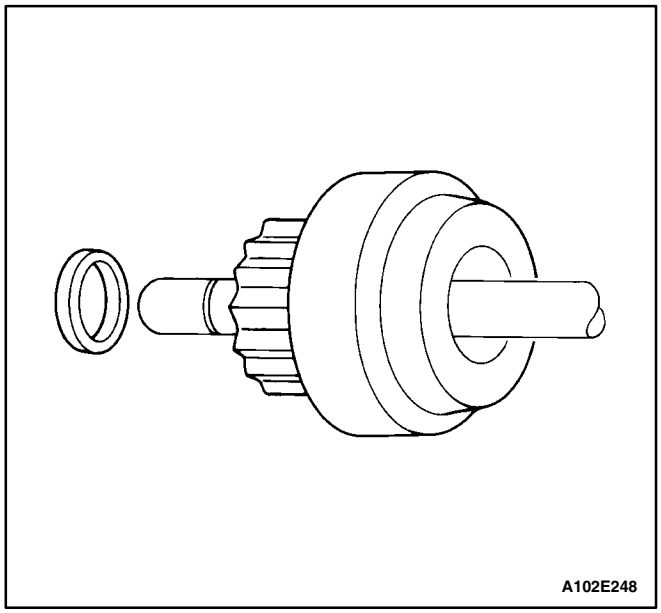
STARTING SYSTEM



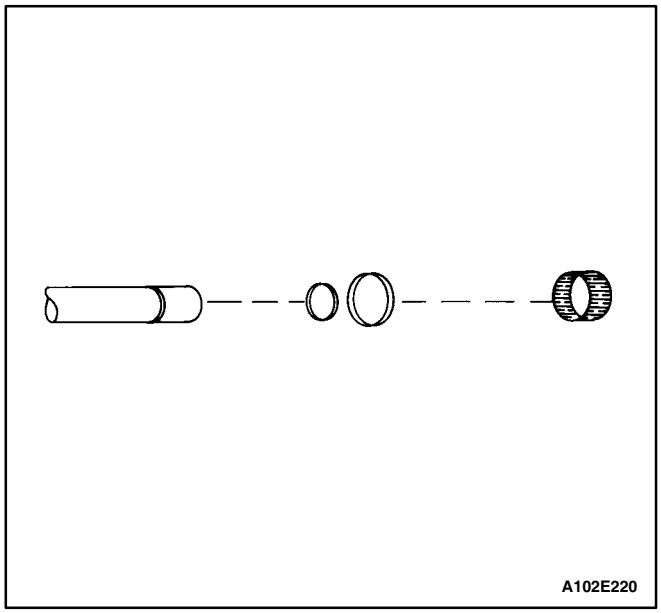

A102E249

Assembly Procedure

1. Clean all of the starter motor parts, but do not use grease-dissolving solvents for cleaning the armature and the field coils.
2. Lubricate the gears with lubricant. (Begin at Step 7 if proceeding with just the reassembly of the solenoid.)
3. If full disassembly of the starter and the solenoid was performed, begin reassembly by placing the gear support on the driveshaft assembly.


A102E248

4. Install the drive and the pinion stop on the driveshaft.


A102E220

5. Install the lock ring into the groove on the driveshaft and insert the collar.
6. Install the needle bearing.

SPECIFICATIONS

SCAN TOOL DATA TABLE

Parameter	Scaling	Value
Desired Idle Speed	RPM	ECM idle command (varies with temperature)
Engine RPM	RPM	±50 RPM from desired RPM in drive (A/T) ±50 RPM from desired RPM in neutral (M/T)
MAP	kPa	29 – 55 (varies with manifold and barometric pressure)
Throttle Position Volt	V	0 v
Start–up IAT	C	varies
Intake Air Temperature	C	10 – 90 C
Coolant Temperature (Start–up)	C	varies
Engine Coolant Temperature	C	85 – 105 C
IAC Motor Position	–	1 – 50
O2 Sensor (B1–S1)	mV	1–1000 mV (varies continuously)
O2 Sensor (B1–S2)	mV	1–1000 mV (varies continuously)
Fuel System Status	Closed Loop/Open Loop	“Closed Loop” (may enter “Open Loop” at extended idle)
Rich/Lean (B1–S1)	Rich/Lean	varies
Lean to Rich Average	mS	10 –211 ms or 0 ms
Rich to Lean Average	mS	10 –211 ms or 0 ms
Engine Load Value	%	0 – 100 % (varies)
Short Term Fuel Trim	%	-30 – 30%
Long Term Fuel Trim	%	-30 – 30%
Linear EGR Feedback	V	varies
EGR Duty Cycle	%	0 %
EGR EWMA Result	–	< = 0
Spark Advance		varies
MIL Odometer	Km	0 Km
MIL On Time	Min	0 Min
Base Injection PWM	mS	1.0 – 5.0 ms
Barometric Pressure	kPa	varies with altitude
Ignition Voltage	V	13.5 – 14.8 V
Air/Fuel Ratio	Ratio	14.6 (Closed Loop Enable)
Calculated Air Flow	G/S	varies
Total Misfire (Current)	–	0
Misfire History Cyl. 1	–	0
Misfire History Cyl. 2	–	0
Misfire History Cyl. 3	–	0
Misfire History Cyl. 4	–	0
Vehicle Speed	Km/H	0 Km/H
A/C Pressure	V	varies
A/C Request	Yes/No	No
A/C Clutch	On/Off	Off

* Condition: Warmed up, idle, park or neutral, A/C off

FASTENER TIGHTENING SPECIFICATIONS

Application	N m	Lb-Ft	Lb-In
Camshaft Position Sensor	12	–	106
Crankshaft Position Sensor Retaining Bolt	10	–	89
Electronic Ignition System Ignition Coil Retaining Bolts	10	–	89
Engine Control Module (ECM) Retaining Bolt – SOHC	5	–	44
Engine Coolant Temperature Sensor	20	15	–
Evaporative Emission Canister Flange Bolt	20	15	–
Exhaust Gas Recirculation Valve Retaining Bolts	20	15	–
Fuel Pressure Regulator Retaining Bolt – SOHC	12	–	106
Fuel Rail Mounting Bolts	25	18	–
Fuel Rail Retaining Bolts	25	18	–
Fuel Tank Retaining Bolts	20	15	–
Heated Oxygen Sensor	41	30	–
Idle Air Control Valve Retaining Bolts	3	–	27
Knock Sensor Bolt	20	15	–
MAP Sensor Mounting Bracket Bolt	4	–	35
MAP Sensor Retaining Bolts and Nuts	8	–	71
Oxygen Sensor	41	30	–
Parking Brake Cable Retainer Clamps	4	–	89
Throttle Body Retaining Bolts	15	11	–
Throttle Position Sensor Retaining Bolts	2	–	18
VGIS Actuator Assembly Mounting Bracket Bolt	16	12	–

MULTIPLE ECM INFORMATION SENSOR DTCS SET

System Description

The engine control module (ECM) monitors various sensors to determine engine operating conditions. The ECM controls fuel delivery, spark advance, transaxle operation, and emission control device operation based on the sensor inputs.

The ECM provides a sensor ground to all of the sensors. The ECM applies 5 volts through a pull–up resistor and monitors the voltage present between the sensor and the resistor to determine the status of the Engine Coolant Temperature (ECT) sensor, the Intake Air Temperature (IAT) sensor, and the Transmission Fluid Temperature (TFT) sensor. The ECM provides the Exhaust Gas Recirculation (EGR) Pintle Position sensor, the Throttle Position (TP) sensor, the Manifold Absolute Pressure (MAP) sensor, and the Fuel Tank Pressure sensor with a 5 volt reference and a sensor ground signal. The ECM monitors the separate feedback signals from these sensors to determine their operating status.

Diagnostic Aids

Be sure to inspect the ECM and engine grounds for being secure and clean.

A short to voltage in one of the sensor circuits can cause one or more of the following diagnostic trouble codes (DTCs) to be set: P0108, P0113, P0118, P0123, P1106, P1111, P1115, P1121.

If a sensor input circuit has been shorted to voltage, ensure that the sensor is not damaged. A damaged sensor will continue to indicate a high or low voltage after the affected circuit has been repaired. If the sensor has been damaged, replace it.

An open in the sensor ground circuit between the ECM and the splice will cause one or more of the following DTCs to be set: P0108, P0113, P0118, P0123, P1106, P1111, P1115, P1121.

A short to ground in the 5 volt reference circuit or an open in the 5 volt reference circuit between the ECM and the splice will cause one or more of the following DTCs to be set: P0107, P0112, P0117, P0122, P1107, P1112, P1114, P1122.

Check for the following conditions:

Inspect for a poor connection at the ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.

Inspect the wiring harness for damage. If the harness appears to be OK, observe an affected sensor's displayed value on the scan tool with the ignition ON and the engine OFF while moving connectors and wiring harnesses related to the affected sensors. A change in the affected sensor's displayed value will indicate the location of the fault.

Test Description

Number(s) below refer to the step number(s) on the Diagnostic Table.

1. The powertrain On-Board Diagnostic (EOBD) system check prompts the technician to complete some basic checks and store the freeze frame and failure records data on the scan tool if applicable. This creates an electronic copy of the data taken when the malfunction occurred. The information is then stored on the scan tool for later reference.

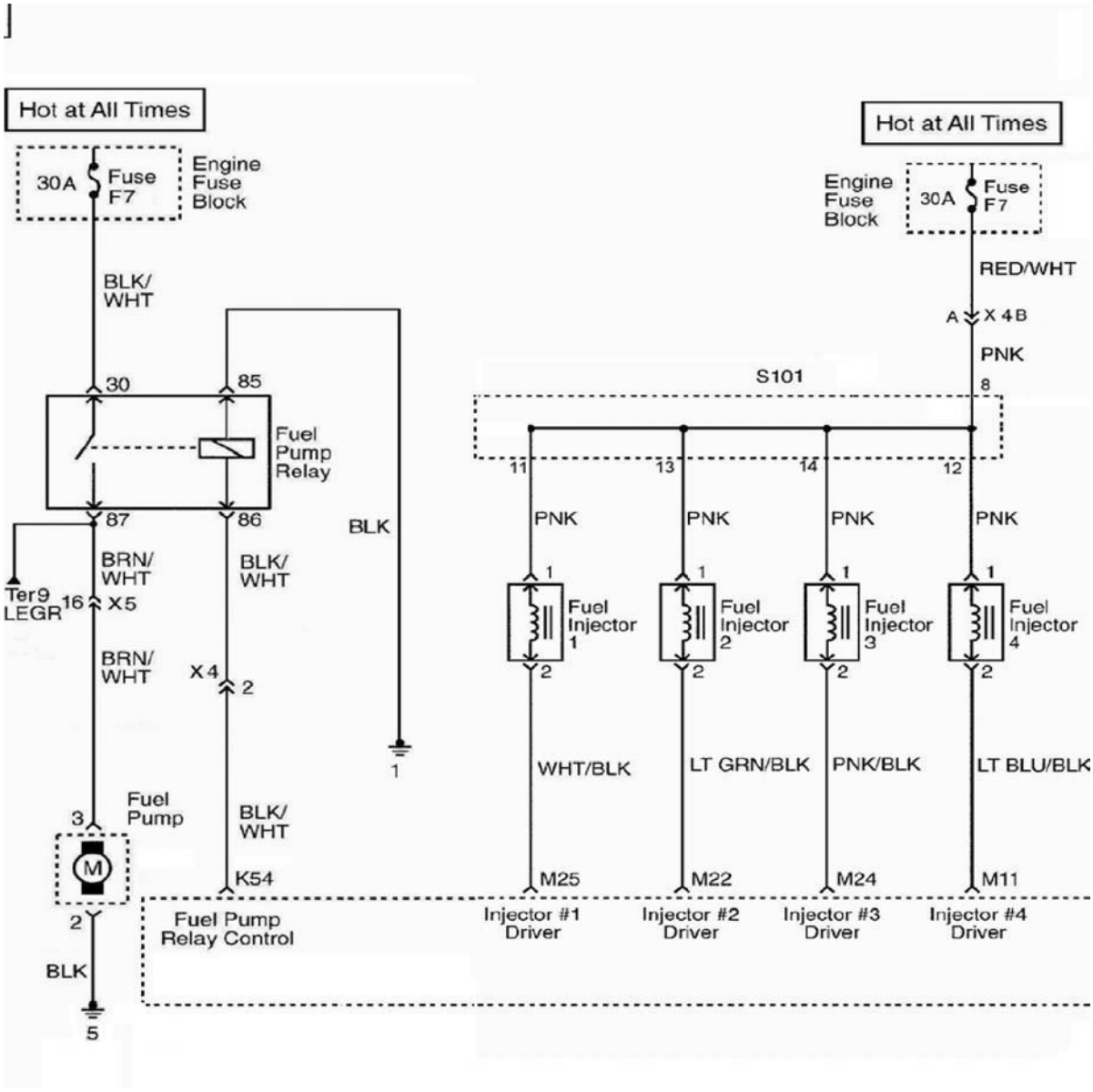
9. A faulty EGR valve can leak a small amount of current from the ignition feed circuit to the 5 volt reference circuit. If the problem does not exist with the EGR valve disconnected, replace the EGR valve.

11 – 19. If a sensor input circuit has been shorted to voltage, ensure that the sensor has not been damaged. A damaged IAT or ECT sensor will continue to indicate a high voltage or low temperature after the affected circuit has been repaired. A damaged TP, MAP, fuel tank pressure, or EGR Pintle Position sensor will indicate a high or low voltage or may be stuck at a fixed value after the affected circuit has been repaired. If the sensor has been damaged, replace it.

20. ECM must be programmed. Refer to the latest Techline procedure for ECM reprogramming.

Multiple ECM Information Sensor DTCs Set

Step	Action	Value	Yes	No
1	Perform an On-Board Diagnostic (EOBD) System Check. Is the system check complete?	–	Go to *Step 2*	Go to "On-Board Diagnostic System Check"
2	1. Ignition OFF, disconnect the engine control module (ECM). 2. Ignition ON, check the 5 volt reference circuit for the following conditions: Poor connection at the ECM. Open between the ECM connector affected sensors shorted to ground or voltage. 3. If a problem is found, locate and repair the open or short circuit as necessary. Is a problem found?	–	Go to *Step 21*	Go to *Step 3*
3	1. Check the sensor ground circuit for the following conditions: Poor connection at the ECM or affected sensors. Open between the ECM connector and the affected sensors. 2. If a problem is found, repair it as necessary. Is a problem found?	–	Go to *Step 21*	Go to *Step 4*
4	Measure the voltage between the Exhaust Gas Recirculation (EGR) Pintle Position Sensor signal circuit at the ECM harness connector and ground. Does the voltage measure near the specified value?	0 v	Go to *Step 5*	Go to *Step 9*
5	Measure the voltage between the Manifold Absolute Pressure (MAP) sensor signal circuit at the ECM harness connector and ground. Does the voltage measure near the specified value?	0 v	Go to *Step 6*	Go to *Step 12*
6	Measure the voltage between the Throttle Position (TP) sensor signal circuit at the ECM harness connector and ground. Does the voltage measure near the specified value?	0 v	Go to *Step 7*	Go to *Step 13*
7	Measure the voltage between the Intake Air Temperature (IAT) sensor signal circuit at the ECM harness connector and ground. Does the voltage measure near the specified value?	0 v	Go to *Step 8*	Go to *Step 14*
8	Measure the voltage between the Engine Coolant Temperature (ECT) sensor signal circuit at the ECM harness connector and ground. Does the voltage measure near the specified value?	0 v	Go to *Step 10*	Go to *Step 15*
9	1. Disconnect the EGR valve. 2. Measure the voltage between the EGR Pintle Position sensor signal circuit at the ECM harness connector and ground. Does the voltage measure near the specified value?	0 v	Go to *Step 11*	Go to *Step 16*
10	Measure the voltage between the Transmission Fluid Temperature (TFT) sensor signal circuit at the ECM harness connector and ground. Does the voltage measure near the specified value?	0 v	Go to *Step 18*	Go to *Step 17*


Hot at All Times
30A
Fuse F7
Engine Fuse Block
BLK/ WHT
30
85
Fuel Pump Relay
87
86
BLK
BRN/ WHT
BLK/ WHT
Ter9 LEGR
16
X5
BRN/ WHT
X4
2
1
3
Fuel Pump
BLK/ WHT
M
K54
2
BLK
5
Fuel Pump Relay Control
Hot at All Times
Engine Fuse Block
30A
Fuse F7
RED/WHT
A
X4B
PNK
S101
8
11
13
14
12
PNK
PNK
PNK
PNK
1
Fuel Injector 1
Fuel Injector 2
Fuel Injector 3
Fuel Injector 4
2
WHT/BLK
LT GRN/BLK
PNK/BLK
LT BLU/BLK
M25
M22
M24
M11
Injector #1 Driver
Injector #2 Driver
Injector #3 Driver
Injector #4 Driver

TAA1F260

NO MALFUNCTION INDICATOR LAMP

Circuit Description

When the ignition is turned ON, the Malfunction Indicator Lamp (MIL) will be turned ON and remain ON until the engine is running, if no Diagnostic Trouble Codes (DTCs) are stored. Battery voltage is supplied through the ignition switch directly to the MIL telltale. The engine control module (ECM) controls the MIL by providing a ground path through the MIL control circuit to turn on the MIL.

Diagnostic Aids

An open ignition F11 fuse will cause the entire cluster to be inoperative.

Check the battery and ignition feed circuits for poor connections if the MIL is intermittent.

Any circuitry that is suspected as causing an intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminals to wiring connections, or physical damage to the wiring harness.

Test Description

Number(s) below refer to the step number(s) on the diagnostic table.

1. The On-Board Diagnostic (EOBD) System Check prompts the technician to complete some basic checks and to store the freeze frame and failure records data on the scan tool, if applicable. This creates an electronic copy of the data taken when the malfunction occurred. The information is stored in the scan tool for later reference.
3. Connections that are suspected of being faulty should be thoroughly checked as described in the diagnostic aids.
4. If the engine fails to start and the MIL is inoperative, then the fault can be isolated to either the ECM ignition feed, the battery feed, or a poor ground at the engine block or at the ECM.
8. It takes very little resistance for the battery and the ignition feed circuits to cause an intermittent condition and should also be checked for a poor connection as described in diagnostic aids.
9. Probing the MIL circuit with a test light to ground stimulates the ECM's control of the MIL. If the MIL illuminates, then the malfunction can be isolated to the control of the MIL or a poor connection at the MIL terminal to the ECM. Connections that are suspected of being faulty should be thoroughly checked as described in the diagnostic aids.
12. Before replacing the ECM, check for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wiring harness. Replacement ECMs must be reprogrammed. Refer to the latest Techline information for reprogramming procedures.
21. ECM grounds will only cause a problem if all of the grounds are not making a good connection. If a ECM ground problem is suspected, the most probable place to check is at the engine block, where all the grounds meet.
22. If not faults have been found at this point and no DTCs were set, refer to the diagnostic aids for additional checks and information.

MALFUNCTION INDICATOR LAMP ON STEADY

Circuit Description

When the ignition is turned ON, the Malfunction Indicator Lamp (MIL) will be turned on and remain on until the engine is running, if no Diagnostic Trouble Codes (DTCs) are stored. Battery voltage is supplied through the ignition switch directly to the MIL telltale. The engine control module (ECM) controls the MIL by providing a ground path through the MIL control circuit to turn ON the MIL.

Test Description

Number(s) below refer to the step number(s) on the diagnostic table.

1. The On-Board Diagnostic (EOBD) System Check prompts the technician to complete some basic checks and store the freeze frame and failure records data on then scan tool, if applicable. This creates an electronic copy of the data taken when the malfunction occurred. The information is stored in the scan tool for later reference.
2. When the ignition is turned ON, the MIL should be turned on and remain on until the engine is running or until an emission related DTC is stored.
3. This step checks the ability of the ECM to control the MIL. The scan tool has the ability to command the MIL on and off.
5. A shorted MIL circuit can be diagnosed with a scan tool.
7. The replacement ECM must be reprogrammed. Refer to the latest Techline information for reprogramming procedures.

Malfunction Indicator Lamp On Steady

Step	Action	Value	Yes	No
1	Perform an On-Board Diagnostic (EOBD) System Check. Is the system check complete?	–	Go to *Step 2*	Go to "On-Board Diagnostic System Check"
2	Turn the ignition switch ON, with the engine OFF. Is the Malfunction Indicator Lamp (MIL) ON?	–	Go to *Step 3*	Go to "No Malfunction Indicator Lamp"
3	1. Install the scan tool. 2. Command the MIL on and off. Does the MIL turn on and off when commanded?	–	Go to *Step 8*	Go to *Step 4*
4	1. Turn the ignition switch OFF. 2. Disconnect the engine control module (ECM) connectors. 3. Turn the ignition switch ON. Is the MIL off?	–	Go to *Step 7*	Go to *Step 5*
5	Check the MIL control circuit for a short to ground and repair as necessary. Is the repair necessary?	–	Go to *Step 8*	Go to *Step 6*
6	Replace the instrument panel cluster. Refer to *Section 9E, Instrumentation and Driver Information*. Is the repair complete?	–	Go to *Step 8*	–
7	1. Turn the ignition switch OFF. 2. Replace the ECM. Is the repair complete?	–	Go to *Step 8*	–
8	1. Using the scan tool, clear the Diagnostic Trouble Codes (DTCs). 2. Attempt to start the engine. Does the engine start and continue to run?	–	Go to *Step 9*	Go to *Step 1*
9	1. Allow the engine to idle until normal operating temperature is reached. 2. Check if any DTCs are set. Are any DTCs displayed that have not been diagnosed?	–	Go to the applicable DTC table	System OK