**General Specifications**

| Item | Specification |
|---|---|
| **Cooling System Capacity** | |
| 4.0L OHV | 11.4 liters (12.0 quarts) |
| 4.0L SOHC | 13.2 liters (14.0 quarts) |
| 5.0L | 14.9 liters (15.7 quarts) |
| **Pressure Test** | |
| Cooling system | 138 kPa (20 psi) |
| Cap | 89-124 kPa (13-18 psi) |
| **Thermostat Opening Temperature** | |
| Starts to open | 90°C (194°F) |
| Fully open | 99°C (210°F) |
| **Lubricants/Adhesives/Cleaners** | |
| Premium Engine Coolant<br>E2FZ-19549-AA (in Canada, Motorcraft CXC-8-B, in Oregon, F5FZ-19549-CC) | ESE-M97B44-A |
| Premium Cooling System Flush<br>F1AZ-19A503-A | ESR-M14P7-A |
| Pipe Sealant with Teflon®<br>D8AZ-19554-A | WSK-M2G350-A2 |
| Gasket and Trim Adhesive<br>F3AZ-19B508-AA | ESR-M18P7-A |
| Metal Surface Cleaner<br>F4AZ-19A536-RA | WSE-M5B392-A |
| Dow Corning Silastic 734-R7V | Equivalent Commercial Product |
| Dow Corning Primer 1200 | Equivalent Commercial Product |
| Premium Long-Life<br>Grease XG-1-C | ESA-M1C75-B |

**Torque Specifications**

| Description | Nm | lb-ft | lb-in |
|---|---|---|---|
| **5.0L** | | | |
| Block heater screw | 1.6-1.8 | — | 14-16 |
| Engine compartment light switch assembly bolt | — | — | — |
| Engine coolant temperature sensor | 13-20 | 10-15 | — |

| | | | |
|---|---|---|---|
| Fan clutch bolts | 19-26 | 14-19 | — |
| Fan clutch to water pump pulley nut | 46-63 | 34-46 | — |
| Fan shroud bolts | 6-8 | — | 53-71 |
| Radiator coolant recovery reservoir bolts | 6-8 | — | 53-71 |
| Radiator to radiator support bolts | 6-8 | — | 53-71 |
| Speed control servo bolt | 8.9-12.1 | — | 79-107 |
| Thermostat housing bolts | 16-24 | 12-18 | — |
| Transmission cooling line fitting to radiator | 20-30 | 17-22 | — |
| Transmission cooling line to cooler fitting nut | 20-30 | 17-22 | — |
| Fan blade to fan clutch bolts | 6-8 | — | 53-71 |
| Hose clamps | 11-15 | 8-11 | — |
| Water pump bolts | 20-28 | 15-21 | — |
| Water pump pulley bolts | 16-25 | 12-18 | — |
| Water temperature indicator sender unit | 11-24 | 8-18 | — |
| **4.0L** | | | |
| Battery ground cable | 7-10 | — | 62-89 |
| Belt idler pulley bolts | 45 | 33 | — |
| Block heater screw | 1.6-1.8 | — | 14-16 |
| Engine block coolant drain plug | 16-24 | 12-18 | — |
| Engine coolant temperature sensor | 13-20 | 10-15 | — |
| Fan blade to fan clutch bolts | 19-26 | 14-19 | — |
| Fan clutch to water pump pulley nut | 43-63 | 34-46 | — |
| Fan shroud bolts | 6-8 | — | 53-71 |
| Radiator coolant recovery reservoir bolts | 6-8 | — | 53-71 |
| Radiator draincock | 2.0-2.7 | — | 18-25 |
| Radiator to radiator support bolts | 6-8 | — | 53-71 |
| Speed control servo bolt | 8.9-12.1 | — | 79-107 |
| Thermostat housing bolts (4.0L push rod) | 16-24 | 12-18 | — |
| Thermostat housing bolts (4.0L SOHC) | 8-11 | — | 71-97 |
| Transmission cooling line fitting to radiator | 30 | 22 | — |
| Water pump bolts | 8.5-12 | 6-9 | — |
| Water pump pulley bolts | 22-28 | 17-20 | — |
| Water pump stud bolts | 8.5-12 | 6-9 | — |
| Water temperature indicator sender unit | 11-24 | 8-18 | — |

## Engine Cooling

The engine cooling system consists of the:

- block heater (6A051)
- engine coolant temperature (ECT) sensor (12A648)
- fan blade (8600)
- fan clutch (8A616)
- fan shroud (8146)
- radiator (8005)
- radiator cap (8100)
- radiator coolant recovery reservoir (8A080)
- water thermostat (8575)
- water pump (8501)
- ECT sender unit (10884)

- radiator draincock (8115)
- oil filter adapter (6881)

The radiator allows excess engine heat to be transferred to the air.

Radiator tanks cannot be repaired, install as an assembly.

For the 2.3L engine, the thermostat and housing must be serviced as an assembly.

Engine coolant provides freeze protection, boil protection, cooling efficiency and corrosion protection to the engine and cooling components. In order to obtain these protections, the engine coolant must be maintained at the correct concentration and fluid level in the degas bottle.

When adding engine coolant, use a 50/50 mixture of engine coolant and clean, drinkable water.

To maintain the integrity of the coolant and the cooling system:

- Add Motorcraft Premium Engine Coolant VC-4-A (CXC-10 in Canada, VC-5 in Oregon) or equivalent meeting Ford specification ESE-M97B44-A.
- Do not add orange-colored extended life coolant VC-2 or equivalent, meeting Ford specification WSS-M97B44-D. Mixing coolants may degrade the coolant's corrosion protection.
- Do not add alcohol or methanol or any engine coolants mixed with alcohol or methanol antifreeze. These can cause engine damage from overheating or freezing.
- Do not mix with recycled coolant unless it meets the requirements of Ford specification ESE-M97B44-A. Not all coolant recycling processes meet this Ford specification; use of such a coolant may harm the engine and cooling system components.

The water temperature indicator sender unit provides a signal to the temperature gauge.

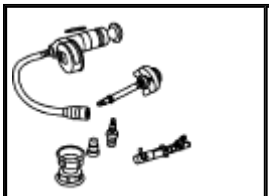
The optional block heater:

- electrical heating element is installed in the core plug opening.

    - uses a standard 110V electrical supply
- keeps the engine coolant warm during cold weather.

## Engine Cooling

**Special Tool(s)**

| | |
|---|---|
|  ST1474-A | Pressure Tester<br>014-R1072 or equivalent |

**Inspection and Verification**

1. Verify the customer's concern by operating the engine to duplicate the condition.
2. Inspect to determine if any of the following mechanical or electrical concerns apply.

**Visual Inspection Chart**

| Mechanical | Electrical |
|---|---|
| • Leaks<br>• Damaged hoses<br>• Loose/damaged hose clamps<br>• Damaged water thermostat gasket<br>• Damaged head gaskets<br>• Damaged intake manifold gasket<br>• Damaged water pump<br>• Damaged radiator coolant recovery reservoir<br>• Damaged heater core<br>• Damaged fan/fan clutch | • Damaged engine coolant temperature sensor<br>• Damaged wiring |

3. If the inspection reveals an obvious concern that can be readily identified, repair it as necessary.
4. If the concern remains after the inspection, determine the symptom(s) and go to the Symptom Chart.

**Symptom Chart**

**SYMPTOM CHART**

| Condition | Possible Sources | Action |
|---|---|---|
| • Loss of coolant | • Radiator (8005).<br>• Water pump seal.<br>• Radiator hoses. | • GO to Pinpoint Test A . |

| | | |
|---|---|---|
| | • Heater hoses.<br>• Heater core.<br>• Engine gaskets.<br>• Radiator coolant recovery reservoir bottle. | |
| • The engine overheats | • Water thermostat (8575).<br>• Water pump.<br>• Internal engine coolant leak.<br>• Radiator.<br>• Heater core.<br>• Inoperative cooling fan radiator cap. | • GO to Pinpoint Test B . |
| • The engine (6007) does not reach normal operating temperature | • Water thermostat. | • GO to Pinpoint Test C . |
| • The block heater (6A051) does not operate correctly | • Block heater power cable.<br>• Block heater. | • GO to Pinpoint Test D . |

**Pinpoint Tests**

**PINPOINT TEST A: LOSS OF COOLANT**

| CONDITIONS | DETAILS/RESULTS/ACTIONS |
|---|---|
| **A1** CHECK THE ENGINE COOLANT LEVEL | |
| **NOTE:** Allow the engine to cool before checking the engine coolant level. | |
| 1  | 2 Visually check the engine coolant level at the radiator coolant reservoir bottle.<br>• **Is the engine coolant level within specification?**<br>→ **Yes**<br>GO to A2 .<br>→ **No**<br>REFILL the engine coolant as necessary. GO to A6 . |
| **A2** CHECK THE PRESSURE RELIEF CAP | |
| | 1 Carry out the radiator cap test; refer to the Component Tests in this section.<br>• **Is radiator cap OK?** |

| | |
|---|---|
| | → **Yes**<br>GO to A3 .<br><br>→ **No**<br>INSTALL a new radiator cap. TEST the system for normal operation. |
| **A3** CHECK THE ENGINE COOLANT FOR INTERNAL LEAK | |
| 1<br>  | 2 Inspect the engine coolant in radiator coolant recovery reservoir for signs of transmission fluid or engine oil.<br><br>• **Is oil or transmission fluid evident in coolant?**<br><br>→ **Yes**<br>If engine oil is evident, GO to Section 303-00 . If transmission fluid is evident, INSTALL a new radiator as necessary.<br><br>→ **No**<br>GO to A4 . |
| **A4** CHECK THE ENGINE AND THE TRANSMISSION FOR COOLANT | |
| | 1 Remove the oil level dipsticks (6750) from the engine and the transmission.<br><br>• **Is coolant evident in oil or transmission fluid?**<br><br>→ **Yes**<br>If coolant is in engine, GO to Section 303-00 . If coolant is in transmission (7003), INSTALL a new radiator as necessary. GO to Section 307-01A or Section 307-01B to repair the automatic transmission.<br><br>→ **No**<br>GO to A5 . |
| **A5** PRESSURE TEST THE ENGINE COOLING SYSTEM | |
| | 1 Pressure test the engine cooling system; refer to the Component Tests in this section.<br><br>• **Does the engine cooling system leak?**<br><br>→ **Yes**<br>REPAIR or INSTALL new components. TEST the system for normal operation.<br><br>→ **No**<br>The cooling system is operational. RETURN to the Symptom Chart. |
| **A6** CHECK THE COOLANT RECOVERY SYSTEM | |
| | 1 **WARNING: Never remove the radiator cap under any conditions while** |

| | |
|---|---|
| | **the engine is operating. Failure to follow these instructions could result in personal injury and/or damage to the cooling system or engine. To avoid having scalding hot coolant or steam blow out of the cooling system, use extreme care when removing the radiator cap from a hot radiator. Wait until the engine has cooled, then wrap a thick cloth around the radiator cap and turn it slowly to the first stop. Step back while the pressure is released from the cooling system. When you are certain all the pressure has been released, press down on the radiator cap (with a cloth), turn and remove.**<br><br>Allow the engine to cool.<br><br>2 Remove the radiator cap.<br><br>3 Inspect the radiator cap for foreign material between the sealing gasket and the diaphragm.<br><br>• **Is the radiator cap OK?**<br><br>→ **Yes**<br>GO to A7 .<br><br>→ **No**<br>CLEAN or INSTALL a new radiator cap. TEST the system for normal operation. GO to A1 . |
| **A7** CHECK THE DEGAS BOTTLE | |
| | 1 **NOTE:** The engine must be cool when coolant is added to the radiator coolant recovery reservoir.<br><br>Add coolant to the radiator coolant recovery reservoir until fluid is between the coolant fill level marks.<br><br>• **Check the radiator coolant recovery reservoir for leaks?**<br><br>→ **Yes**<br>INSTALL a new radiator coolant recovery reservoir. TEST the system for normal operation.<br><br>→ **No**<br>CARRY OUT the cooling system pressure test; REFER to Pressure Tests in this section. REPAIR as necessary. TEST the system for normal operation. |

**PINPOINT TEST B: THE ENGINE OVERHEATS**

| CONDITIONS | DETAILS/RESULTS/ACTIONS |
|---|---|
| **B1** CHECK THE ENGINE COOLANT LEVEL | |
| **NOTE:** If the engine is hot, allow the engine to cool before proceeding. | |
| 1  | 1 **WARNING: Never remove the radiator cap under any conditions while the engine is operating. Failure to follow these instructions could result in personal injury and/or damage to the cooling system or engine. To avoid having scalding hot coolant or steam blow out of the cooling system, use** |

| | |
|---|---|
| | **extreme care when removing the radiator cap from a hot radiator. Wait until the engine has cooled, then wrap a thick cloth around the radiator cap and turn it slowly to the first stop. Step back while the pressure is released from the cooling system. When you are certain all the pressure has been released, press down on the radiator cap (with a cloth), turn and remove.**<br>2 Check the engine coolant level at the radiator coolant recovery reservoir.<br>• **Is the engine coolant OK?**<br>→ **Yes**<br>GO to B2 .<br>→ **No**<br>REFILL the engine coolant at the radiator coolant recovery reservoir. GO to Pinpoint Test A . |
| **B2** CHECK THE COOLANT CONDITION | |
| | 1 Check the coolant for contaminants such as rust, corrosion, or discoloration.<br>• **Is the coolant condition OK?**<br>→ **Yes**<br>GO to B3 .<br>→ **No**<br>FLUSH the engine cooling system; REFER to Flushing—Engine and Radiator in this section. TEST the system for normal operation. |
| **B3** CHECK FOR AN AIRFLOW OBSTRUCTION | |
| | 1 Inspect the A/C condenser core (19712) and radiator for obstructions such as leaves or dirt.<br>• **Is there an obstruction?**<br>→ **Yes**<br>REMOVE the obstruction. CLEAN the A/C condenser core and radiator. TEST the system for normal operation.<br>→ **No**<br>GO to B4 . |
| **B4** CHECK THE HEATER CORE OPERATION | |
| 2  | 1 Install the radiator cap.<br>3 As the engine starts to heat up, feel the inlet and outlet heater water hoses (18472). They should feel approximately the same after three or four minutes. |

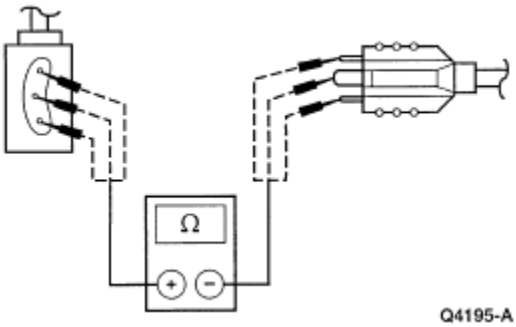
| | |
|---|---|
| | • **Is the heater water hose approximately the same temperature as the inlet heater water hose?**<br><br>→ **Yes**<br>GO to B5 .<br><br>→ **No**<br>TURN the engine off. REPAIR or INSTALL a new heater core. REFER to Section 412-02 . TEST the system for normal operation. |
| **B5** CHECK THE WATER THERMOSTAT OPERATION | |
| 1<br>  | 1 Start the engine and allow the engine to run for 10 minutes.<br><br>2 Feel the inlet and outlet heater water hoses and the underside of the upper radiator hose (8260).<br><br>• **Are the upper radiator hose and the heater water hoses cold?**<br><br>→ **Yes**<br>INSTALL a new water thermostat. TEST the system for normal operation.<br><br>→ **No**<br>GO to B6 . |
| **B6** CHECK THE COOLING FAN OPERATION | |
| 1<br>  | 1 Carry out the cooling fan component tests; refer to the Fan Clutch Test in this section.<br><br>• **Is the cooling fan operation OK?**<br><br>→ **Yes**<br>GO to Section 303-00 for diagnosis and testing of the engine.<br><br>→ **No**<br>INSTALL a new fan component determined to be faulty; REFER to Fan Clutch Test in this section. TEST the system for normal operation. |

**PINPOINT TEST C: THE ENGINE DOES NOT REACH NORMAL OPERATING TEMPERATURE**

| CONDITIONS | DETAILS/RESULTS/ACTIONS |
|---|---|
| **C1** CHECK THE ENGINE TEMPERATURE | |
| 1 | 1 Start the engine and allow the engine to idle for 10 minutes. |

| | |
|---|---|
|  <br>2<br>  | 2 Feel the inlet and heater water hoses and the underside of the upper radiator hose.<br><br>• **Are the upper radiator hose and the heater water hoses cold?**<br><br>→ **Yes**<br>INSTALL a new water thermostat. TEST the system for normal operation.<br><br>→ **No**<br>GO to Section 413-01 for diagnosis and testing of the engine coolant temperature gauge. |

**PINPOINT TEST D: THE BLOCK HEATER DOES NOT OPERATE CORRECTLY**

| CONDITIONS | DETAILS/RESULTS/ACTIONS |
|---|---|
| **D1** CHECK THE POWER CABLE | |
| 1<br>  <br>2<br>  <br>Block Heater<br>3<br>  <br> | 3 Check resistance in circuits 1, 2, and 3 of the block heater.<br><br>• **Is the resistance in circuits 1, 2, and 3 less than 5 ohms?**<br><br>→ **Yes** |

| | |
|---|---|
| | INSTALL a new block heater.<br><br>→ **No**<br>INSTALL a new power cable. TEST the system for normal operation. |

**Component Tests**

**Pressure Test**

**WARNING: Never remove the radiator cap under any conditions while the engine is operating. Failure to follow these instructions could result in personal injury and/or damage to the cooling system or engine. To avoid having scalding hot coolant or steam blow out of the cooling system, use extreme care when removing the radiator cap from a hot radiator. Wait until the engine has cooled, then wrap a thick cloth around the radiator cap and turn it slowly to the first stop. Step back while the pressure is released from the cooling system. When you are certain all the pressure has been released, press down on the radiator cap (with a cloth), turn and remove.**

1. Remove the radiator cap. Fill the radiator as needed. Fit the pressure tester to the radiator neck using an aftermarket adapter.

2. **CAUTION: Do not pressurize the cooling system beyond 102 kPa (14.9 psi).**

   Pump the cooling system to a maximum of 102 kPa (14.9 psi) and hold for two minutes. If the pressure drops within this time, inspect for leaks and repair as necessary.

**Cap**

1. Inspect the radiator cap and seals for damage or deterioration. Install a new radiator cap (8100) if necessary.

2. Fit the radiator cap to the Radiator/Heater Core Pressure Tester Kit using the aftermarket adapter.

3. **NOTE:** If the plunger of the pressure tester is depressed too fast, an incorrect pressure reading will result.

   Slowly pump the pressure tester until the pressure gauge stops increasing and note the highest pressure reading. Release the pressure and repeat the test. Install a new radiator cap if the pressure is not 99.3-121.4 kPa (14.4-17.6 psi).

**Thermostat—Water**

A new water thermostat should be installed only after the following electrical and mechanical tests have been carried out.

**Thermostat—Electrical Test**

**CAUTION: Always vent the exhaust to the outside when carrying out this test.**

**NOTE:** The electrical thermostat test is most accurate if carried out indoors at less than 37.8°C (100°F) ambient air. This test may be carried out with or without the hood open and with the engine warm or cold.

1. Check the engine coolant level. Fill as needed.

2. With the ignition OFF, remove the engine coolant temperature (ECT) sensor harness connector and attach ECT Sensor "T" Cable as a jumper between the powertrain control module (PCM) (12A650) and the ECT Sensor. Attach the 73 Digital Multimeter to the ECT Sensor "T" Cable. Voltage values (0-5 V) may now be monitored while the sensor retains its connection to the wiring harness.
   A scan tool may be used to monitor the ECT on vehicles equipped with data link connector (DLC). The SBDS sequence to use for the screen is: Toolbox-Electronic Engine Control and DCL-Item.

3. **NOTE:** Running this test with the vehicle in gear or with the A/C compressor clutch engaged (running) will cause incorrect diagnosis.

   Place the transmission in PARK (P) or NEUTRAL (N).

4. Start the engine and allow the engine to idle throughout this test. Allow the engine to run for two minutes, then record the ECT voltage. Record the ECT voltage every 60 seconds. When the ECT voltage trend changes direction or only changes slightly (0.03 volt or less) from the previous reading, record this as the thermostat opening voltage. Use the voltage and corresponding coolant temperature chart listed below.

| Coolant Temperature °C (°F) | ECT (Volts) |
|---|---|
| 22 (71) | 3.00 |
| 43 (109) | 2.01 |
| 71 (159) | 1.01 |
| 82 (180) | 0.75 |
| 91 (195) | 0.059 |
| 97 (206) | 0.050 |
| 105 (221) | 0.040 |

5. If the thermostat opening voltage is greater than 0.58 volt and less than 90°C (194°F), install a new water thermostat.

6. If the thermostat opening voltage is less than 0.58 volt and less than 90°C (194°F), the water thermostat is good and a new thermostat should not be installed. Refer to the Symptom Chart for further instructions.

**Thermostat—Mechanical Test**

1. Remove the water thermostat.

2. Check the water thermostat for seating. Hold the water thermostat up to a lighted background. Leakage of light around the thermostat valve at room temperature indicates that a new water thermostat should be installed. Some water thermostats have a small leakage notch at one location on the perimeter of the thermostat valve, which is considered normal.

3. Immerse the water thermostat in a boiling antifreeze and water mixture.

4. See the General Specifications chart for water thermostat opening temperatures.

**Radiator Leak Test, Removed From Vehicle**

**CAUTION: Never leak test an aluminum radiator in the same water that copper/brass radiators are tested in. Flux and caustic cleaners may be present in the cleaning tank and they will damage aluminum radiators.**

**NOTE:** Always install plugs in the oil cooler fittings before leak testing or cleaning any radiator.

**NOTE:** Clean the radiator before leak testing to avoid contamination of tank.

1. Leak test the radiator in clean water with 138 kPa (20 psi) air pressure.

**Fan Clutch Test**

1. Spin the fan blade (8600) by hand. A light resistance should be felt. If there is no resistance or very high resistance, the minimum and maximum fan speeds must be checked as follows:

**Fan Clutch Test—Minimum Speed Requirement**

1. Use a suitable marker to mark the water pump pulley (8509), one of the fan blade retaining bolts and the crankshaft pulley (6312).
2. Connect a tachometer to the engine.
3. Install a throttle adjusting tool.
4. Connect a digital photoelectric tachometer.
5. **WARNING: To avoid the possibility of personal injury or damage to the vehicle, do not operate the engine until the fan blade has been first examined for possible cracks and separation.**

   Start the engine and run it at approximately 1,500 rpm until the normal operating temperature has been achieved.
6. Adjust the engine speed to 2,300 rpm.
7. Operate the digital photoelectric tachometer at 3,000 rpm and aim it at the water pump pulley. Adjust the engine speed until the light flash and the water pump pulley mark are synchronized.
8. Aim the digital photoelectric tachometer at the fan blade bolts. Adjust the strobe light until the light flash is synchronized with the marked fan blade bolt (the fan blade appears to stand still).
9. The fan blade speed must not be greater than 1,500 rpm at 3,000 water pump rpm.
10. Turn the engine off.

11. If the fan blade speed was greater than 1,500 rpm, install a new fan clutch (8A616).

**Fan Clutch Test—Maximum Speed Requirement**

1. Carry out Steps 1 through 5 of the Fan Clutch Test—Minimum Speed Requirement.

2. **NOTE:** The temperature should be above 96°C (205°F) for maximum fan speed.

   Block off areas on each side of the radiator in the engine compartment and the front of the radiator grille (8200). This will raise the temperature of the air striking the fan clutch and should cause the fan blade to operate at maximum speed.

3. Place the climate control function selector switch in the MAX A/C position and the blower motor switch in the HI position.

4. Adjust the strobe to 3,000 rpm.

5.  **WARNING: To avoid the possibility of personal injury or damage to the vehicle, do not operate the engine until the fan blade has been first examined for possible cracks and separation.**

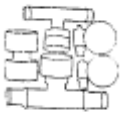
   Start the engine and adjust the engine speed until the digital photoelectric tachometer light and the water pump pulley mark are synchronized.

6. Aim the digital photoelectric tachometer light at the fan blade retaining bolts. Adjust the digital photoelectric tachometer light until the light flash is synchronized with the marked fan blade bolt (the fan blade appears to stand still).

7. If the fan blade speed is less than 2,300 rpm, install a new fan clutch.

## Cooling System Inspection

**Special Tool(s)**

| | |
|---|---|
|  ST1720-A | Fluid Tester<br>014-R1060 or equivalent |
|  ST1168-A | Flush Kit<br>164-R3658 or equivalent |

1. **WARNING: Never remove the radiator cap (8100) under any conditions while the engine is operating. Failure to follow these instructions could result in damage to the cooling system or engine and/or personal injury. To avoid having scalding hot coolant or steam blow out of the radiator (8005), use extreme care when removing the radiator cap from a hot radiator. Wait until the engine has cooled, then wrap a thick cloth around the radiator cap and turn it slowly to the first stop. Step back while the pressure is released from the cooling system. When it is certain all the pressure has been released, press down on the cap (still with a cloth), turn and remove.**

   **NOTE:** Check the coolant in the radiator coolant recovery reservoir (8A080) and radiator, if vehicle has not been allowed to reach normal operating temperature. This will make sure sufficient coolant exchange has occurred.

   Allow the engine to cool and remove the radiator cap.

2. Inspect the coolant in both the radiator and the radiator coolant recovery reservoir for coolant color:
   - Clear light green or blue indicates higher water content than necessary.
   - Dark brown indicates possible use of unauthorized Stop Leak. Use Cooling System Stop Leak Powder E6AZ-19558-A or equivalent meeting Ford specification ESE-M99B170-A only.
   - A light or reddish brown color indicates rust in the cooling system. Flush the system and refill with the correct mixture of water and Premium Engine Coolant E2FZ-19549-AA (in Canada, Motorcraft CXC-8-B, in Oregon, F5FZ-19549-CC) or equivalent meeting Ford specification ESE-M97B44-A.
   - An iridescent sheen on top of the coolant indicates a trace of oil is entering the cooling system.
   - A milky brown color indicates that oil is entering the cooling system.
   - A reddish milky appearance indicates transmission fluid is entering the system.

3. **CAUTION: If there is coolant in the engine oil, the cause must be corrected and the oil changed or engine damage may occur.**

The causes of the leak might be:

- a blown head gasket (6051).
- a cracked or warped cylinder head (6049).
- a crack in the engine oil gallery and the cooling passageways.

4. The causes of other leaks might be:
   - a leaky radiator.
   - a leaky transmission fluid cooler.
     Drain the fluids and repair or install new fluids as necessary. Add the correct mixture of water and Premium Engine Coolant E2FZ-19549-AA (in Canada, Motorcraft CXC-8-B, in Oregon, F5FZ-19549-CC) or equivalent meeting Ford specification ESE-M97B44-AA.

5. If the coolant appearance is OK, test the coolant range with the Rotunda Battery and Antifreeze Tester:
   - Maximum range is 60/40.
   - Minimum range is 45/55.

6. Coolant system conditions:
   - If the cooling system is low, top off only with a premixed solution.
   - If the coolant mixture is weak, add straight coolant until the readings are within acceptable levels.
   - If the coolant mixture is strong, remove some coolant and add water until the readings are within acceptable levels.

**Cooling System Hoses**

7. **CAUTION: Cooling system hoses, which operate under a positive pressure of approximately 110 kPa (16 psi) and a temperature of over 95°C (200°F), are subject to considerable vibration. Any hoses with cuts or deterioration should be replaced, as they are likely to fail on the road with the attendant risk of engine damage.**

   **CAUTION: Reasonably fresh replacement hoses should be used. Replacement hoses which have been in storage for several years should be checked for ozone-caused hardening. Hoses which have become hard will be difficult to seal and may break in service.**

   Inspect the hoses for:
   - Visible signs of deterioration such as cracking or checking. Install a new hose if there is visible deterioration.
   - Swelling near the clamps and at the hose ends. Install a new hose if there is swelling.
   - Oil or oily dirt on the hoses from engine oil leaks or careless filling. Clean off the oil and oily dirt on the hoses. Oil will attack the rubber over time. If there is weakening or deterioration of a hose, install a new hose.
   - Cuts. If a hose is cut other than a very superficial cut, install a new hose.
   - A hose contacting metal parts, especially sharp edges. If a hose is contacting metal parts, loosen the clamps and relocate the hose. In some cases it may be necessary to put plastic shielding on the hose to protect it. If the hose has already been cut or worn, install a new hose.

8. Inspect the clamps for any damage.

**Fan Blade**

**WARNING: Do not attempt to straighten or repair the fan blade. Install a new fan blade if it is damaged.**

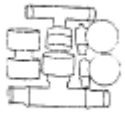
1. Inspect the fan for damage or cracking. Cracking is most likely to occur near the base of each individual blade. If the fan is damaged, install a new one. For additional information, refer to Fan—Blade in this section.

**Transmission Fluid Cooler Connection Leaks**

1. Check to see that the fitting nut is fully tightened. If the leak persists, apply a thin, even coat of Dow Corning 1200 Primer or equivalent using a brush. Allow to dry for 10 minutes at room temperature. Apply Dow Corning Silastic 734RTV or equivalent in undiluted form around the leaking connection and allow it to dry for one hour.

## Cooling System Draining, Filling and Bleeding

**Special Tool(s)**

| | |
|---|---|
|  ST1168-A | Flush Kit<br>164-R3658 or equivalent |

**Draining**

**WARNING: Do not open the cooling system while it is hot or engine is running.**

**CAUTION: The coolant must be recovered in a suitable, clean container for reuse. If the coolant is contaminated it must be recycled or disposed of correctly.**

**NOTE:** About 80% of the coolant capacity can be recovered with the engine in the vehicle. Dirty, rusty or contaminated coolant requires replacement.

1. Release the pressure in the cooling system by slowly turning the radiator cap (8100) one half to one turn counterclockwise to the first stop on the filler neck. When the pressure has been released, remove the radiator cap.
2. Place a suitable container below the radiator draincock (8115). Drain the coolant.
3. Close the radiator draincock when finished.

**Filling**

1. Install the radiator and reconnect all radiator hoses and transmission oil cooler lines (if equipped).
2. Fill the radiator through the radiator cap opening. Close the cap when full.
3. Fill the radiator coolant recovery reservoir to the cold fill line.
4. Run the engine until it reaches operating temperature.
5. Turn off the engine and allow the cooling system to cool. Release the pressure in the cooling system by slowly turning the radiator cap (8100) one half to one turn counterclockwise to the first stop on the filler neck. When the pressure has been released, remove the radiator cap. Add more coolant mixture (with the correct 50/50 ethylene glycol and water mixture) to the radiator until full.
6. Add more coolant mixture to the radiator coolant recovery reservoir until the level reaches the cold fill line.

7. Repeat Steps 2 through 6 as necessary.

**Bleeding**

1. Bleed the cooling system as follows:
   - Select the maximum heater temperature and blower motor speed settings. Position the control to discharge air from the A/C vents to the instrument panel (04320).
   - **WARNING: Do not stand in line with or near the engine cooling fan blade when revving the engine.**

     Start the engine and allow it to idle. While the engine is idling, feel for hot air from the A/C vents.
   - **CAUTION: If the air discharge remains cool and the engine coolant temperature gauge does not move, the engine coolant level is low in the engine and must be filled. Stop the engine, allow it to cool and fill the cooling system; refer to Cooling System Draining, Filling and Bleeding in this section.**

     Start the engine and allow it to idle until the normal operating temperature is reached. Hot air should discharge from the A/C vents. The engine coolant temperature gauge should maintain a stabilized reading in the middle of the NORMAL range and the upper radiator hose (8260) should feel hot to the touch.
   - Shut the engine off and allow it to cool.
   - Check the engine for coolant leaks.
   - Check the engine coolant level in the radiator coolant recovery reservoir and fill it as necessary.

**Cooling System, Cleaning**

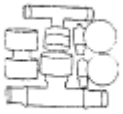
1. **CAUTION: Always remove the water thermostat (8575) prior to pressure flushing.**

   To remove the rust, sludge and other foreign material from the cooling system, use Premium Cooling System Flush F1AZ-19A503-A or equivalent meeting Ford specification ESR-M14P7-A that is safe for use with aluminum radiators.
   Cleaning restores cooling efficiency and helps prevent overheating. A pulsating or reversed direction of flushing water will loosen sediment more quickly than a steady flow in the normal coolant flow direction.
   In severe cases, cleaning solvents may not correctly clean the cooling system for efficient operation. It will be necessary to use the pressure flushing method, using Rotunda Flush Kit.

2. Dispose of old coolant and flushing water contaminated with antifreeze and cleaning chemicals in accordance with local, state and federal laws.

## Flushing —Engine and Radiator

**Special Tool(s)**

| | |
|---|---|
|  ST1168-A | Flush Kit<br>164-R3658 or equivalent |
|  ST1167-A | Drain Kit<br>164-R3662 or equivalent |

1. **WARNING: Do not open the cooling system while it is hot or while the engine is running.**

   Drain the cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.

2. Remove the water thermostat.

3. Install the water thermostat housing (8A587) without the water thermostat.

4. **NOTE:** Refer to the cooling system Flush-All Operating Instructions for specific vehicle hook-up.

   Use cooling system Flush-All, Flush Kit Hardware Package and Drain Kit to flush the engine and radiator.
   Use Ford Premium Cooling System Flush F1AZ-19A503-A or equivalent meeting Ford specification ESR-M14P7A.

5. Install the water thermostat.

6. Backflush the heater core (18476) if necessary. For additional information, refer to Flushing—Heater Core in this section.

7. Fill the cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.

## Flushing —Heater Core

1. **WARNING: Do not open the cooling system while it is hot or while the engine is running.**

   Partially drain the cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.

2. **NOTE:** Refer to the cooling system Flush-All Operating Instructions for particular vehicle hook-up.

   Use cooling system Flush-All, Flush Kit Hardware Package and Drain Kit to back flush the heater core. Use Premium Cooling System Flush F1AZ-19A503-A or equivalent meeting Ford specification ESR-M14P7A.

3. Fill the cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.

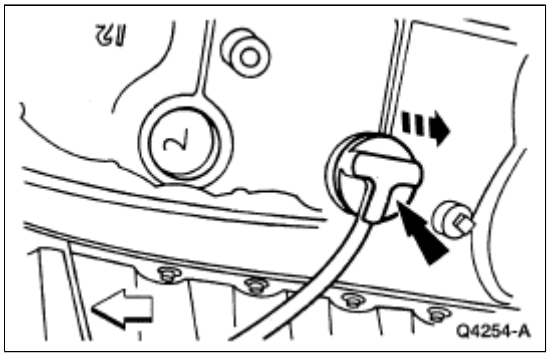
## Block Heater

### Removal

1. Drain the cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.

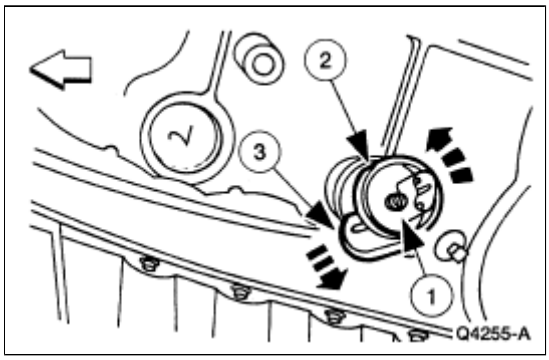
2. Raise and support the vehicle. For additional information, refer to Section 100-02 .

3. Disconnect the connector.



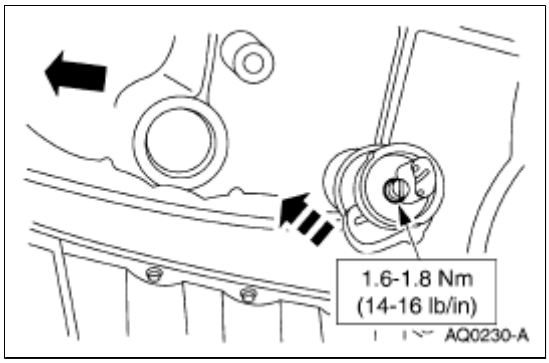

4. Remove the block heater (6A051).
    1. **NOTE:** Do not loosen the screw more than necessary for removal.

       Loosen the screw.
    2. Twist and slide the block heater to release the retainer clip and discard the retainer clip.
    3. Remove the block heater.




### Installation

1. To install, reverse the removal procedure.

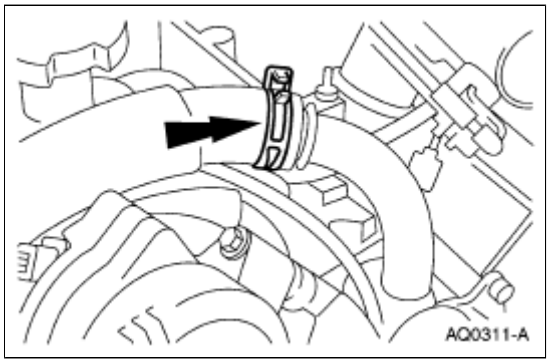

1.6-1.8 Nm
(14-16 lb/in)
AQ0230-A

## Thermostat —4.0L (Push Rod)

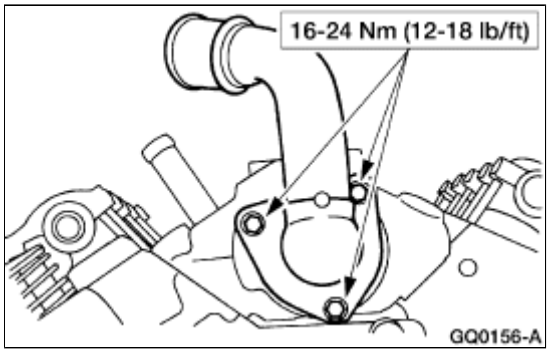
### Removal and Installation

1. Drain the cooling system. For additional information, refer to the Cooling System Draining, Filling and Bleeding in this section.

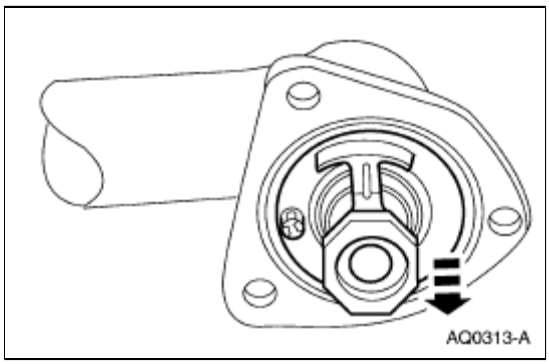
2. Disconnect the upper radiator hose.




3. Remove the thermostat housing.




4. Remove the thermostat and gasket assembly.
   - Clean and inspect the mating surfaces.



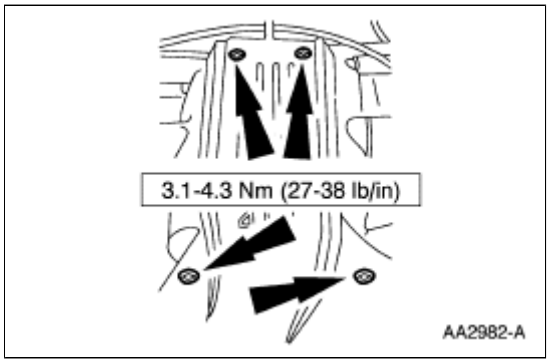
5. To install, reverse the removal procedure.

## Thermostat —4.0L SOHC

### Removal and Installation

1. Partially drain the cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.

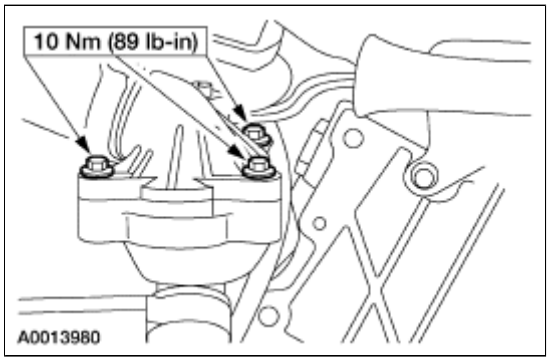
2. Remove the bolts and the accelerator control splash shield.




3. Remove the air cleaner outlet tube. For additional information, refer to Section 303-12 .

4. Remove the upper radiator hose.

5. Remove the bolts, water outlet adapter and thermostat.
   - Inspect the O-ring seal. Install a new O-ring seal if necessary.




6. To install, reverse the removal procedure.

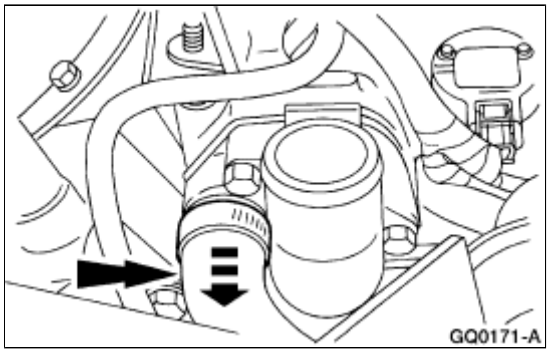
## Thermostat —5.0L

### Removal

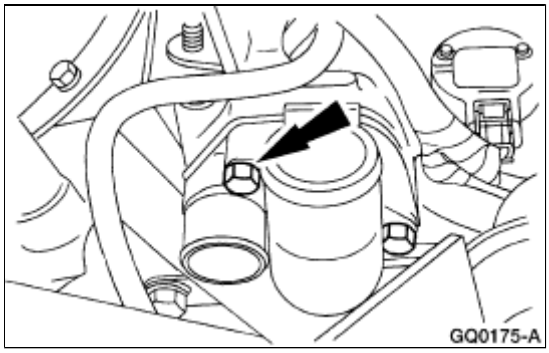
1. Partially drain the cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.

2. Remove the upper radiator hose (8260).

3. Position the hose clamp back and remove the water bypass hose from the water hose connection.

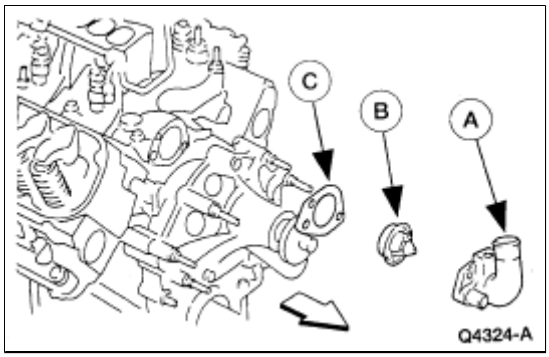



4. Remove the two bolts from the water hose connection (8592).




5. **CAUTION: Do not pry on the water hose connection to remove.**

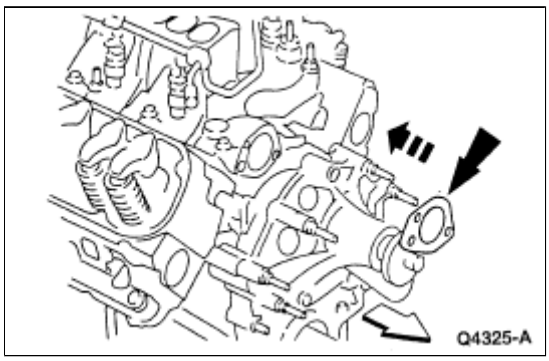
   Remove the (A) water hose connection, the (B) water thermostat (8575) and the (C) thermostat gasket.
   - Clean and inspect the mating surfaces.



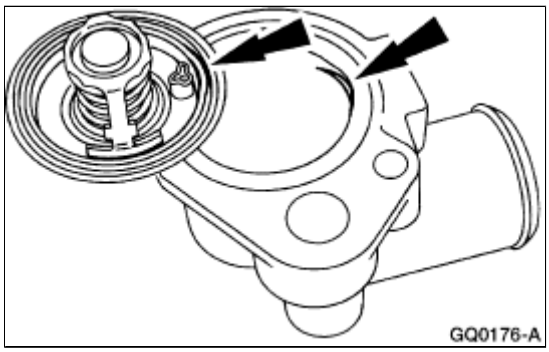

**Installation**

1. **NOTE:** Coat the new thermostat gasket with Gasket and Trim Adhesive F3AZ-19B508-AA or equivalent prior to installation.

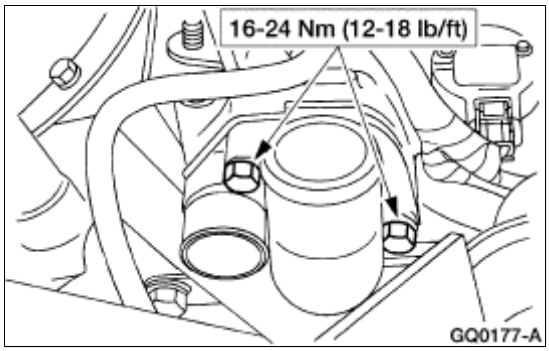
   Install the new thermostat gasket.



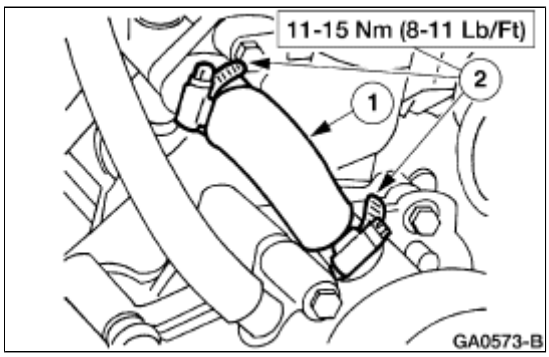

2. Install the water thermostat into the water hose connection.
   - Align the notch in the thermostat with the notch in the water hose connection.




3. Install the water hose connection.




4. Install the water bypass tube (8548).
    1. Position the water bypass tube and hose clamps.
    2. Tighten the hose clamps.



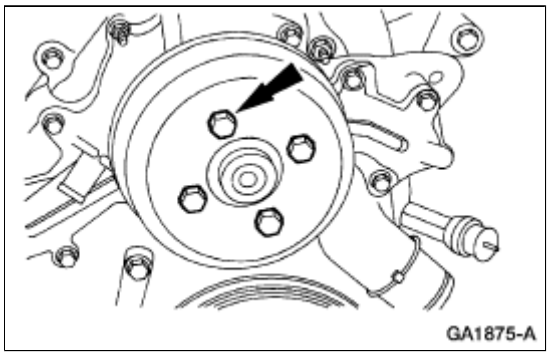

5. Install the upper radiator hose.

6. Fill the cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.

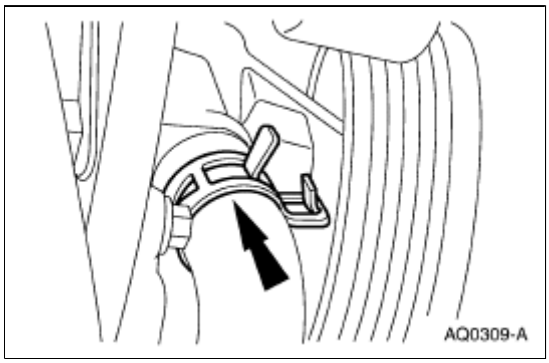
## Water Pump —4.0L (Push Rod)

### Removal

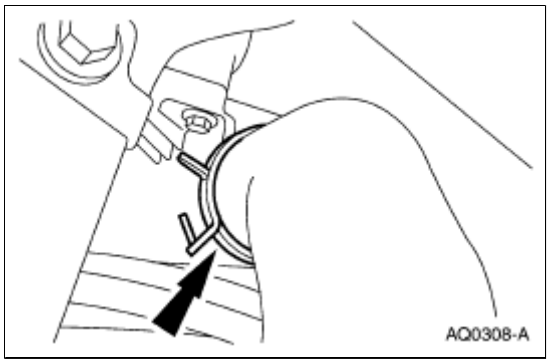
1. Drain the engine cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.
2. Remove the fan shroud. For additional information, refer to Shroud—Fan in this section.
3. Remove the accessory drive belt. For additional information, refer to Section 303-05 .
4. Remove the water pump pulley.



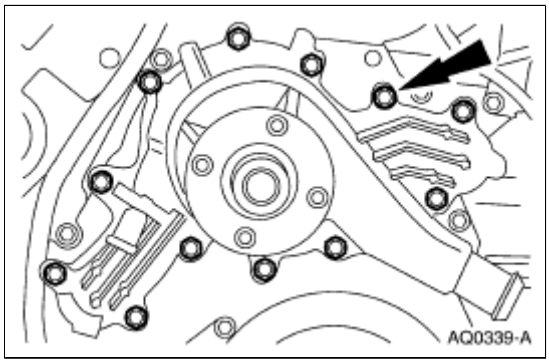

5. Disconnect the heater water hose (18472) at the water pump.



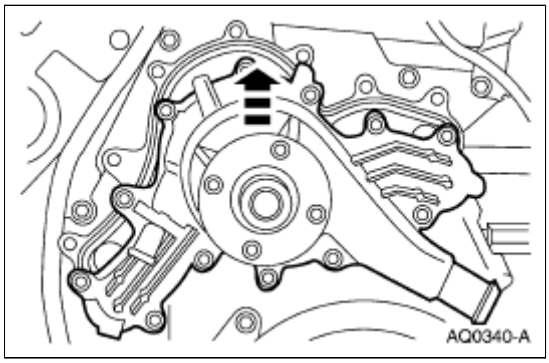

6. Disconnect the lower radiator hose (8286) at the water pump.




7. Remove the bolts.




8. Remove the water pump.

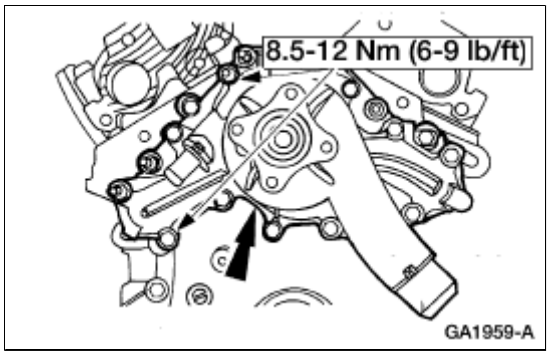



9. **CAUTION: Use care when scraping the water pump-to-engine block mating surfaces. Gouges in the aluminum could form leak paths.**

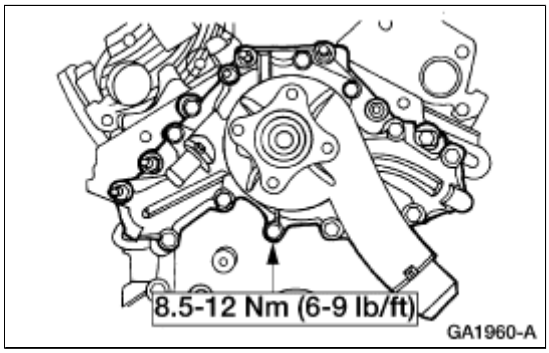
   Clean all the sealing surfaces.

**Installation**

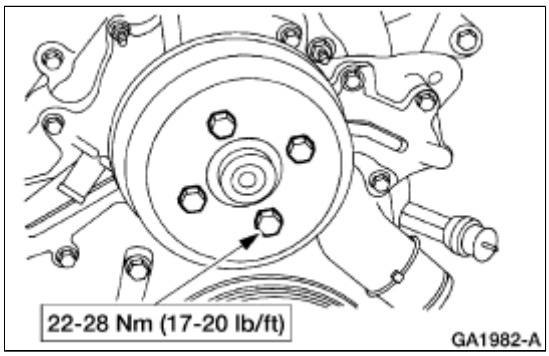
1. Position the water pump and install the two stud bolts.



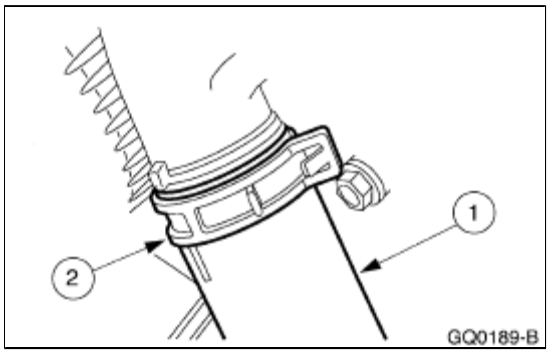

2. Install the water pump bolts.



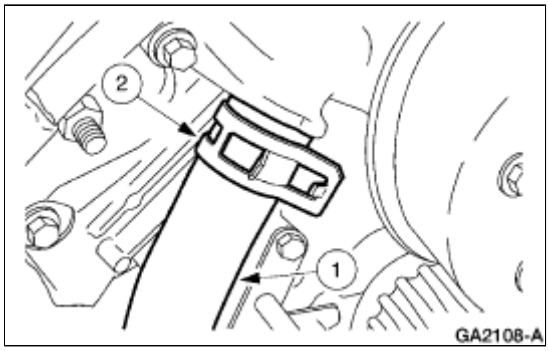

3. Install the water pump pulley.




4. Connect the lower radiator hose to the water pump.
    1. Position the hose.
    2. Install the clamp.



5. Connect the heater hose to the water pump.
    1. Position the hose.
    2. Install the clamp.




6. Install the accessory drive belt. For additional information, refer to Section 303-05 .

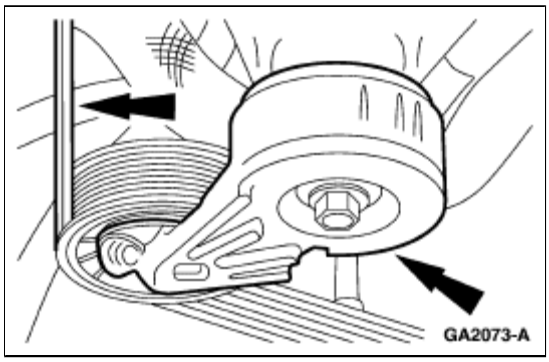
7. Install the fan shroud. For additional information, refer to Shroud—Fan in this section.

8. Fill the cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.

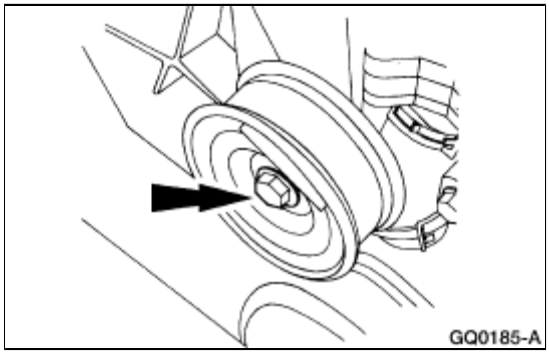
## Water Pump —4.0L SOHC

### Removal

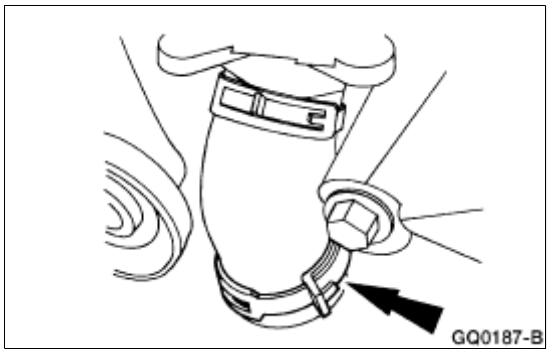
1. Remove the fan shroud. For additional information, refer to Shroud—Fan in this section.
2. Remove the fan and clutch assembly. For additional information, refer to Fan—Blade in this section.
3. Drain the engine cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.
4. Lift the accessory drive belt tensioner and remove the accessory drive belt.



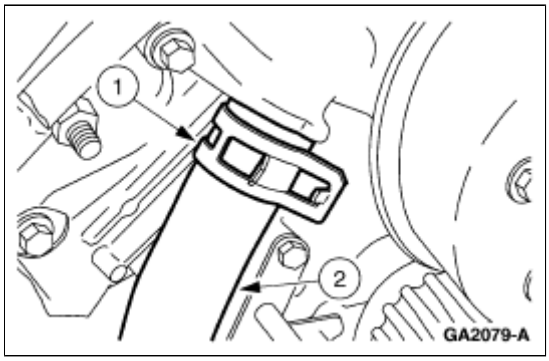

5. Remove the belt idler pulley.



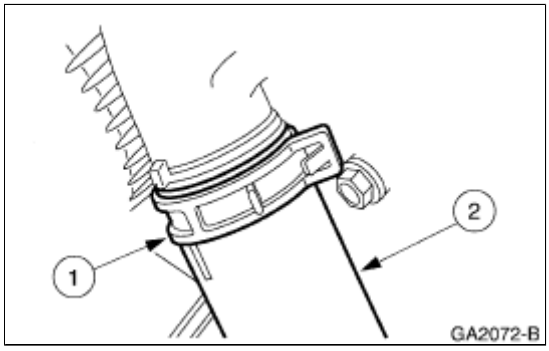

6. Slide the water bypass hose clamp back.



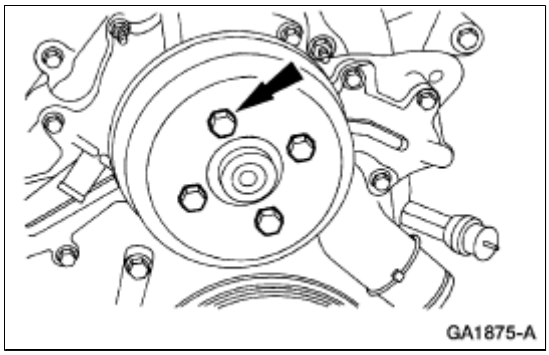

7. Disconnect the heater hose at the water pump.
    1. Release the clamp.
    2. Remove the hose.



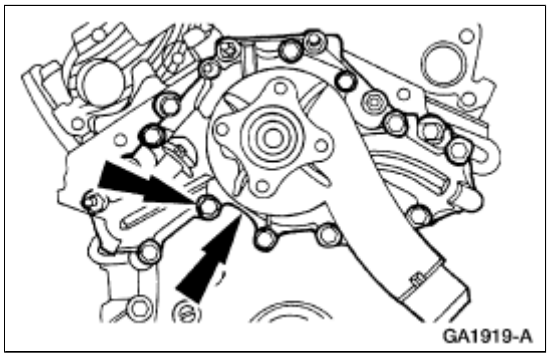

8. Disconnect the lower radiator hose at the water pump.
    1. Release the clamp.
    2. Remove the hose.




9. Remove the water pump pulley.



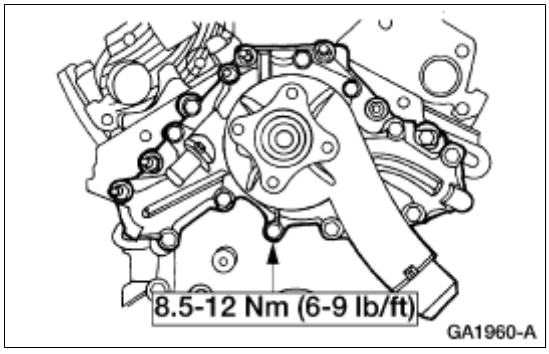

10. Remove the water pump.



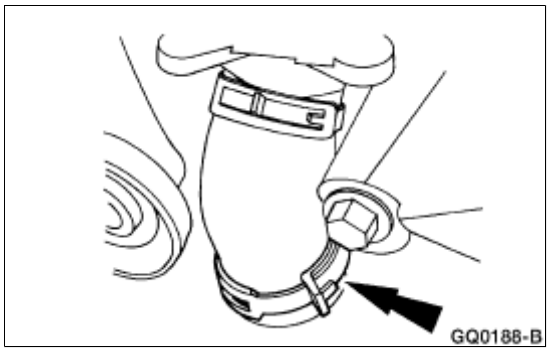

**Installation**

1. **NOTE:** Use Metal Surface Cleaner F4AZ-19A536-RA or equivalent meeting Ford specification WSE-M5B392-A and a suitable plastic or wooden scraper to clean the sealing surfaces.

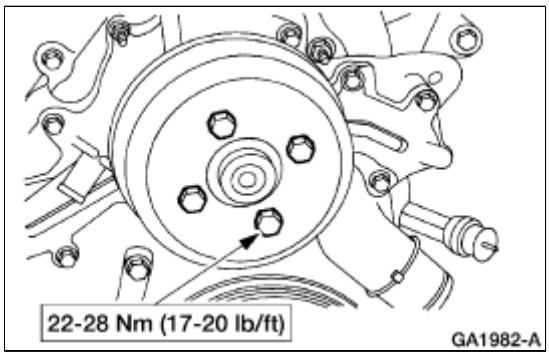
   Install the water pump.



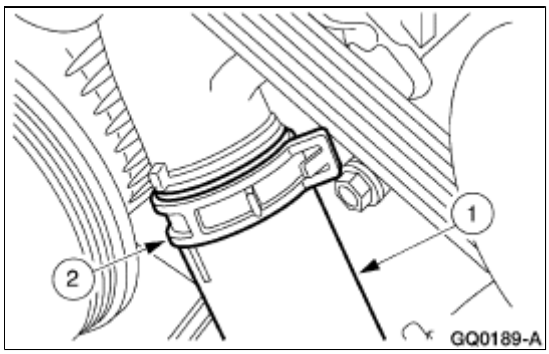

2. Connect the water bypass hose and position the clamp.



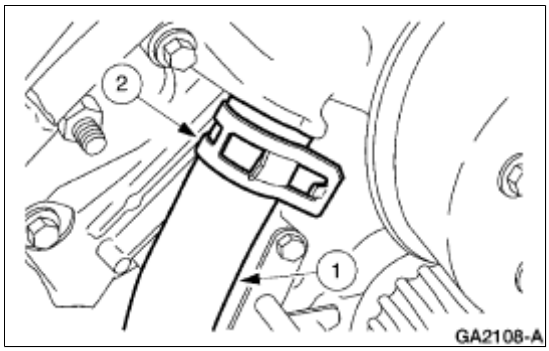

3. Install the water pump pulley.



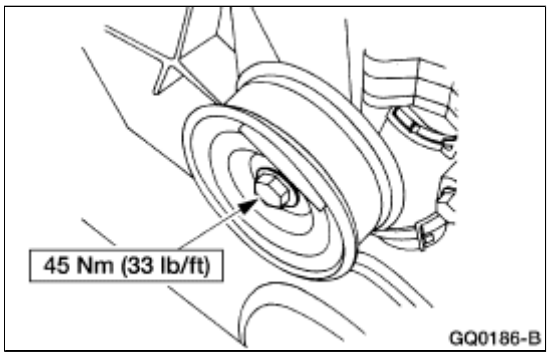

4. Connect the lower radiator hose to the water pump.
    1. Position the hose.
    2. Install the clamp.



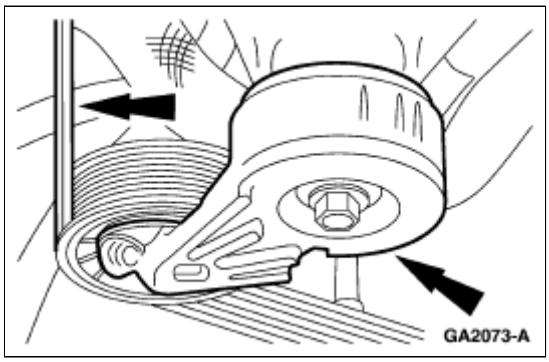

5. Connect the heater hose to the water pump.
    1. Position the hose.
    2. Install the clamp.




6. Install the belt idler pulley.




7. Lift the accessory drive belt tensioner and install the drive belt.




8. Install the fan and clutch assembly. For additional information, refer to Fan—Blade in this section.
9. Install the fan shroud. For additional information, refer to Shroud—Fan in this section.
10. Fill and bleed the engine cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.

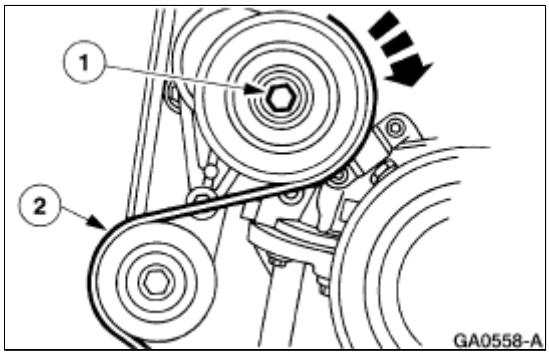
## Water Pump —5.0L

### Removal

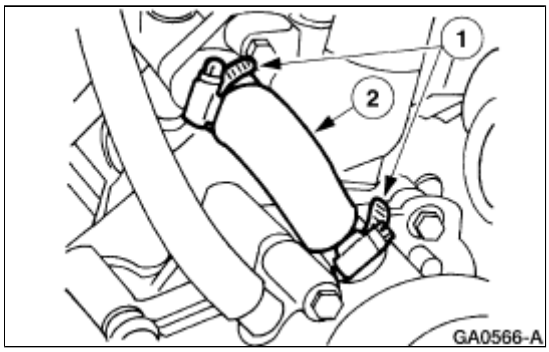
1. Remove the fan shroud. For additional information, refer to Shroud—Fan in this section.

2. Drain the cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.

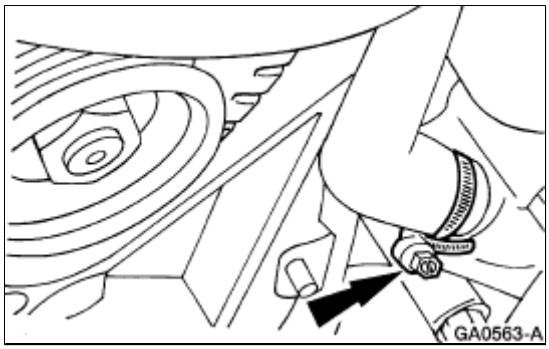
3. Remove the accessory drive belt.
    1. Turn the tensioner pulley clockwise.
    2. Remove the accessory drive belt.



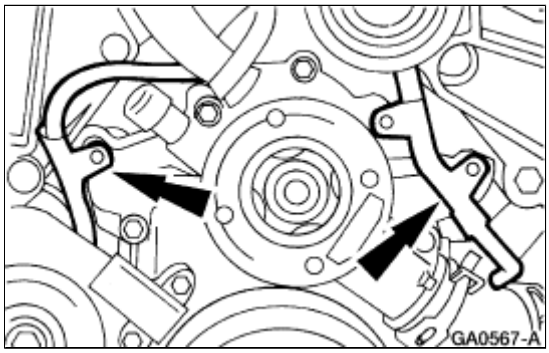

4. Remove the water bypass hose (8597).
    1. Loosen the water bypass hose clamps.
    2. Remove the water bypass tube (8548).



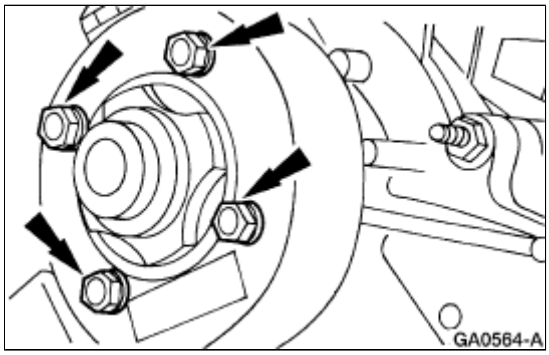

5. Loosen the water heater hose clamp and disconnect the water heater hose from the water pump (8501).



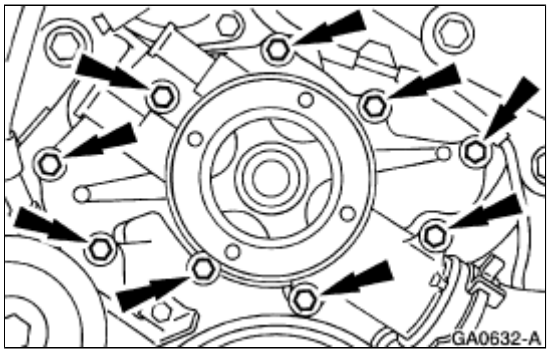

6. Position the engine control sensor wiring aside.



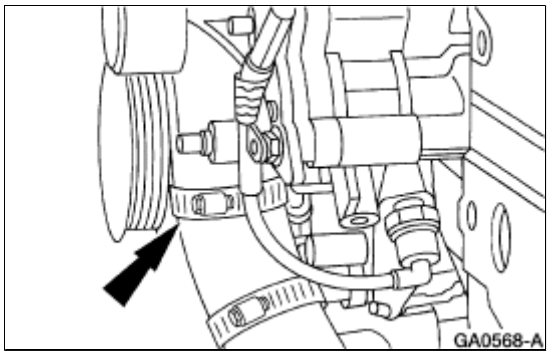

7. Remove the bolts and the water pump pulley.




8. Remove the bolts and remove the water pump from the engine front cover (6019).



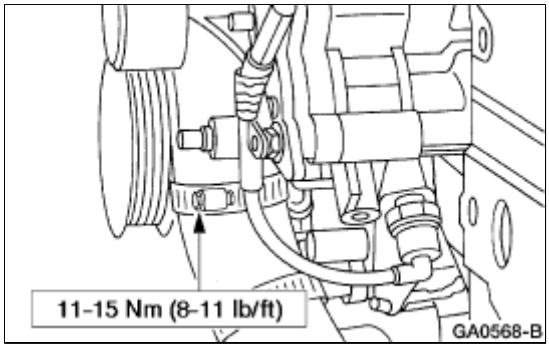

9. Loosen the water pump inlet hose clamp and remove the water pump.



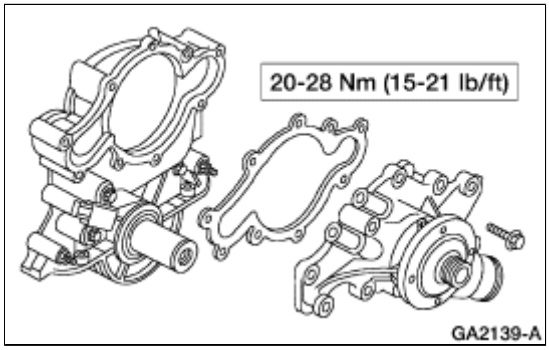

**Installation**

1. Use Metal Surface Cleaner F4AZ-19A536-RA or equivalent meeting Ford specification WSE-M5B392-A and a suitable plastic or wooden scraper to clean the gasket surfaces of the engine front cover and water pump.

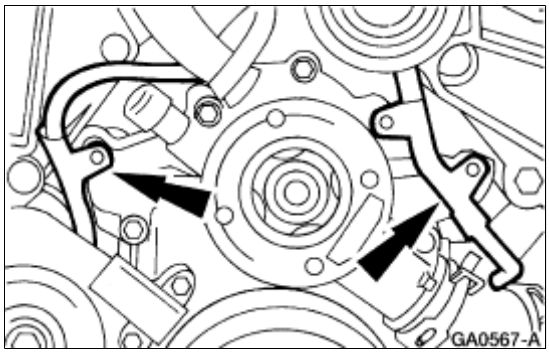
2. Install the water pump inlet hose on the water pump.



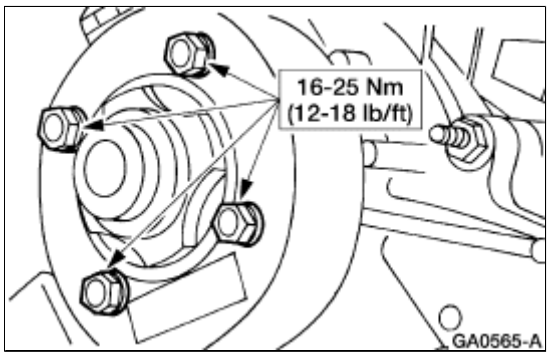

3. Position the water pump and install the bolts.



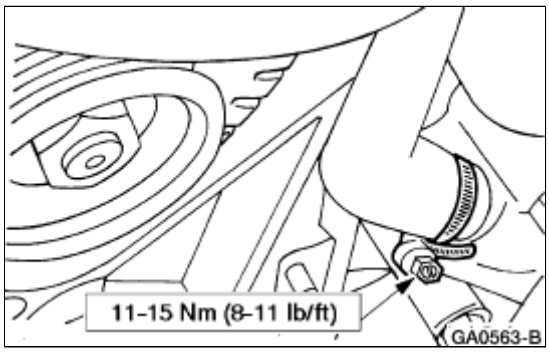

4. Position the engine control sensor wiring.



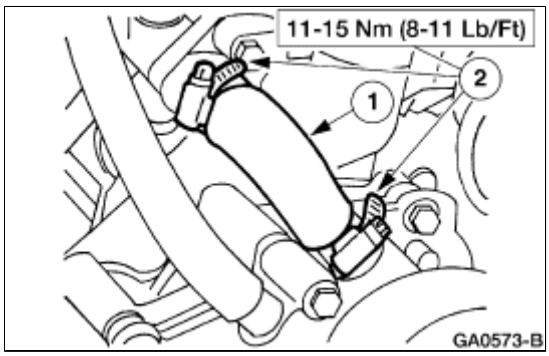

5. Install the water pump pulley.



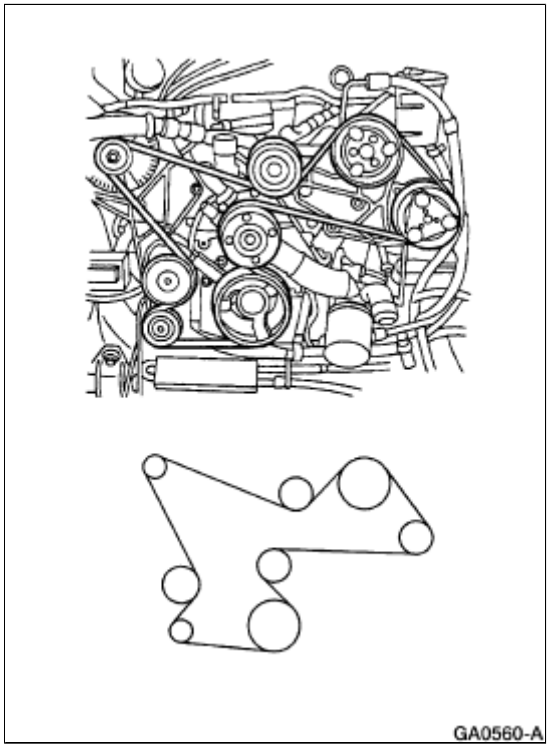

6. Install the water heater hose and clamp.



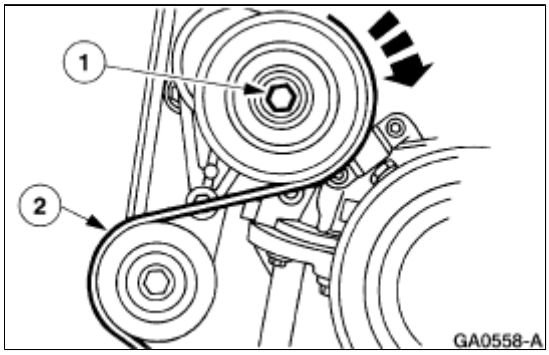

7. Install the water bypass tube.
    1. Position the water bypass tube.
    2. Install the two water bypass hose clamps.



8. Position the accessory drive belt.




9. Install the accessory drive belt.
    1. Turn the tensioner clockwise.
    2. Install the belt.




10. Install the fan shroud. For additional information, refer to Shroud—Fan in this section.

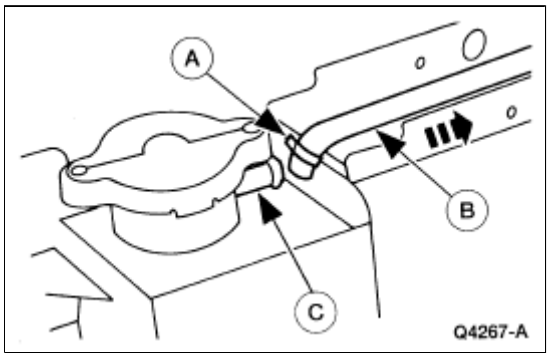
11. Fill the cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.

12. Start the engine and check for leaks.

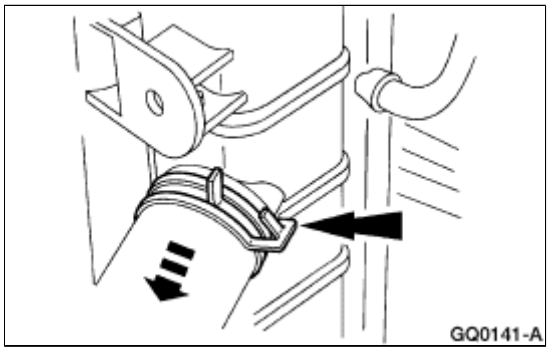
## Radiator —4.0L

### Removal

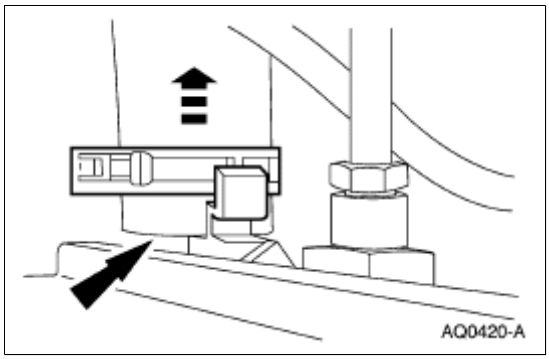
1. Drain the cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.
2. Remove the air cleaner outlet tube (9B659). For additional information, refer to Section 303-12 .
3. Position the (A) overflow tube clamp back and disconnect the (B) radiator overflow tube from the (C) radiator filler neck.




4. Remove the fan shroud. For additional information, refer to Shroud—Fan in this section.
5. Position the hose clamp back and disconnect the upper radiator hose from the radiator.

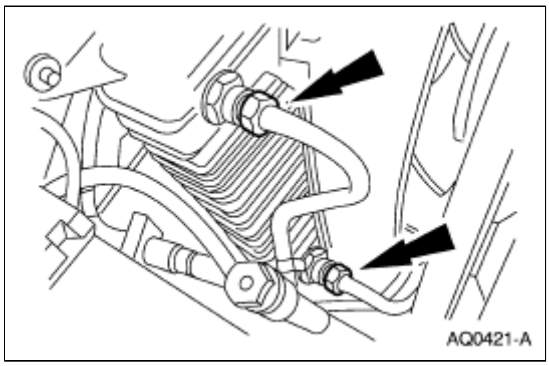



6. Position the hose clamp back and disconnect the lower radiator hose.

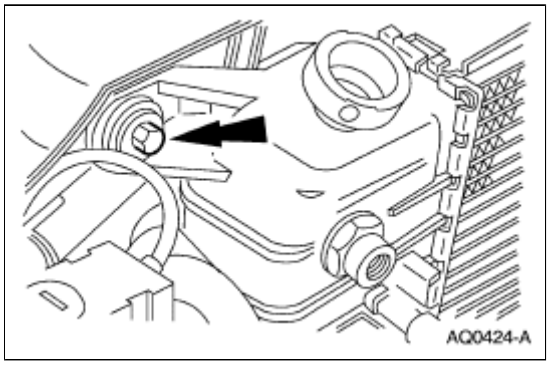



7. **NOTE:** To avoid disturbing the transmission oil cooler fittings, use a backup wrench.

   Disconnect the two transmission cooling lines, if equipped.



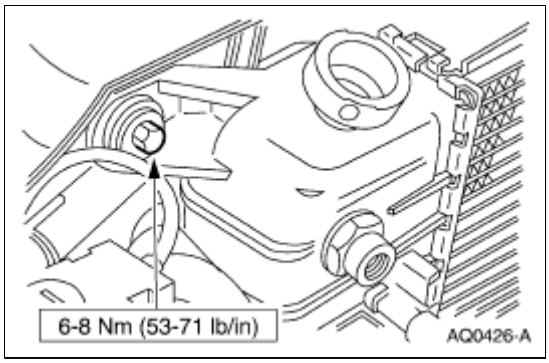

8. Remove the two bolts.




9. Lift the radiator up and remove from the vehicle.

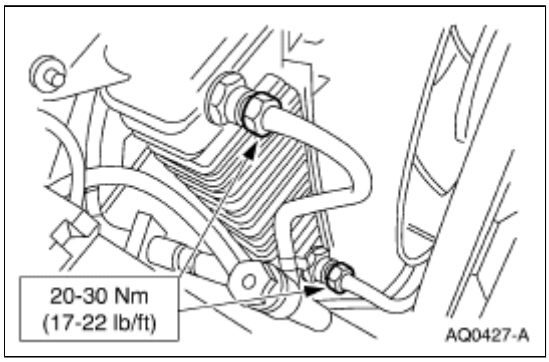
**Installation**

1. Position the radiator onto the lower radiator support rubber insulators and install the two bolts.

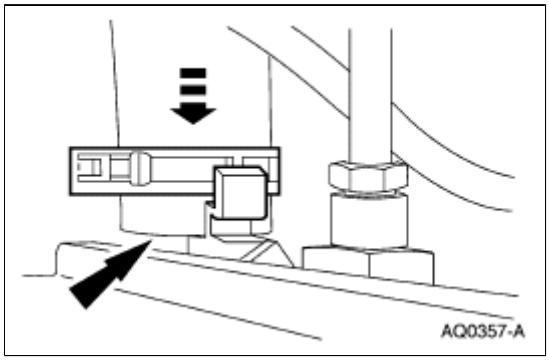



2. **NOTE:** To avoid disturbing the transmission oil cooler fittings, use a backup wrench.

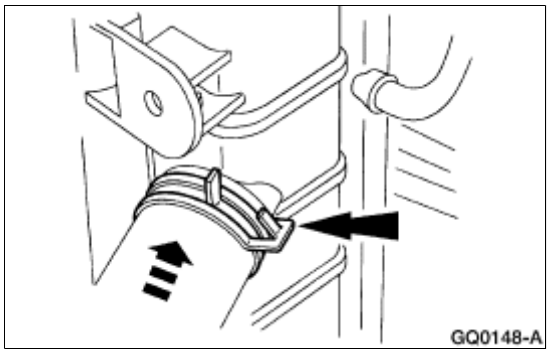
   Connect the transmission cooler lines, if equipped.
   - Make sure the transmission fluid is at the correct level.




3. Position the lower radiator hose and slide the clamp forward.

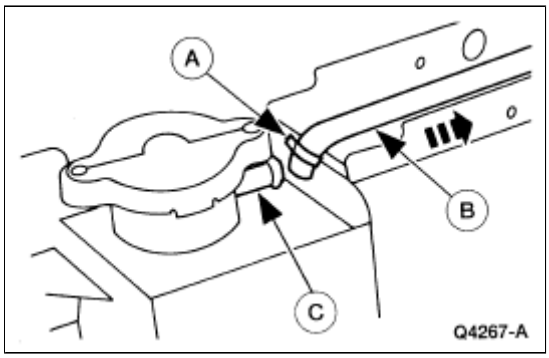



4. Position the upper radiator hose and slide the clamp forward.




5. Install the fan shroud. For additional information, refer to Shroud—Fan in this section.

6. Connect the (B) radiator overflow hose to the (C) radiator filler neck and position the (A) clamp.



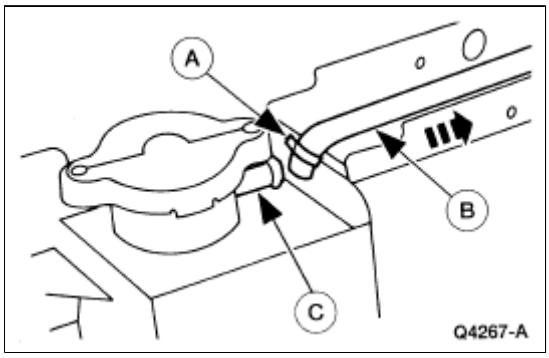

7. Install the engine air cleaner outlet tube. For additional information, refer to Section 303-12 .

8. Fill the cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.

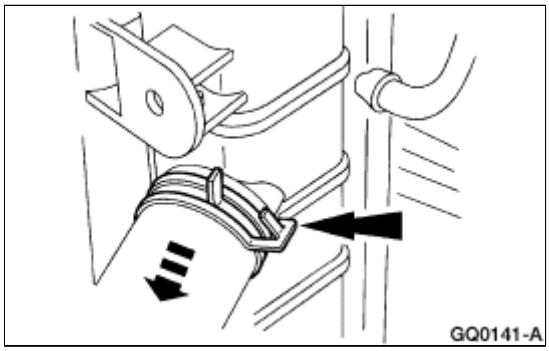
## Radiator —5.0L

### Removal

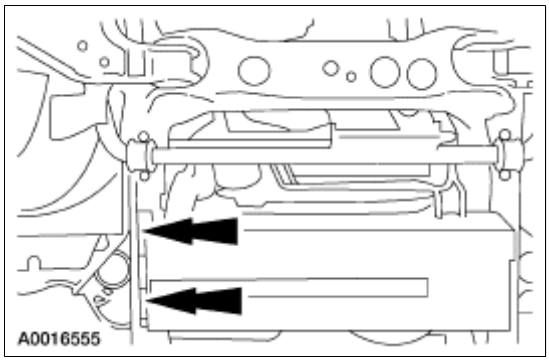
1. Remove the air cleaner outlet tube (9B659). For additional information, refer to Section 303-12 .
2. Drain the cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.
3. Position the (A) overflow tube clamp back and disconnect the (B) radiator overflow tube from the (C) radiator filler neck.



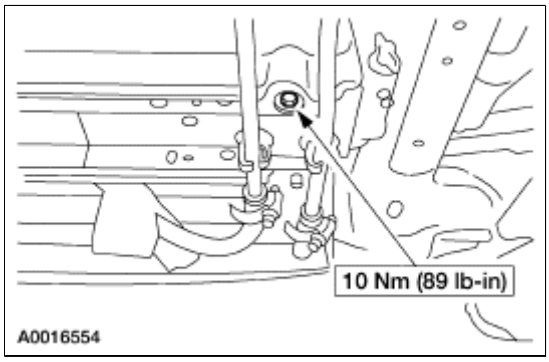

4. Remove the fan shroud. For additional information, refer to Shroud—Fan in this section.
5. Position the hose clamp back and disconnect the upper radiator hose from the radiator.



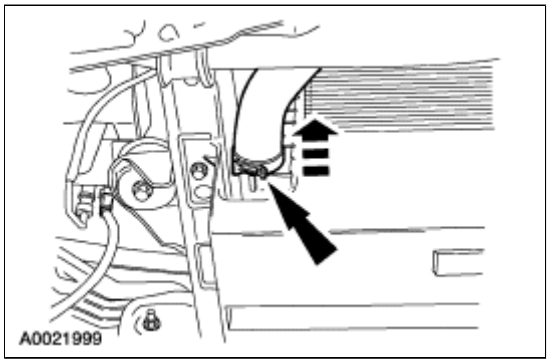

6. Raise and support the vehicle. For additional information, refer to Section 100-02 .
7. Remove the air deflector.




8. Remove the bolt.



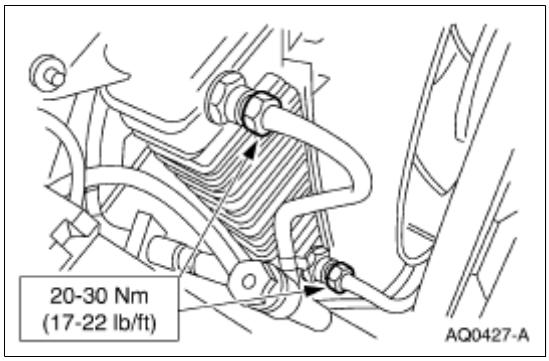

9. Position the hose clamp back and disconnect the lower radiator hose.



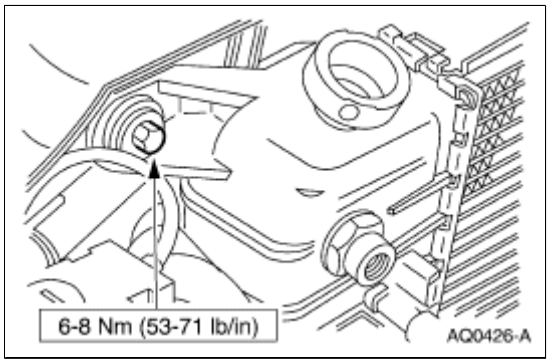

10. Lower the vehicle.

11. **NOTE:** To avoid disturbing the transmission oil cooler fittings, use a backup wrench.

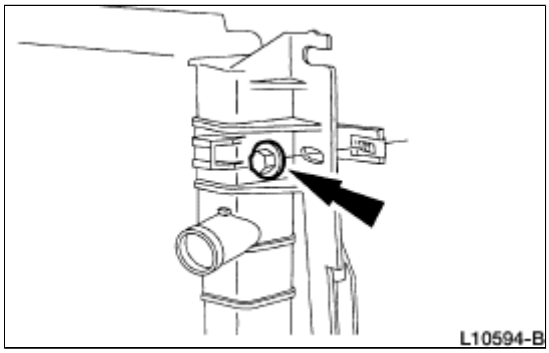
    Disconnect the two transmission cooling lines.



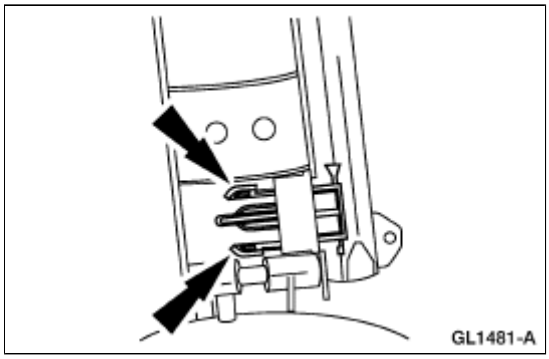

12. Remove the bolts.



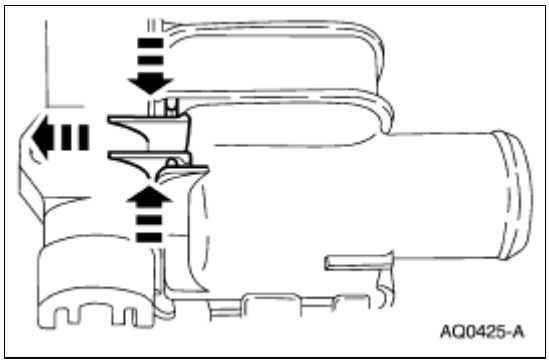

13. Remove the bolt.



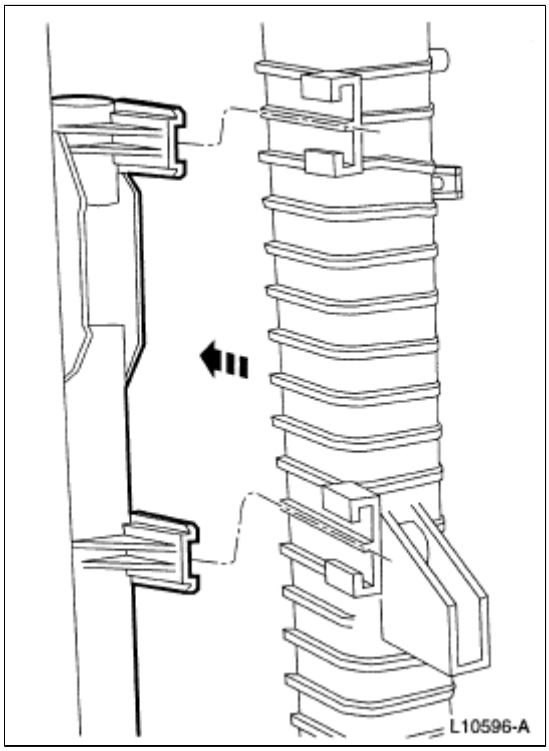

14. Squeeze to release the buckle.




15. Squeeze to release the anti rattle clip.




16. Slide the A/C condenser out of the locators.



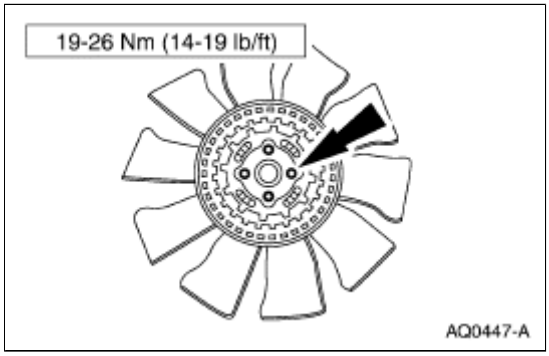

17. Lift the radiator up and remove from the vehicle.

18. To install, reverse the removal procedure.

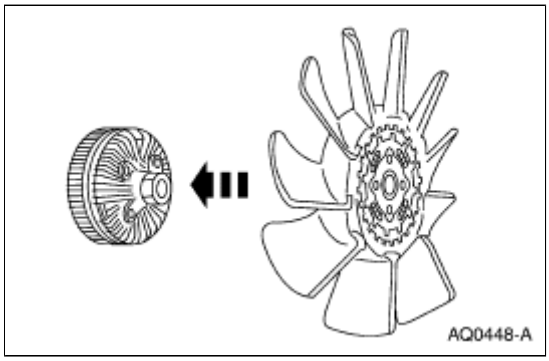
## Fan —Blade

### Removal and Installation

1. Remove fan shroud. For additional information, refer to Shroud—Fan in this section.
2. Remove the bolts.




3. Separate the fan blade from the fan clutch.




4. To install, reverse the removal procedure.

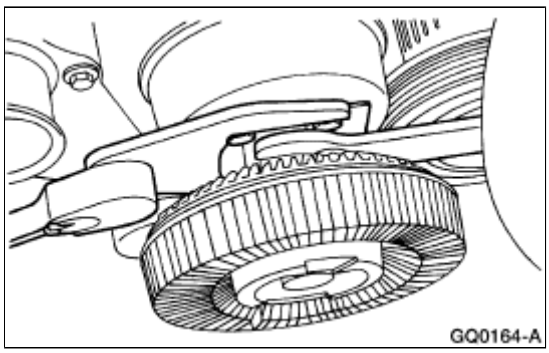
## Shroud —Fan

**Special Tool(s)**

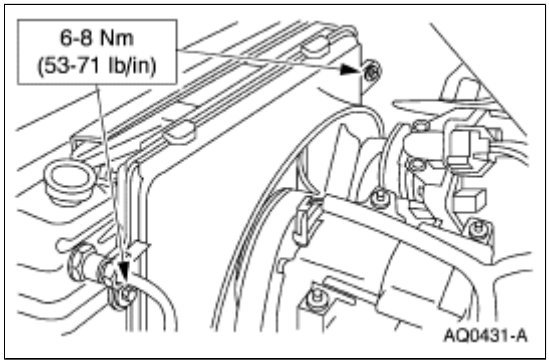
| | |
|---|---|
|  ST1828-A | Fan Pulley Holding Wrench (3.0L, 4.0L)<br>303-239 (T84T-6312-C) |
|  | Fan Clutch Nut Wrench (3.0L, 4.0L)<br>303-240 (T84T-6312-D) |
|  ST1128-A | Fan Clutch Wrench (5.0L)<br>303-558 (T96T-6312-A) |
|  ST1129-A | Fan Hub Wrench (5.0L)<br>303-559 (T96T-6312-B) |

**Removal and Installation**

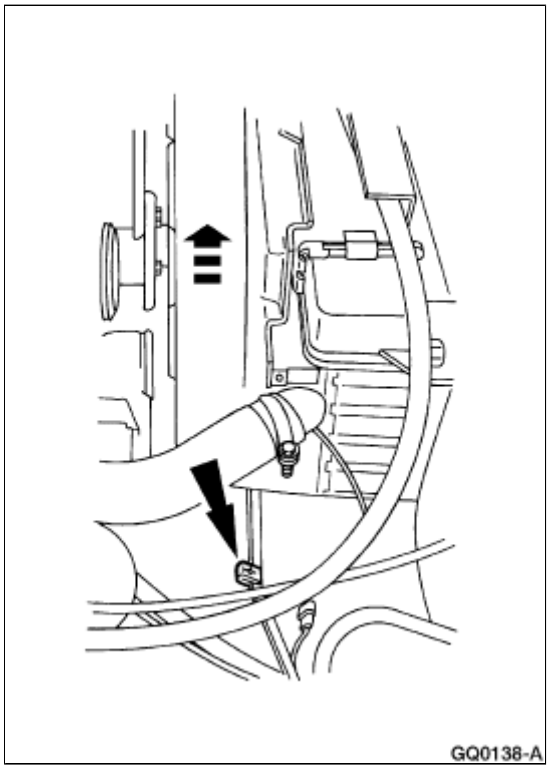
1. Remove the air cleaner outlet tube (9B659). For additional information, refer to Section 303-12 .
2. Use the Fan Clutch Wrench and the Fan Hub Wrench to loosen and remove the fan blade.


GQ0164-A

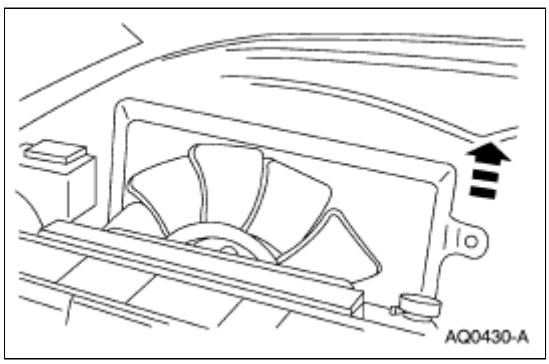
3. Remove the bolts.




4. Lift the fan shroud out of the lower retaining clips.




5. Lift the fan shroud and the fan blade and clutch assembly together and remove from the vehicle.



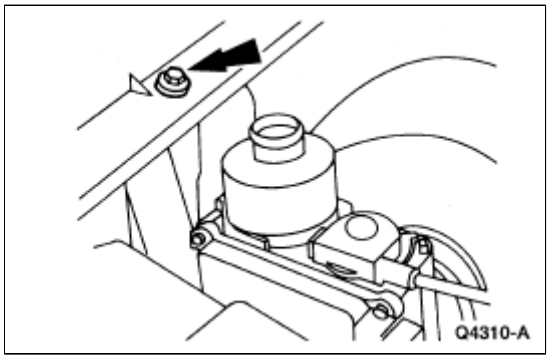
6. To install, reverse the removal procedure.

## Coolant Recovery Reservoir

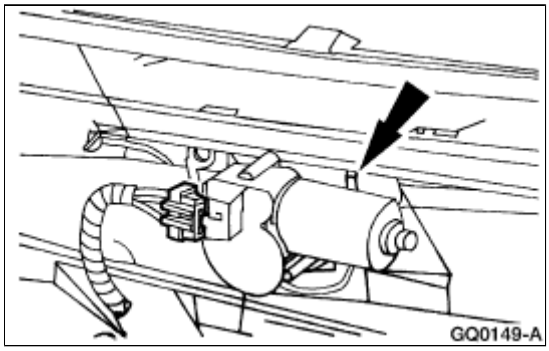
### Removal

1. Remove the air cleaner outlet tube (9B659) and the engine air cleaner (ACL) (9600). For additional information, refer to Section 303-12 .

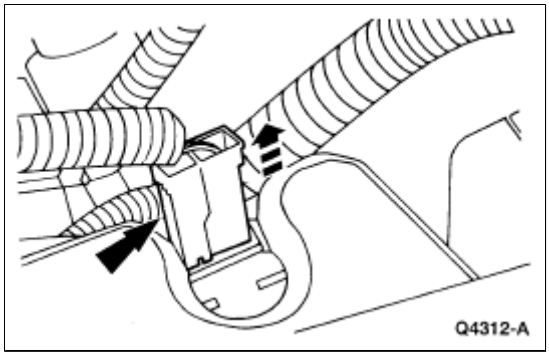
2. Remove the bolt and position the speed control servo aside.




3. Disconnect the windshield washer hose from under the dash panel and plug the end of the hose.

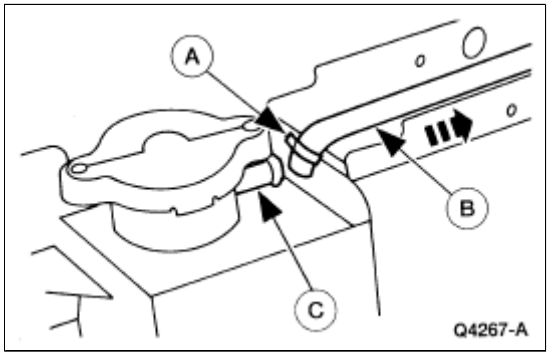



4. Disconnect the windshield washer pump electrical connector from the windshield washer reservoir (17618).

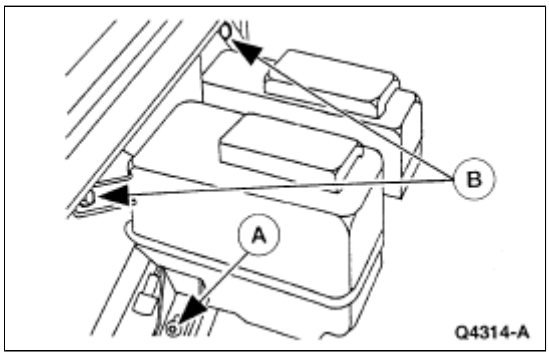



5. Position the (A) clamp back and disconnect the (B) radiator overflow hose (8075) from the (C)

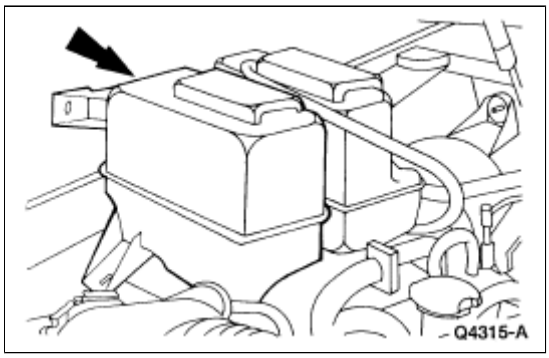
radiator filler neck and plug the hose.




6. Remove the (A) two nuts and the (B) bolts.

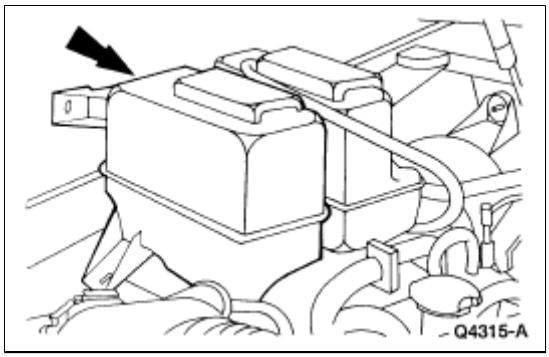



7. Remove the radiator coolant recovery reservoir (8A080) and the windshield washer reservoir.

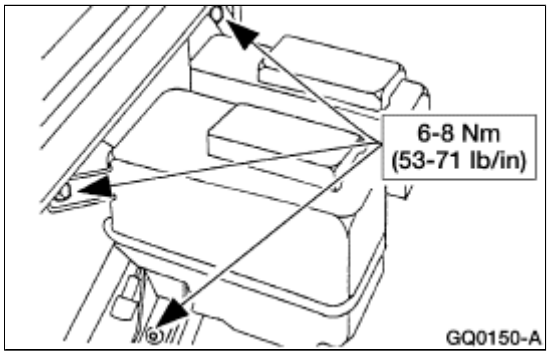



**Installation**

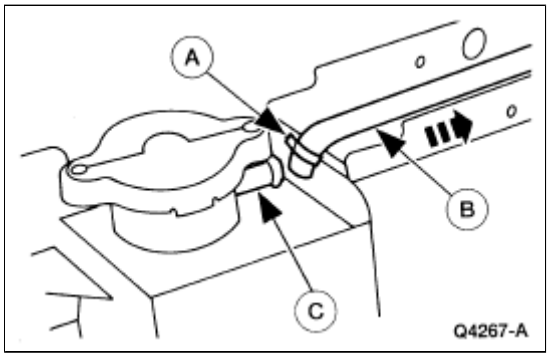
1. Install the radiator coolant recovery reservoir and the windshield washer reservoir.



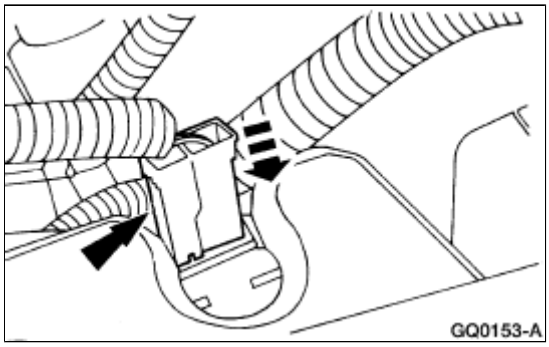

2. Install the bolts and the two nuts.



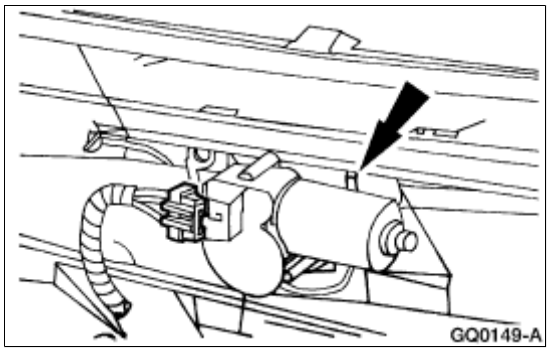

3. Connect the (B) radiator overflow hose to the (C) radiator filler neck and position the (A) clamp.



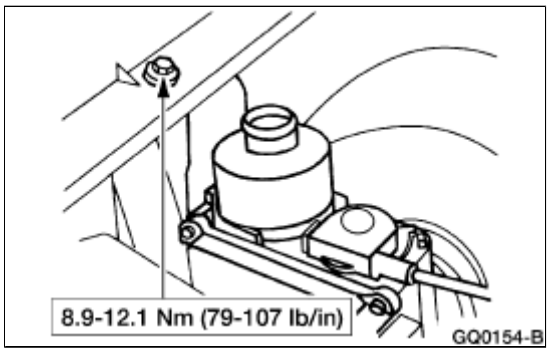

4. Connect the windshield washer pump electrical connector to the windshield washer reservoir.




5. Connect the windshield washer hose under the dash panel.




6. Position the speed control servo and bracket and install the bolt.



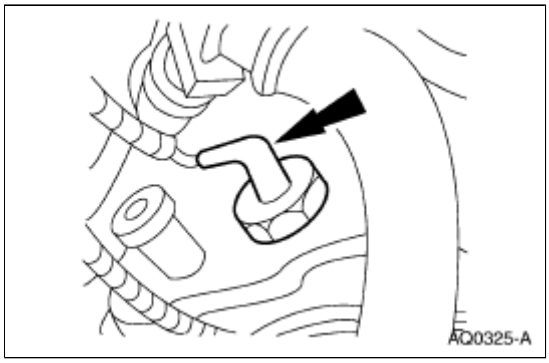

7. Install the engine air cleaner (ACL) and the air cleaner outlet tube. For additional information, refer to Section 303-12 .

8. Fill the cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.

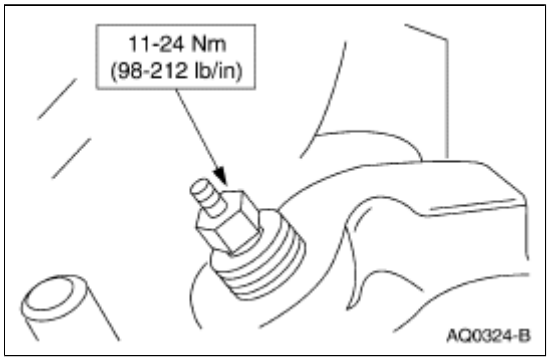
## Sender Unit —Water Temperature Indicator, 4.0L (Push Rod), 5.0L

### Removal and Installation

1. Disconnect the battery ground cable (14301). For additional information, refer to Section 414-01 .
2. Drain the cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.
3. Disconnect the water temperature sending wire.




4. Remove the water temperature indicator sender unit (10884).

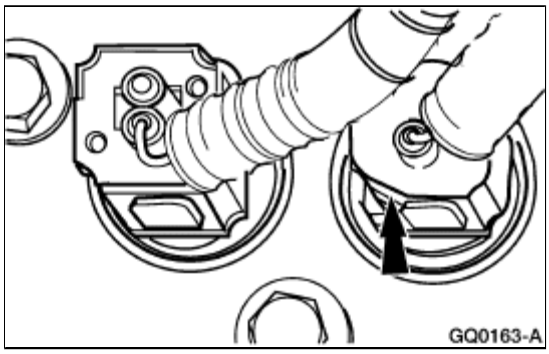



5. To install, reverse the removal procedure.

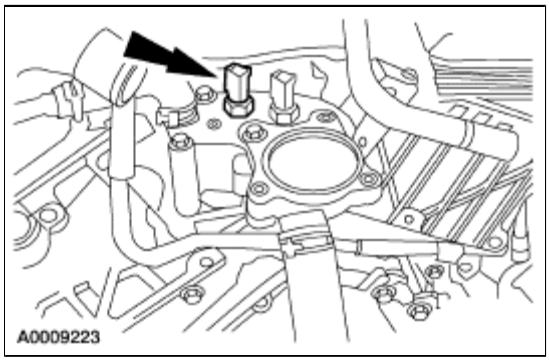
## Sender Unit —Water Temperature Indicator, 4.0L SOHC

### Removal and Installation

1. Disconnect the battery ground cable (14301). For additional information, refer to Section 414-01 .
2. Partially drain the cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.
3. Remove the upper intake manifold; refer to Section 303-01B .
4. Disconnect the electrical connector.




5. Remove the water temperature indicator sending unit.




6. To install, reverse the removal procedure.

**General Specifications**

| Item | Specification |
|---|---|
| Super Premium SAE 5W-30 Motor Oil<br><br>XO-5W30-QSP | Ford specification WSS-M2C153-G |

**Torque Specifications**

| Description | Nm | lb-ft | lb-in |
|---|---|---|---|
| Fuel damper bolts | 9 | — | 80 |
| Fuel line to damper | 20 | 15 | — |
| Fuel supply manifold stud bolts | 15 | 11 | — |
| Throttle body bolts | 10 | — | 89 |
| Engine bulkhead connector bolt | 6 | — | 53 |
| PCM connector bolt | 6 | — | 53 |

## Fuel Charging and Controls

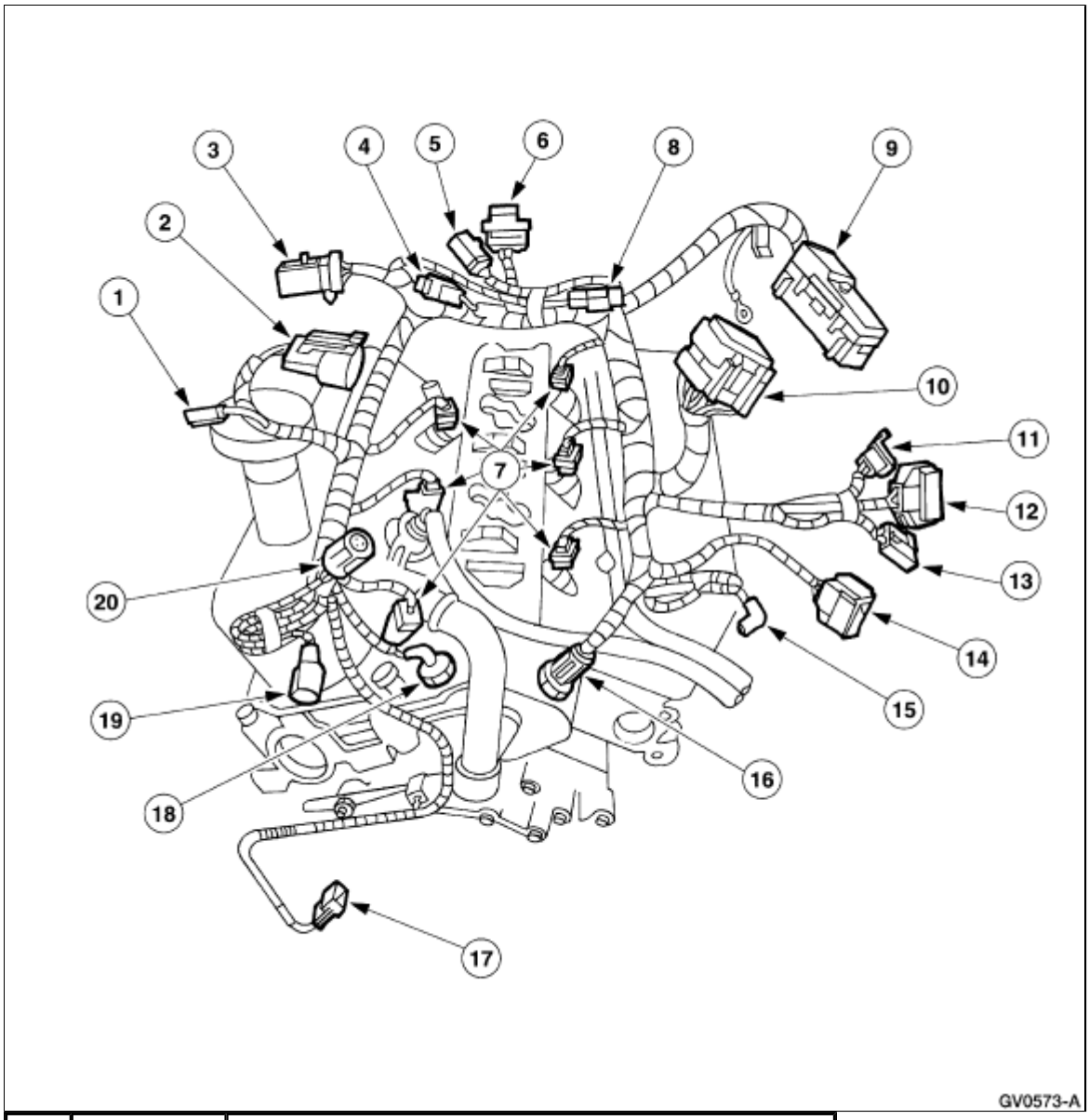
The fuel charging and controls system consists of the:

- throttle body.
- fuel injectors.
- fuel charging wiring.
- fuel injection supply manifold.
- fuel damper.
- fuel pressure relief valve.

The fuel charging and controls system is:

- a sequential, multiport fuel injection (SFI) system.
- pulse-width modulated.
- mass air flow controlled.

**Fuel Charging Wiring Harness**




| Item | Part Number | Description |
|---|---|---|
| 1 | — | Radio ignition interference capacitor electrical connector |
| 2 | — | Ignition coil electrical connector |
| 3 | — | LH transmission harness electrical connector |
| 4 | — | RH heated oxygen (HO2S) sensor electrical connector |
| 5 | — | RH transmission harness electrical connector |
| 6 | — | Camshaft position (CMP) sensor electrical connector |
| 7 | — | Fuel injector electrical connectors. |
| 8 | — | LH HO2S electrical connector |
| 9 | — | Powertrain control module (PCM) electrical connector |
| 10 | — | Engine bulkhead electrical connector |

| | | |
|---|---|---|
| 11 | — | Idle air control (IAC) solenoid electrical connector |
| 12 | — | EGR pressure transducer electrical connector |
| 13 | — | EGR vacuum regulator (EVR) electrical connector |
| 14 | — | Throttle position (TP) sensor electrical connector |
| 15 | — | Oil pressure sending unit electrical connector |
| 16 | — | Engine coolant temperature (ECT) sensor electrical connector |
| 17 | — | Crankshaft position (CKP) sensor electrical connector |
| 18 | — | Water temperature indicator sender electrical connector |
| 19 | — | Manifold absolute pressure (MAP) sensor electrical connector |
| 20 | — | Intake air temperature (IAT) sensor electrical connector |

The fuel injection supply manifold:

- delivers fuel to the individual fuel injectors.
- receives fuel from the fuel supply line.

The throttle body:

- controls air supply to the upper intake manifold by positioning the throttle plate.
- connects the accelerator cable and, if equipped, the speed control actuator cable to the throttle lever.

The fuel injectors:

- are electrically operated by the powertrain control module (PCM).
- atomize the fuel as the fuel is delivered.
- are deposit-resistant.
- each have an internal solenoid which opens to inject fuel into the lower intake manifold .

The fuel pressure relief valve is used to inspect and relieve fuel pressure.

The fuel pulse damper:

- reduces fluctuation of fuel pressure during injector operation.

## Fuel Charging and Controls

Refer to the Powertrain Control/Emissions Diagnosis (PC/ED) manual.

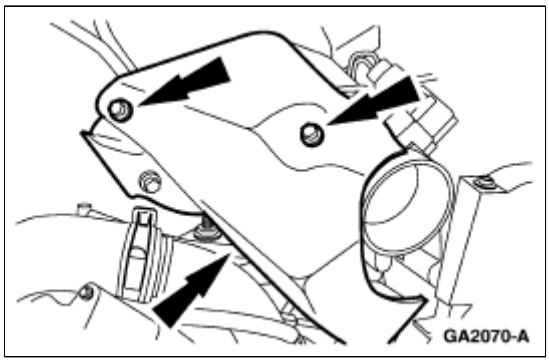
## Throttle Body

### Removal and Installation

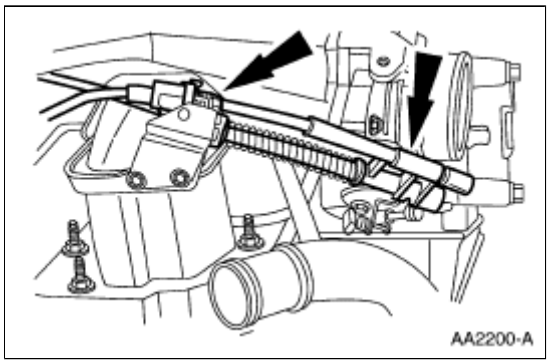
**WARNING: Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in personal injury.**

**CAUTION: The throttle body bore and plate area have a special coating and cannot be cleaned.**

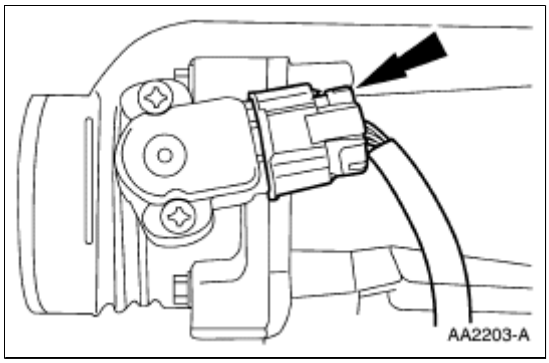
1. Remove the air cleaner outlet tube. For additional information, refer to Section 303-12 .
2. Remove the accelerator cable snow shield.



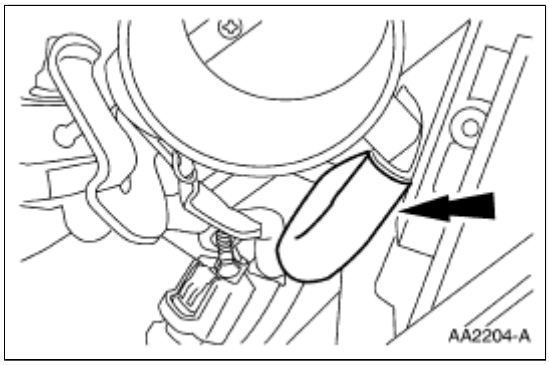

3. Disconnect the accelerator control actuator cable and the speed control actuator cables (if equipped).



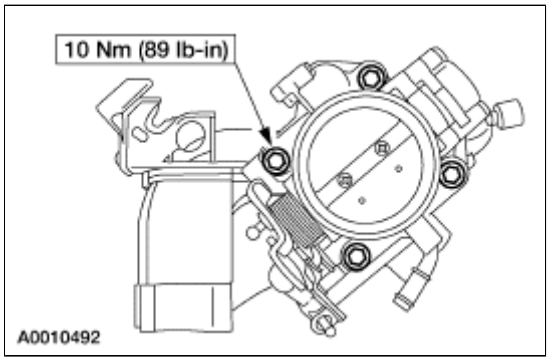

4. Disconnect the throttle position (TP) sensor electrical connector.




5. Disconnect the canister purge line.




6. Remove the throttle body.




7. Inspect and install a new throttle body gasket if necessary.

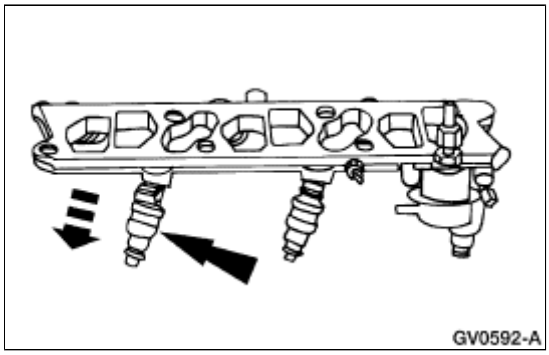
8. To install, reverse the removal procedure.

## Fuel Injectors

### Removal and Installation

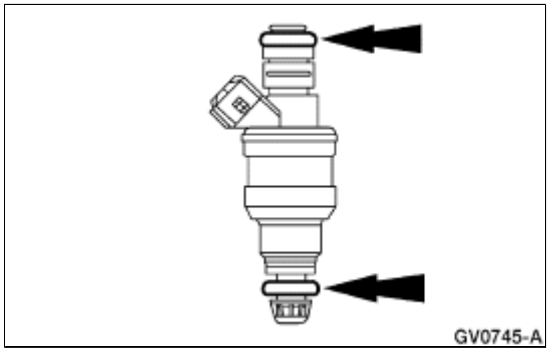
1. Remove the fuel injection supply manifold. For additional information, refer to Supply Manifold—Fuel Injection in this section.

2. Remove the six fuel injectors.




3. **NOTE:** Lubricate new O-ring seals with Super Premium SAE 5W-30 Motor Oil XO-5W30-QSP or equivalent meeting Ford specification WSS-M2C153-G, to aid installation.

   Inspect and install new O-ring seals if necessary.



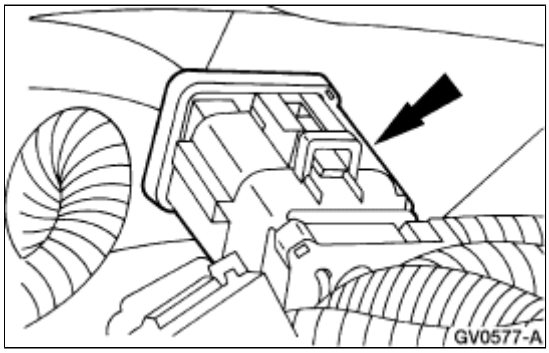

4. To install, reverse the removal procedure.

## Wiring Harness

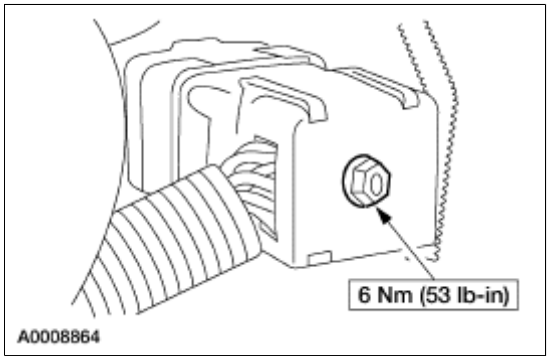
### Removal and Installation

1. Remove the upper intake manifold. For additional information, refer to Section 303-01A .
2. **NOTE:** Automatic transmissons have two harness connections, manual transmissions have only one.

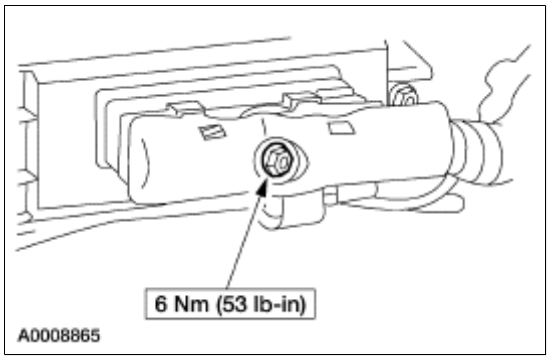
   Disconnect the two transmission harness electrical connectors.



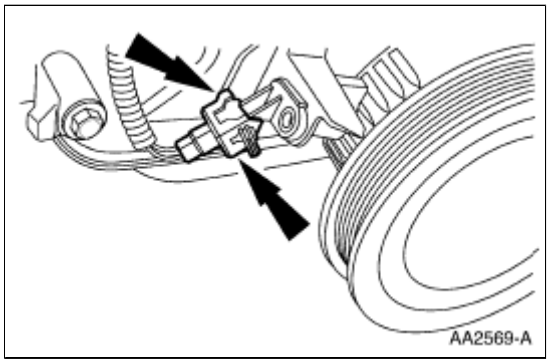

3. Disconnect the two heated oxygen (HO2S) sensor electrical connectors.
4. Disconnect the engine bulkhead connector.



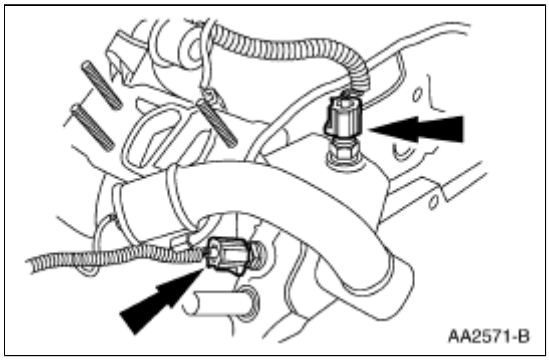

5. Disconnect the PCM electrical connector.



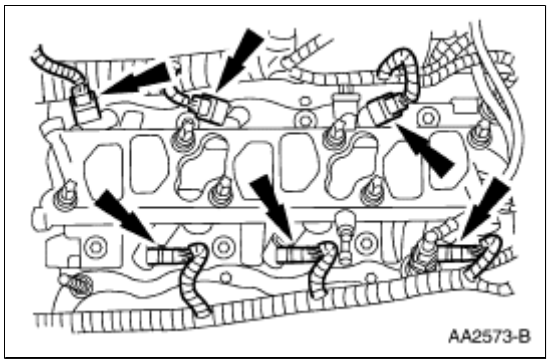

6. Disconnect the crankshaft position (CKP) sensor electrical connector.



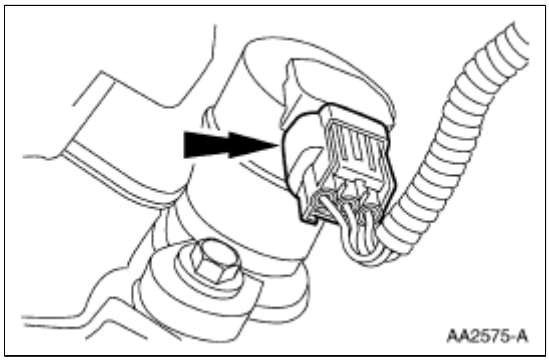

7. Disconnect the electrical connectors:
   - Engine coolant temperature (ECT) sensor
   - Water temperature indicator sender unit



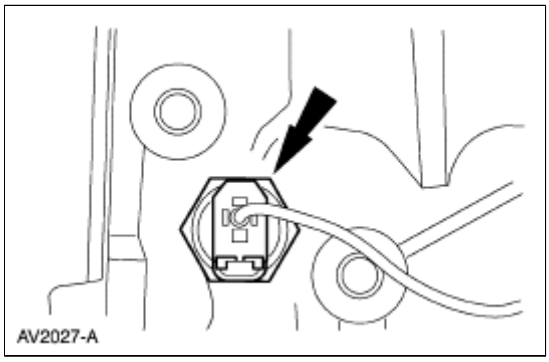

8. Disconnect the fuel injector electrical connectors.




9. Disconnect the camshaft position (CMP) sensor electrical connector.




10. Disconnect the engine oil pressure sensor electrical connector.




11. Remove the wiring harness.

12. To install, reverse the removal procedure.

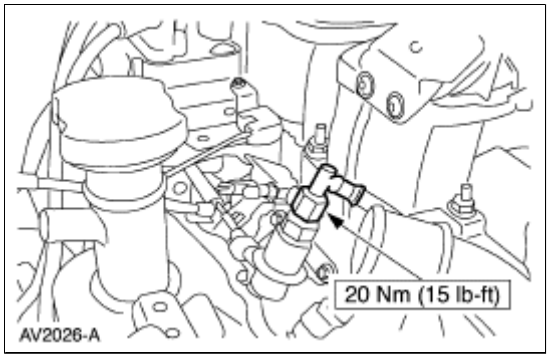
## Fuel Pulse Damper

### Removal and Installation

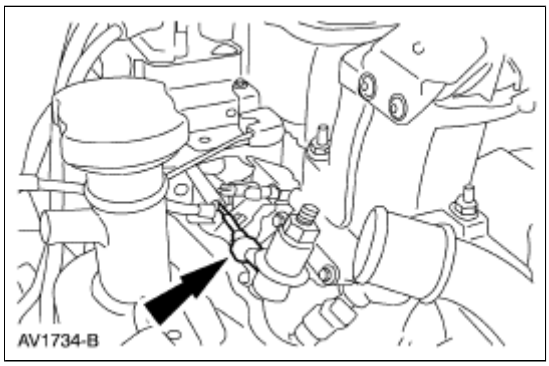
**WARNING: Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in personal injury.**

**WARNING: Fuel in the fuel system remains under high pressure even when the engine is not running. Before working on or disconnecting any of the fuel lines or fuel system components, the fuel system pressure must be relieved. Failure to follow these instructions may result in personal injury.**

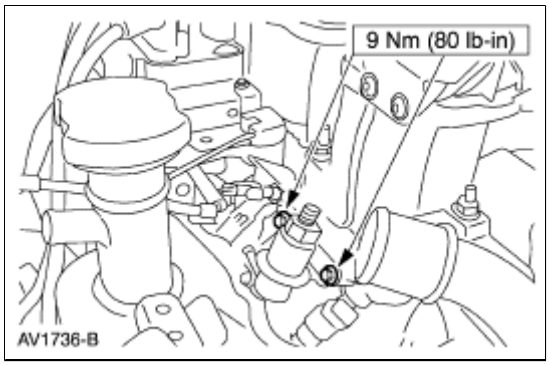
1. Relieve the fuel pressure. For additional information, refer to Section 310-00 .
2. Disconnect the fuel supply line.




3. Disconnect the vacuum line.




4. Remove the fuel pulse damper and discard the O-ring seal.




5. **NOTE:** Lubricate the O-ring seal with Super Premium SAE 5W-30 Motor Oil XO-5W30-QSP or equivalent meeting Ford specification WSS-M2C153-G.

   To install, reverse the removal procedure.

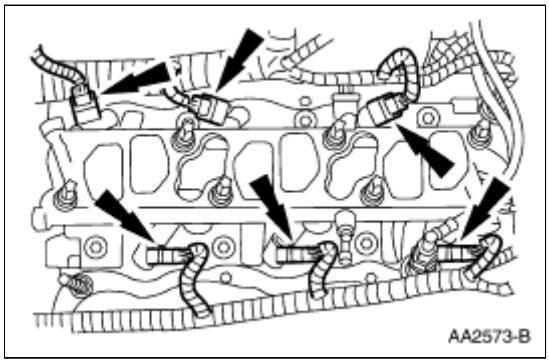
## Supply Manifold —Fuel Injection

### Removal and Installation

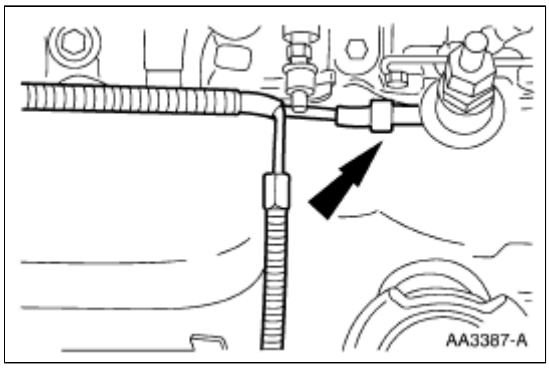
**WARNING: Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in personal injury.**

**WARNING: Fuel in the fuel system remains under high pressure even when the engine is not running. Before working on or disconnecting any of the fuel lines or fuel system components, the fuel system pressure must be relieved. Failure to follow these instructions may result in personal injury.**

1. Relieve the fuel pressure. For additional information, refer to Section 310-00 .
2. Remove the upper intake manifold. For additional information, refer to Section 303-01A .
3. Disconnect the fuel injector electrical connectors.

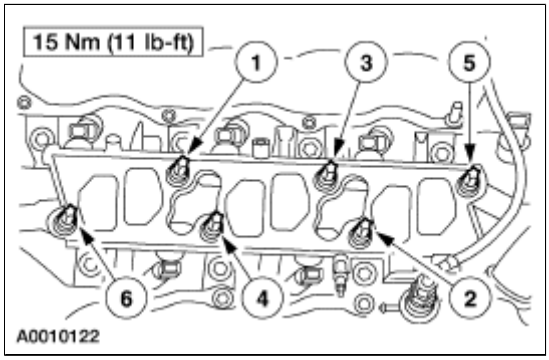



4. Disconnect the fuel damper vacuum line.




5. Disconnect the fuel line. For additional information, refer to Section 310-00 .

6. Remove the fuel injection supply manifold.




7. Remove and discard the fuel injection supply manifold gasket.

8. To install, reverse the removal procedure.

**General Specifications**

| Item | Specification |
|---|---|
| Super Premium SAE 5W-30 Motor Oil XO-5W30-QSP | WSS-M2C153-G |

**Torque Specifications**

| Description | Nm | lb-ft | lb-in |
|---|---|---|---|
| Fuel injection supply manifold bolts | 25 | 18 | — |
| Fuel pressure relief valve bolts | 10 | — | 89 |
| Throttle body bolts | 7 | — | 62 |
| Engine bulkhead connector | 6 | — | 53 |
| PCM connector | 6 | — | 53 |
| Fuel supply line support bracket bolt | 10 | — | 89 |
| Fuel pulse damper bolts | 10 | — | 89 |

## Fuel Charging And Controls

The fuel charging and control system consists of the:

- throttle body
- fuel injectors
- fuel charging wiring
- fuel injection supply manifold
- fuel pulse damper
- fuel pressure relief valve

The fuel charging and controls system is:

- a sequential, multiport fuel injection (SFI) system.
- pulse-width modulated.
- mass air flow controlled.

The fuel injection supply manifold:

- delivers fuel to the individual fuel injectors.
- receives fuel from the fuel supply line.

The throttle body:

- controls air supply to the upper intake manifold by positioning the throttle plate.
- connects the accelerator cable and, if equipped, the speed control actuator cable to the throttle plate.

The fuel injectors:

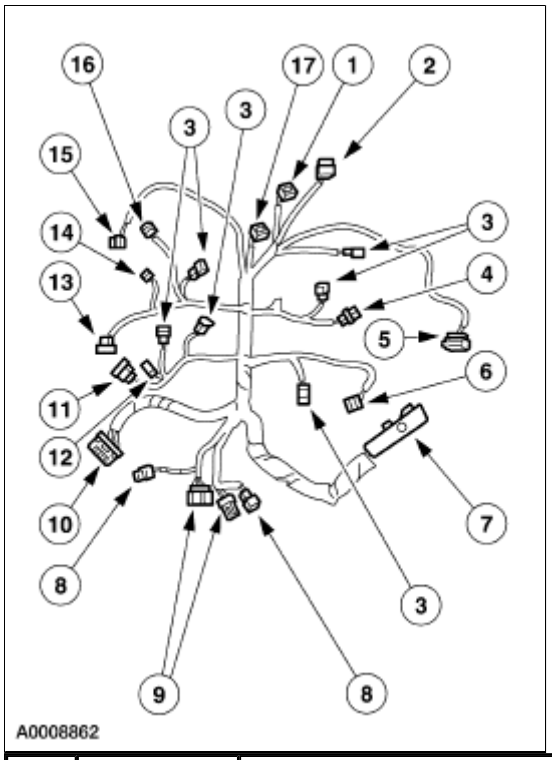
- are electrically operated by the powertrain control module (PCM).
- atomize the fuel as the fuel is delivered.
- are deposit-resistant and self-cleaning.
- each have an internal solenoid which opens a needle valve to inject fuel into the lower intake manifold.

The fuel pressure relief valve is used to monitor and relieve fuel pressure.

The fuel pulse damper:

- reduces fluctuation of the fuel pressure during injector operation.

**Fuel Charging Wiring Harness**




| Item | Part Number | Description |
|---|---|---|
| 1 | — | Engine coolant temperature (ECT) sensor electrical connector |
| 2 | — | Throttle position (TP) sensor electrical connector |
| 3 | — | Fuel injector electrical connectors |
| 4 | — | Knock sensor (KS) electrical connector |
| 5 | — | Mass air flow (MAF) sensor electrical connector |
| 6 | — | EGR vacuum regulator (EVR) electrical connector |
| 7 | — | Powertrain control module (PCM) electrical connector |
| 8 | — | Heated oxygen sensor (HO2S) electrical connector |
| 9 | — | Transmission harness electrical connectors |
| 10 | — | Engine bulkhead electrical connector |
| 11 | — | Ignition coil electrical connector |
| 12 | — | Radio ignition interference capacitor electrical connector |
| 13 | — | Differential pressure feedback EGR transducer electrical connector |
| 14 | — | Camshaft position (CMP) sensor electrical connector |
| 15 | — | Crankshaft position (CKP) sensor electrical connector |
| 16 | — | Idle air control (IAC) electrical connector |
| 17 | — | Water temperature indicator sender unit electrical connector |

## Fuel Charging And Controls

Refer to the Powertrain Control/Emissions Diagnosis (PC/ED) manual.

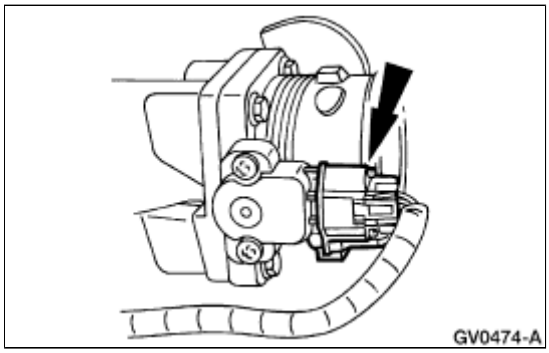
## Throttle Body

### Removal and Installation

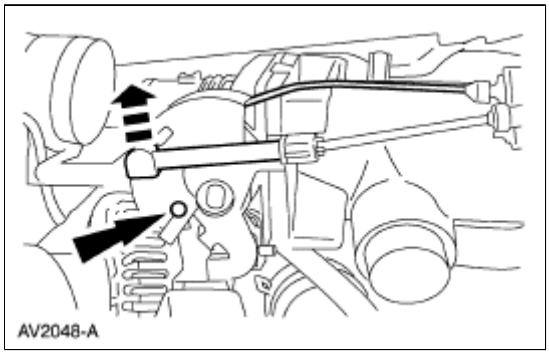
**WARNING: Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel-related components. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in personal injury.**

**CAUTION: Throttle body bore and plate area have a special coating and cannot be cleaned, or possible damage to the throttle body may occur.**

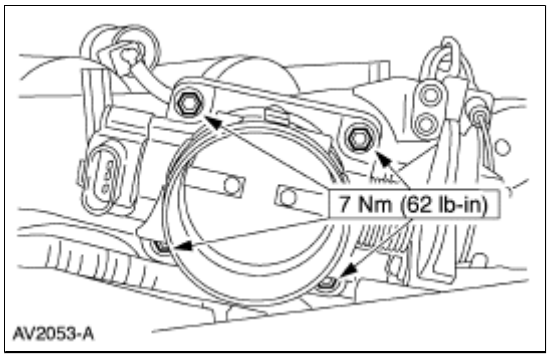
1. Remove the air cleaner outlet tube. For additional information, refer to Section 303-12 .
2. Disconnect the throttle position (TP) sensor electrical connector.




3. Disconnect the accelerator cable and the speed control cable (if equipped).




4. Remove the throttle body.
   - Discard the gasket.



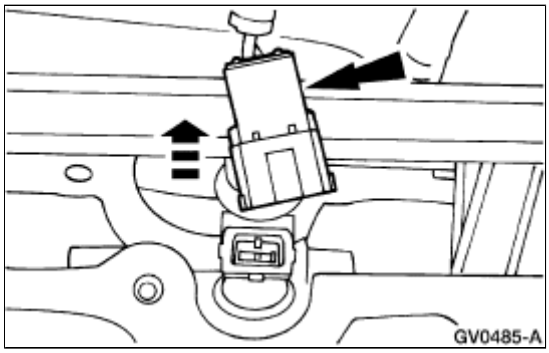

5. To install, reverse the removal procedure.

## Wiring Harness

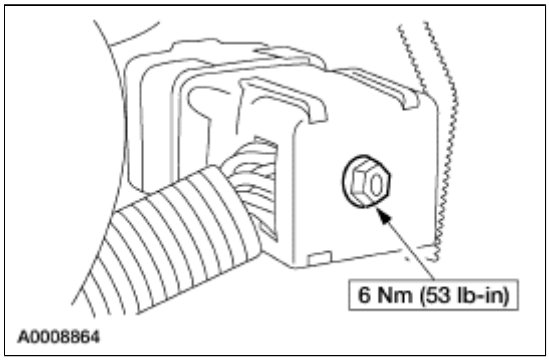
### Removal and Installation

1. Remove the lower intake manifold. For additional information, refer to Section 303-01B .
2. **NOTE:** One connector is shown, the other five are similar.

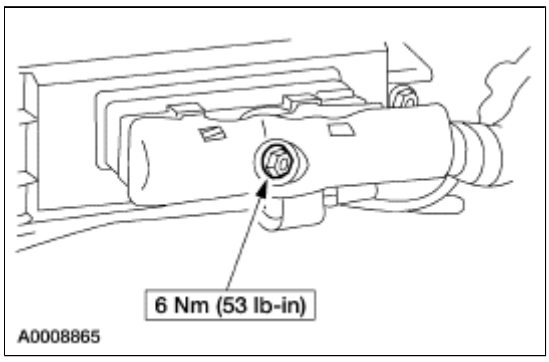
   Disconnect the six fuel injector electrical connectors.



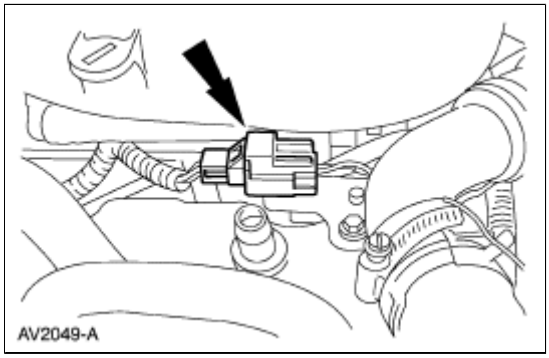

3. Disconnect the engine bulkhead electrical connector.




4. Disconnect the powertrain control module (PCM) electrical connector.

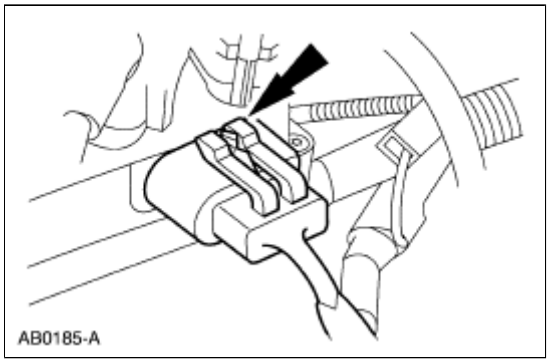


5. Disconnect the knock sensor (KS) electrical connector.

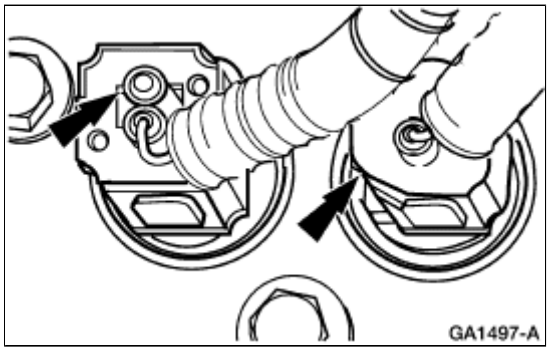



6. Disconnect the heated oxygen sensor (HO2S) connectors.

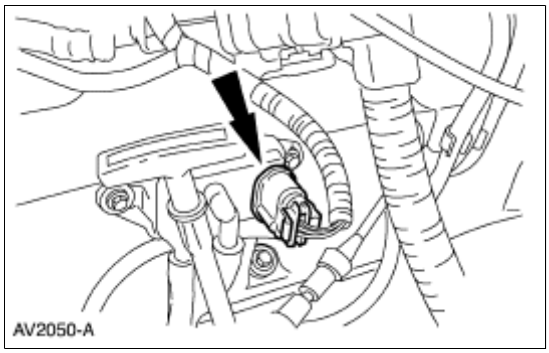
7. Disconnect the ignition coil electrical connector.



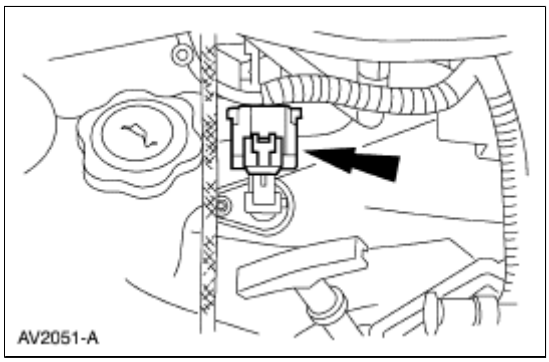

8. Disconnect the electrical connectors:
   - engine coolant temperature (ECT) sensor
   - water temperature indicator sender unit



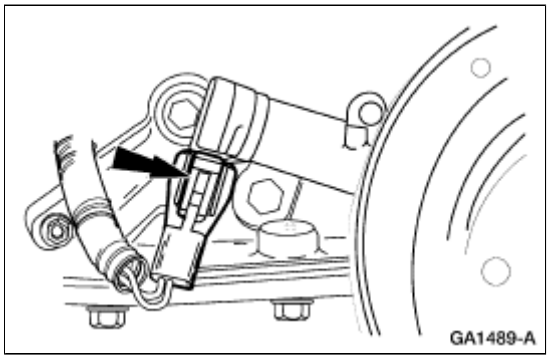

9. Disconnect the differential pressure feedback transducer electrical connector.




10. Disconnect the camshaft position (CMP) sensor electrical connector.




11. Disconnect the crankshaft position (CKP) sensor electrical connector.




12. Remove the wiring harness from the vehicle.

13. To install, reverse the removal procedure.

## Fuel Injection Supply Manifold and Fuel Injector

**Material**

| Item | Specification |
|---|---|
| Super Premium SAE 5W-30 Motor Oil<br>XO-5W30-QSP or equivalent | WSS-M2C153-G |

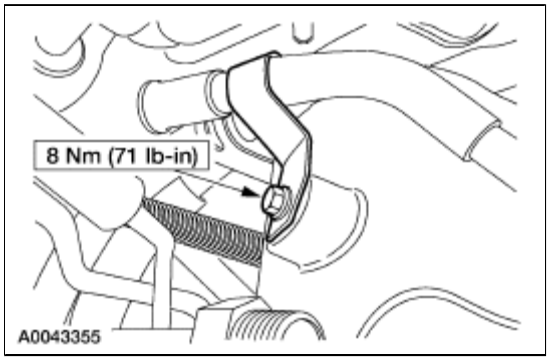
**Removal and Installation**

**WARNING: Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel-related components. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in personal injury.**

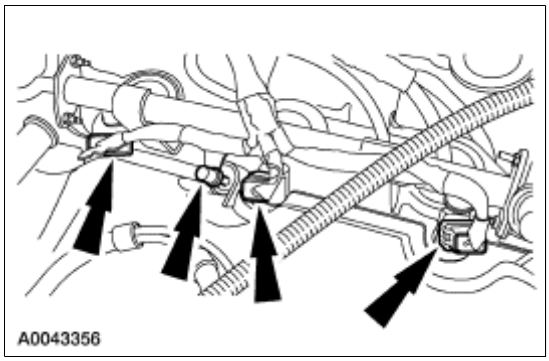
**WARNING: Fuel in the fuel system remains under high pressure even when the engine is not running. Before working on or disconnecting any of the fuel lines or fuel system components, the fuel system pressure must be relieved. Failure to follow these instructions may result in personal injury.**

**CAUTION: If the supply manifold is used as a leverage device, damage may occur to the supply manifold. Care must be taken when working around the supply manifold.**

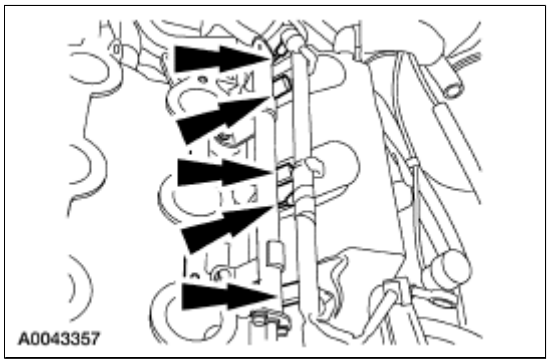
1. Remove the intake manifold. For additional information, refer to Section 303-01B .
2. Disconnect the fuel hose spring lock coupling. For additional information, refer to Section 310-00 .
3. Remove the bolt and the bracket.



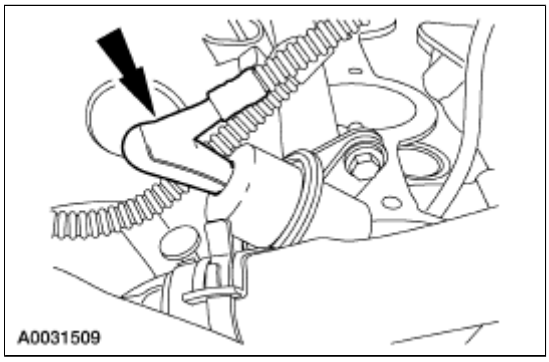

4. Disconnect the right side fuel injector electrical connectors and the two wiring harness retainers.



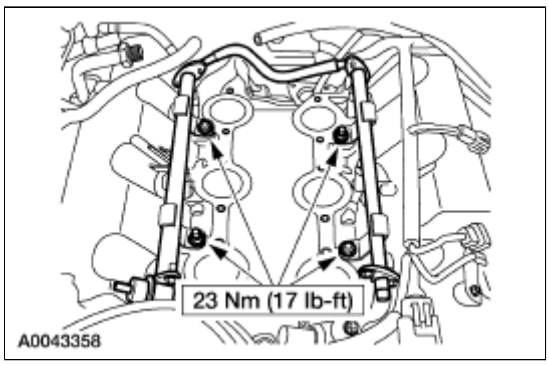

5. Disconnect the left side fuel injector electrical connectors and the wiring harness retainers.



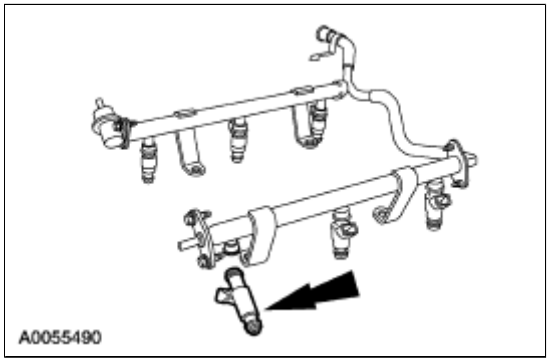

6. Disconnect the fuel pulse damper vacuum hose.




7. Remove the fuel injection supply manifold and the fuel injectors as an assembly.

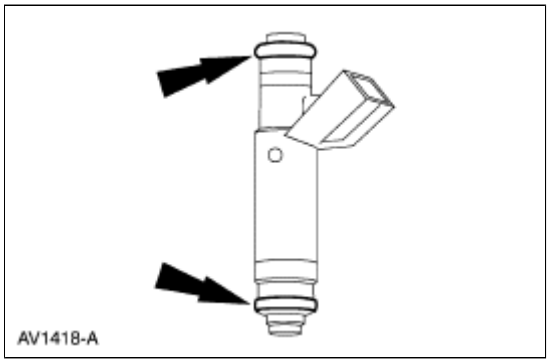


8. Remove the fuel injectors from the fuel injector supply manifold.

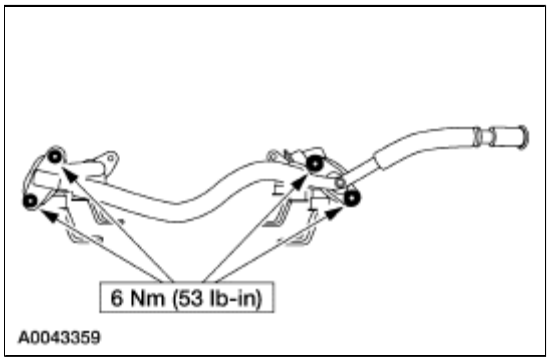



9. **NOTE:** Install new fuel injector O-rings whenever fuel injector removal is required.

   Remove and discard the O-ring seals from the fuel injectors.




10. If necessary, remove the bolts and the fuel supply tube.
    - Discard the O-rings.




11. **CAUTION: O-ring seals are made of special fuel resistant material. Use of ordinary O-ring seals can cause the fuel system to leak. Do not reuse the O-ring seals.**

    To install, reverse the removal procedure.
    - Install new O-ring seals on the fuel injectors and, if necessary, on the fuel supply tube. Lubricate the O-ring seals with clean engine oil.

## Fuel Pulse Damper

**Material**

| Item | Specification |
|---|---|
| Super Premium SAE 5W-30 Motor Oil<br>XO-5W30-QSP or equivalent | WSS-M2C153-G |

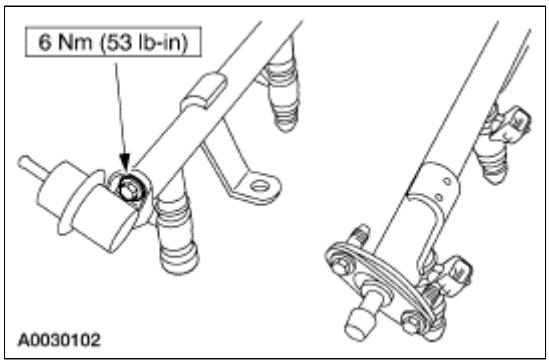
**Removal and Installation**

**WARNING: Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel-related components. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in personal injury.**

**WARNING: Fuel in the fuel system remains under high pressure even when the engine is not running. Before working on or disconnecting any of the fuel lines or fuel system components, the fuel system pressure must be relieved. Failure to follow these instructions may result in personal injury.**

1. Remove the fuel injection supply manifold. For additional information, refer to Fuel Injection Supply Manifold and Fuel Injector in this section.

2. Remove the two bolts, the fuel pulse damper and the O-ring seals.




3. **CAUTION: Use O-ring seals that are made of special fuel-resistant material. Use of ordinary O-ring seals can cause the fuel system to leak. Do not reuse O-ring seals.**

   **NOTE:** Lubricate the new O-ring seals with clean engine oil to aid in installation.

   To install, reverse the removal procedure.

## Fuel Pressure Relief Valve

**Material**

| Item | Specification |
|---|---|
| Super Premium SAE 5W-30 Motor Oil<br>XO-5W30-QSP or equivalent | WSS-M2C153-G |

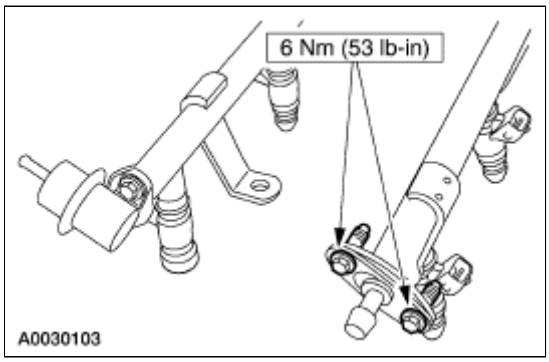
**Removal**

**WARNING: Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel-related components. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in personal injury.**

**WARNING: Fuel in the fuel system remains under high pressure even when the engine is not running. Before working on or disconnecting any of the fuel lines or fuel system components, the fuel system pressure must be relieved. Failure to follow these instructions may result in personal injury.**

1. Remove the fuel injection supply manifold. For additional information, refer to Fuel Injection Supply Manifold and Fuel Injector in this section.

2. Remove the two bolts, the pressure relief valve and the O-ring seals.




3. **CAUTION: Use O-ring seals that are made of special fuel-resistant material. Use of ordinary O-ring seals can cause the fuel system to leak. Do not reuse O-ring seals.**

   **NOTE:** Lubricate the new O-ring seals with clean engine oil to aid installation.

   To install, reverse the removal procedure.

**General Specifications**

| Item | Specification |
|---|---|
| **Fluid/Lubricant Specification** | |
| Super Premium SAE 5W-30 Motor Oil XO-5W30-QSP | WSS-M2C153-G |

**Torque Specifications**

| Description | Nm | lb-ft | lb-in |
|---|---|---|---|
| Engine bulkhead connector bolt | 6 | — | 53 |
| Transmission harness connector bolt | 6 | — | 53 |
| Powertrain control module bolt | 6 | — | 53 |
| Fuel injection supply manifold bolts | 8-12 | — | 71-106 |
| Throttle body bolts | 8-10 | — | 71-89 |

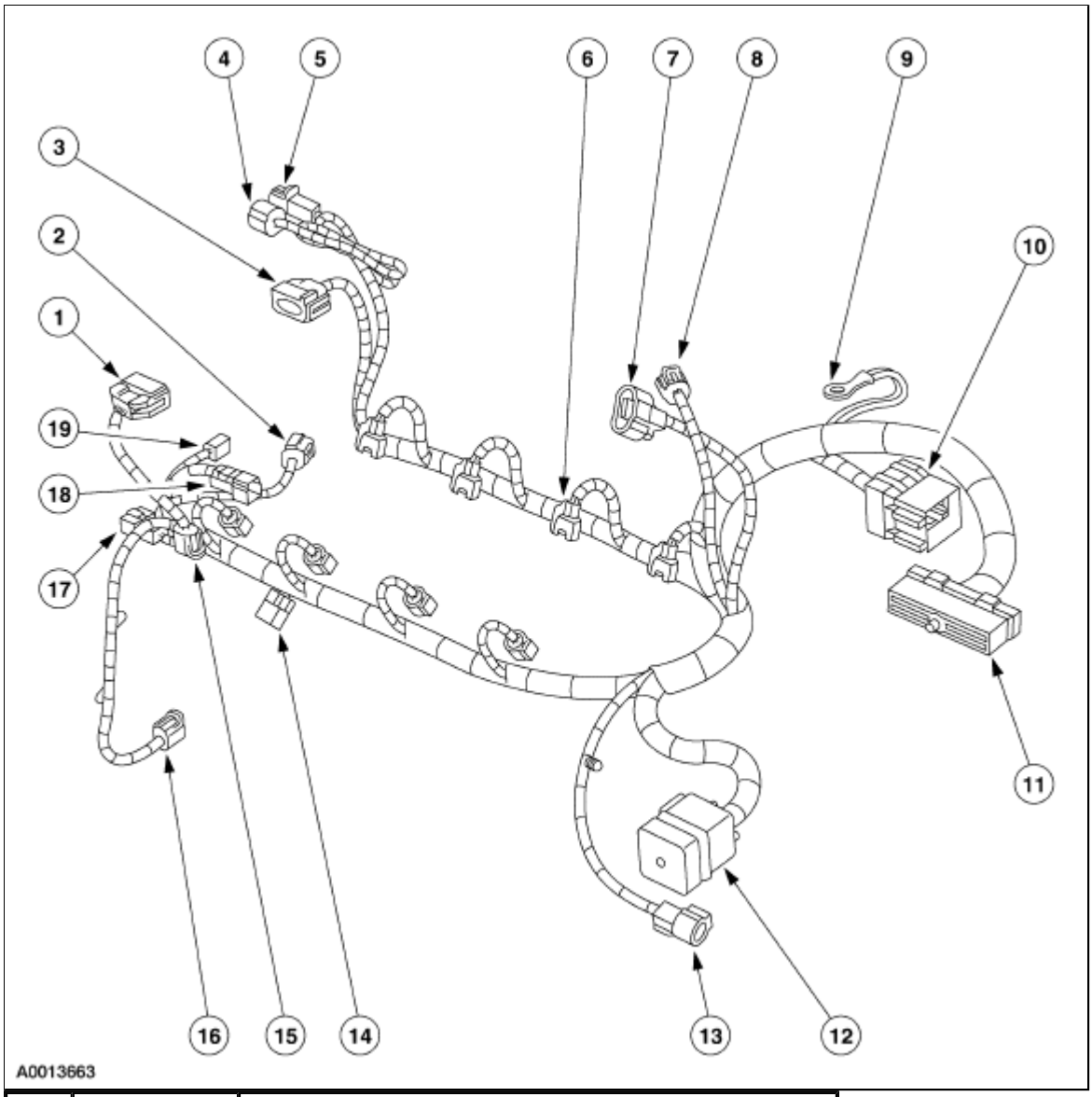
## Fuel Charging And Controls

The fuel charging and controls system consists of the:

- throttle body.
- fuel injectors.
- fuel charging wiring.
- fuel injection supply manifold.
- fuel damper.
- fuel pressure relief valve.

The fuel charging and controls system is:

- a sequential, multiport fuel injection (SFI) system.
- pulse-width modulated.
- mass air flow controlled.




| Item | Part Number | Description |
|---|---|---|
| 1 | — | Ignition coil connector LH |
| 2 | — | Engine coolant temperature (ECT) sensor connector |
| 3 | — | Ignition coil connector RH |
| 4 | — | Intake air temperature (IAT) sensor connector |
| 5 | — | Mass air flow (MAF) sensor connector |
| 6 | — | Fuel injector connector (8) places |
| 7 | — | Throttle position (TP) sensor connector |
| 8 | — | EGR vacuum regulator (EVR) connector |
| 9 | — | Ground connector |
| 10 | — | Engine bulkhead connector |
| 11 | — | Electronic engine control (EEC) electrical connector |
| 12 | — | Transmission harness connector |
| | | |

| | | |
|---|---|---|
| 13 | — | Heated oxygen sensor (HO2S) connector |
| 14 | — | Crankshaft position (CKP) sensor connector |
| 15 | — | Water temperature indicator sender connector |
| 16 | — | Engine oil pressure sending unit connector |
| 17 | — | Octane adjust sensor |
| 18 | — | CID connector |
| 19 | — | Radio capacitor connector |

The fuel injection supply manifold:

- delivers fuel to the individual fuel injectors.
- receives fuel from the fuel supply line.

The throttle body:

- controls air supply to the upper intake manifold by positioning the throttle plate.
- connects the accelerator cable and, if equipped, the speed control actuator cable to the throttle lever.

The fuel injectors:

- are electrically operated by the powertrain control module (PCM).
- atomize the fuel as the fuel is delivered.
- are deposit-resistant.
- each have an internal solenoid which opens to inject fuel into the lower intake manifold.

The fuel pressure relief valve is used to inspect and relieve fuel pressure.

The fuel pulse damper:

- reduces fluctuation of fuel pressure during injector operation.

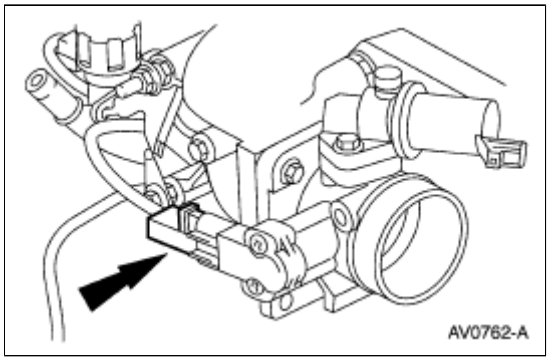
## Throttle Body

### Removal and Installation

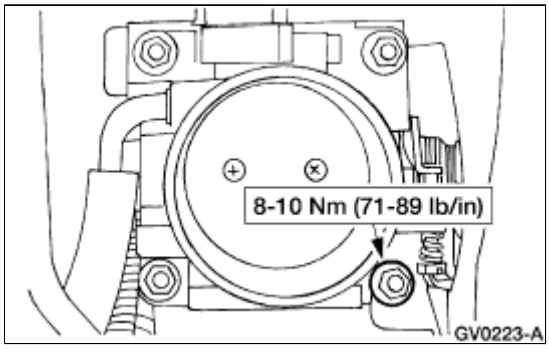
**WARNING: Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in personal injury.**

**CAUTION: Throttle body bore and plate area have a special coating and cannot be cleaned.**

1. Remove the air cleaner outlet tube. For additional information, refer to Section 303-12 .
2. Disconnect the accelerator cable and bracket. For additional information, refer to Section 310-02 .
3. Disconnect the throttle position (TP) sensor electrical connector.




4. Remove the throttle body.



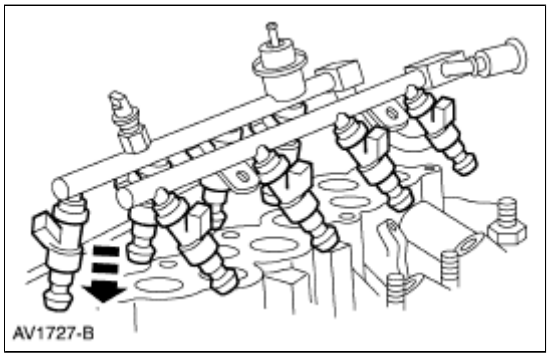

5. To install, reverse the removal procedure.

## Fuel Injectors

### Removal and Installation

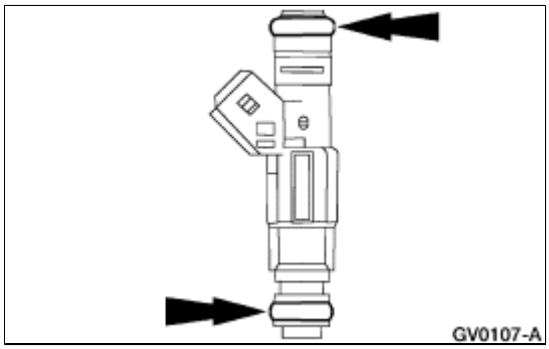
1. Remove the fuel injection supply manifold. For additional information, refer to Supply Manifold—Fuel Injection in this section.

2. Remove the eight fuel injectors.




3. **NOTE:** Lubricate new O-ring seals with Super Premium SAE 5W-30 Motor Oil, XO-5W30-QSP or equivalent meeting Ford specification WSS-M2C153-G, to aid installation.

   Inspect and install new O-ring seals if necessary.

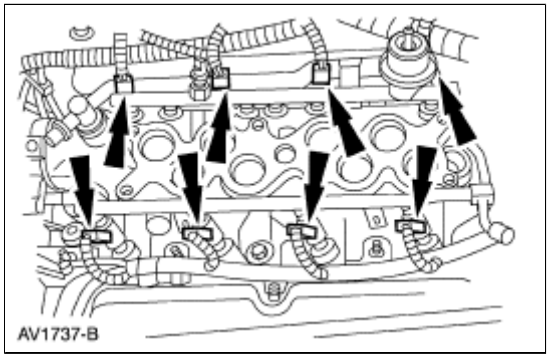



4. To install, reverse the removal procedure.

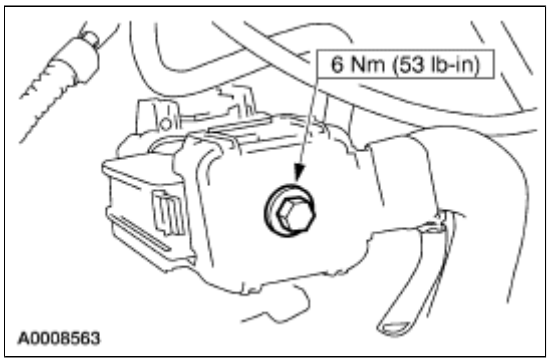
## Wiring Harness

### Removal and Installation

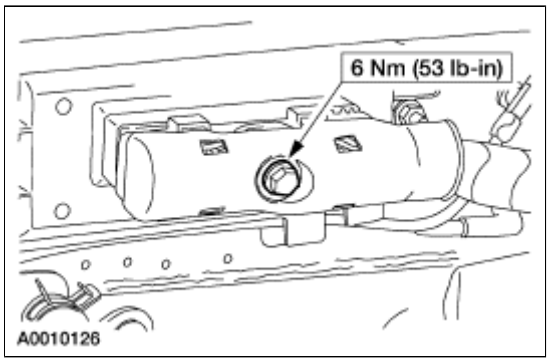
1. Remove the upper intake manifold. For additional information, refer to Section 303-01C .
2. Disconnect the fuel injector electrical connectors.



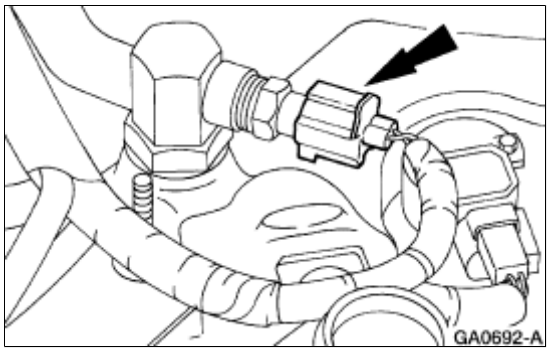

3. Disconnect the engine bulkhead connector.



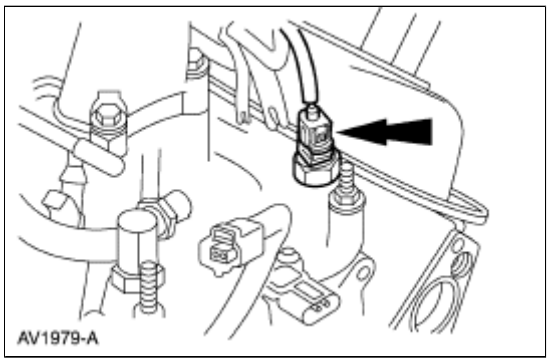

4. Disconnect the powertrain control module (PCM) connector.



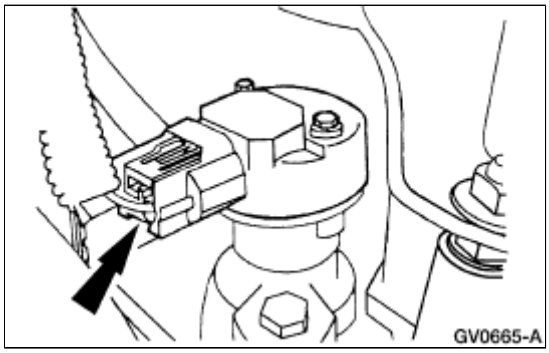

5. Disconnect the engine coolant temperature (ECT) sensor electrical connector.



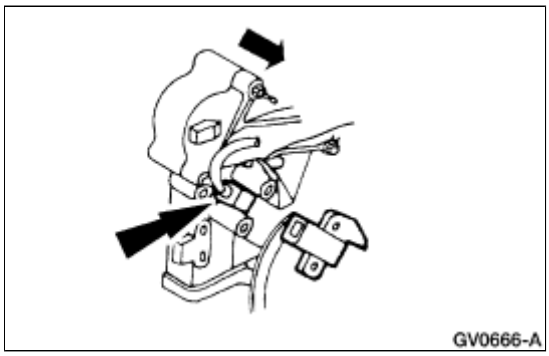

6. Disconnect the water temperature indicator electrical connector.



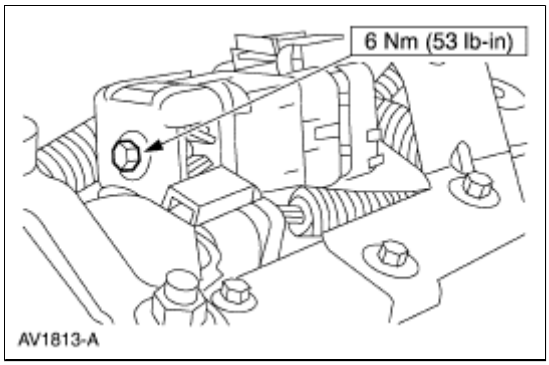

7. Disconnect the camshaft position (CMP) sensor electrical connector.



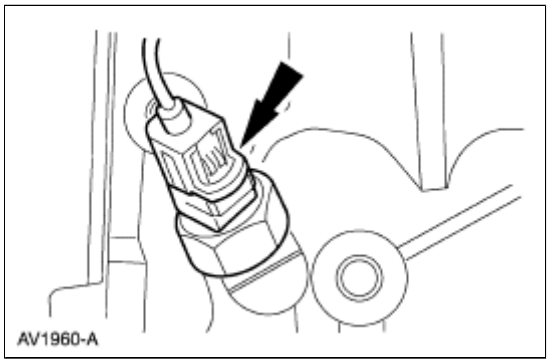

8. Disconnect the crankshaft position (CKP) sensor electrical connector.




9. Disconnect the transmission harness electrical connector.

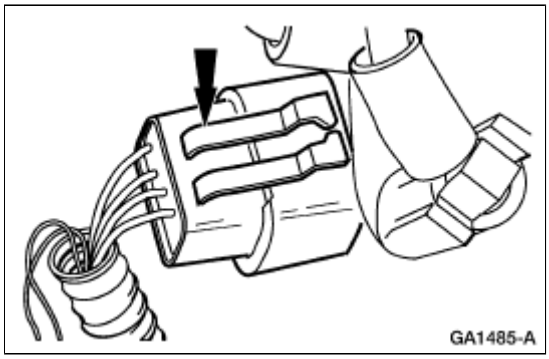



10. Disconnect the engine oil pressure sending unit electrical connector.

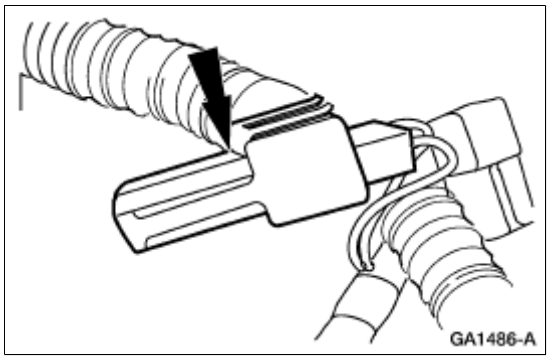



11. Disconnect the two heated oxygen sensor (HO2S) electrical connectors.

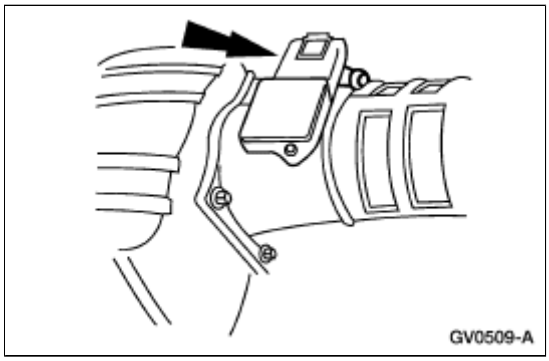
12. Disconnect the ignition coil electrical connectors.




13. Disconnect the radio ignition interference capacitor electrical connector.




14. Disconnect the mass air flow (MAF) sensor electrical connector.




15. Remove the wiring harness from the vehicle.

16. To install, reverse the removal procedure.

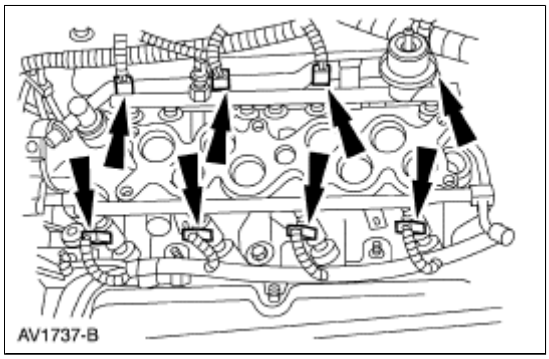
## Supply Manifold —Fuel Injection

### Removal and Installation

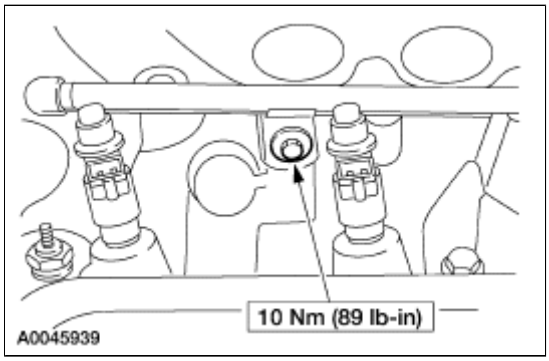
**WARNING: Do not smoke, carry lighted tobacco or open flame of any type when working on or near any fuel- related components. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in personal injury.**

**WARNING: Fuel in the fuel system remains under high pressure even when the engine is not running. Before working on or disconnecting any of the fuel lines or fuel system components, the fuel system pressure must be relieved. Failure to follow these instructions may result in personal injury.**

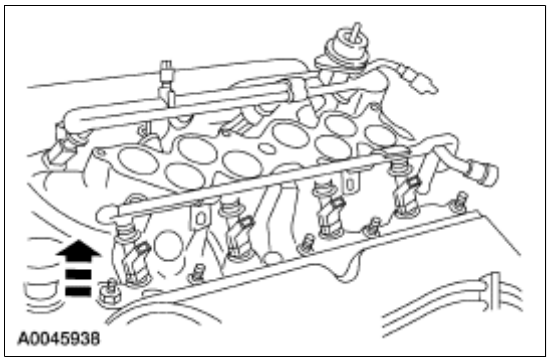
1. Remove the upper intake manifold. For additional information, refer to Section 303-01C .
2. Disconnect the fuel hose spring lock coupling. For additional information, refer to Section 310-00 .
3. Disconnect the eight fuel injector electrical connectors.




4. Remove the four bolts from the fuel injection supply manifold.




5. Remove the fuel injection supply manifold from the lower intake manifold.




6. To install, reverse the removal procedure.

## Fuel Pulse Damper

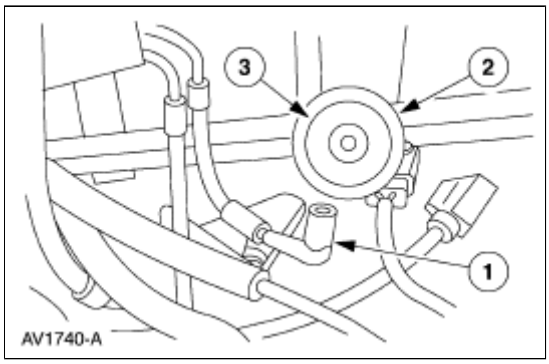
### Removal and Installation

**WARNING: Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in personal injury.**

**WARNING: Fuel in the fuel system remains under high pressure even when the engine is not running. Before working on or disconnecting any of the fuel lines or fuel system components, the fuel system pressure must be relieved. Failure to follow these instructions may result in personal injury.**

1. Relieve fuel pressure. For additional information, refer to Section 310-00 .

2. Remove the fuel pulse damper.
    1. Disconnect the vacuum hose.
    2. Remove the snap ring.
    3. Remove the fuel pulse damper and O-ring seals.




3. **CAUTION: Use O-ring seals that are made of special fuel resistant material. Use of ordinary O-ring seals can cause the fuel system to leak. Do not reuse O-ring seals.**

   **NOTE:** Lubricate the new O-ring seals with clean engine oil, XO-10W30-DSP or equivalent meeting Ford specification WSS-M2C153-G, to aid installation.

   To install, reverse the removal procedure.

**Torque Specifications**

| Description | Nm | lb-ft |
|---|---|---|
| **4.0L (Push Rod) Engine** | | |
| Drive belt tensioner bolt | 40-55 | 30-40 |
| Belt idler pulley bolt | 40-55 | 30-40 |
| **4.0L SOHC Engine** | | |
| Drive belt tensioner bolt | 40-55 | 30-40 |
| Belt idler pulley bolt | 40-55 | 30-40 |
| **5.0L Engine** | | |
| Belt idler pulley bolt (upper) | 47 | 35 |
| Belt idler pulley bolt (lower) | 21-29 | 16-21 |
| Drive belt tensioner bolts | 25 | 18 |

## Accessory Drive

### 4.0L (Push Rod)

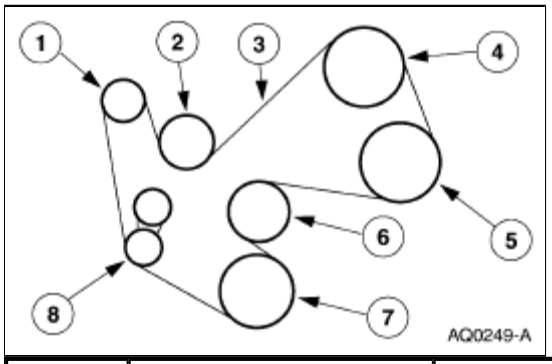
The accessory drive system consists of the following:

- drive belt
- generator
- power steering pump
- A/C compressor
- water pump pulley
- drive belt tensioner
- belt idler pulley
- crankshaft pulley

The accessory drive:

- has a single serpentine drive belt (six ribs).
- has an automatic tensioner.
- is not adjustable.

#### Component Locations




| Item | Part Number | Description |
|---|---|---|
| 1 | 10300 | Generator |
| 2 | 8678 | Belt idler pulley |
| 3 | 8620 | Drive belt |
| 4 | 19703 | A/C compressor |
| 5 | 3A674 | Power steering pump |
| 6 | 8509 | Water pump pulley |
| 7 | 6312 | Crankshaft pulley |
| 8 | 6B209 | Drive belt tensioner |

### 4.0L SOHC

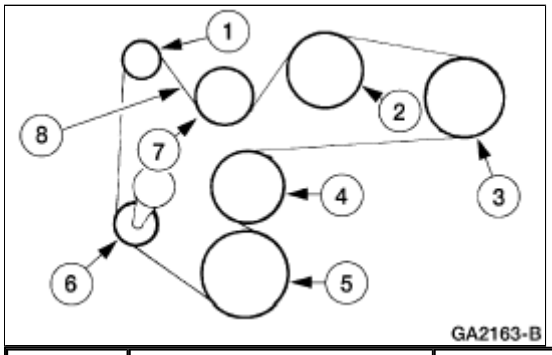
The accessory drive system consists of the following:

- drive belt
- generator
- power steering pump
- A/C compressor
- water pump pulley
- drive belt tensioner
- belt idler pulley
- crankshaft pulley

The accessory drive:

- has a single serpentine drive belt (six ribs).
- has an automatic tensioner.
- is not adjustable.

**Component Locations**




| Item | Part Number | Description |
|---|---|---|
| 1 | 10300 | Generator |
| 2 | 3A674 | Power steering pump |
| 3 | 19703 | A/C compressor |
| 4 | 8509 | Water pump pulley |
| 5 | 6312 | Crankshaft pulley |
| 6 | 6B209 | Drive belt tensioner |
| 7 | 8678 | Belt idler pulley |
| 8 | 8620 | Drive belt |

**5.0L**

The accessory drive system consists of the following:

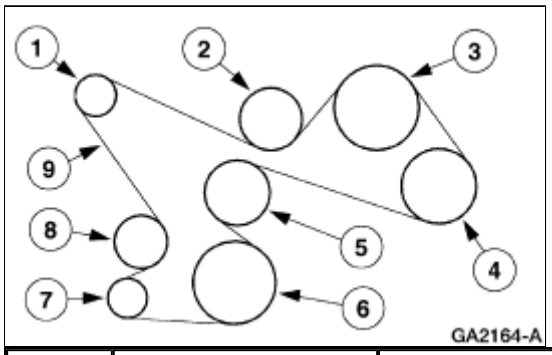
- drive belt
- generator
- power steering pump
- A/C compressor
- crankshaft pulley

- water pump pulley
- drive belt tensioner
- belt idler pulley

The accessory drive:

- has a single serpentine drive belt (six ribs).
- has an automatic tensioner.
- is not adjustable.

**Component Locations**




| Item | Part Number | Description |
|---|---|---|
| 1 | 10300 | Generator |
| 2 | 8678 | Belt idler pulley |
| 3 | 3A733 | Power steering pump pulley |
| 4 | 19703 | A/C compressor |
| 5 | 8509 | Water pump pulley |
| 6 | 6312 | Crankshaft pulley |
| 7 | 8678 | Belt idler pulley |
| 8 | 6B209 | Drive belt tensioner |
| 9 | 8620 | Drive belt |

## Accessory Drive

### Inspection and Verification

1. Verify the customer's concern by operating the engine to duplicate the condition.
2. Inspect to determine if any of the following mechanical concerns apply:

**Visual Inspection Chart**

| Mechanical |
| --- |
| • Drive belt cracking/chunking/wear.<br>• Drive belt noise or squeal.<br>• Pulley misalignment or excessive pulley runout. |

3. Inspect for drive belt cracking/chunking/wear.
4. If the concerns remain after inspection, determine the symptoms and go to the symptom chart.

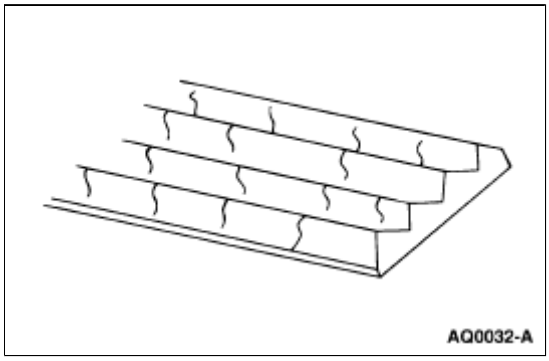
Under severe operating conditions (high temperature, low humidity), drive belt rib cracking can occur at less than 96,000 km (60,000 miles). Drive belt rib cracking (cracks across grooves):

- is not a reason for concern.
- has no detrimental effect on drive belt performance.

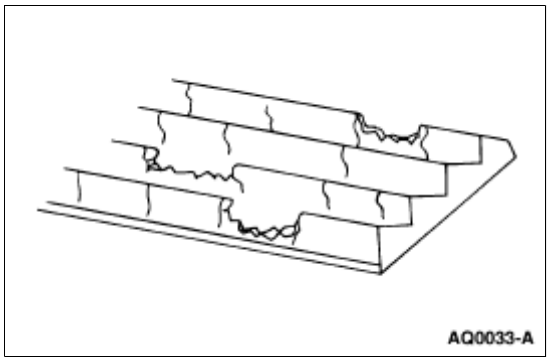
Cracks parallel to grooves are acceptable.

The drive belt is still perfectly functional until rib chunking occurs. Drive belt chunking is where the rubber material actually chunks out between the cracks. The drive belt should be replaced if chunking occurs.

**Vee-Ribbed Serpentine Drive Belt With Cracks Across Backing**




**Vee-Ribbed Serpentine Drive Belt With Chunks of Rib Missing**




5. If the concern(s) remains after inspection, determine the symptoms and go to the Symptom Chart.

**Symptom Chart**

**Symptom Chart**

| Condition | Possible Sources | Action |
|---|---|---|
| • Drive belt cracking | • Drive belt. | • System OK. |
| • Drive belt chunking | • Drive belt. | • INSTALL a new drive belt. For additional information, REFER to Belt—Drive in this section. |
| • Drive belt noise or squeal | • Drive belt.<br>• Pulley(s). | • DETERMINE what area of the pulley(s) the noise is coming from, then check that area with a straightedge and look for the accessory pulley(s) to be out of position in the fore or aft direction, or at an angle to the straightedge. |
| • Drive belt does not hold tension | • Drive belt cracking or damaged. | • INSPECT the drive belt for cracking parallel with and through to the backing. INSTALL a new drive belt if necessary. |
| | • Drive belt tensioners worn or damaged. | • CHECK the drive belt tensioner for damage and correct operation. REFER to the Component Test in this section. INSTALL a new drive belt tensioner if necessary. |
| • Drive belt squeal or chirp | • Incorrect drive belt installed. | • CHECK the drive belt for correct part application. |
| | • Lubricant or other contamination on the drive belt. | • CHECK the drive belt for oil, coolant, power steering fluid, brake fluid or other contamination. REMOVE the drive belt and wash with detergent and water. If the drive belt cannot be cleaned or is damaged (softened) by contamination, INSTALL a new drive belt. |
| | • Drive belt pulleys not aligned | • CHECK the pulleys for proper alignment, devices and pulleys for proper freedom |

| | | |
|---|---|---|
| | properly, damaged or not rotating freely. | of rotation and damage. REPAIR the pulleys and devices as required. |

**Component Test**

**Drive Belt—Misalignment**

**CAUTION: Incorrect drive belt installation will cause excessive drive belt wear and may cause the drive belt to come off the drive pulleys.**

**NOTE:** Original equipment drive belts are made of a special cord construction and are subjected to special testing before they are approved for use.

Non-standard new drive belts may track differently or incorrectly. If a new drive belt tracks incorrectly, install a new original equipment drive belt to avoid performance failure or loss of drive belt.

With the engine running, check drive belt tracking (the position of the drive belt on one of the grooveless pulleys, idlers or drive belt tensioner. If the edge of the drive belt rides beyond the edge of the pulley, noise and premature wear may result). If a drive belt tracking condition exists, visually check the drive belt tensioner for damage, especially the mounting pad surface. If the drive belt tensioner is not installed correctly with the locating pins in the locating holes, the mounting surface pad will be out of position. This will result in abnormal drive belt tension and chirp and squeal noises.

If the above procedures do not correct the drive belt noise, install a new drive belt. However, the drive belt noise may return (with mileage) if one of the above conditions still exists uncorrected.

- With engine running, visually observe the grooves in the pulleys (not the pulley flanges) for excessive wobble. Install new components as required.
- Check all accessories, mounting brackets and drive belt tensioner, for any interference that would prevent the component from mounting properly. Correct any interference condition and recheck belt tracking.
- Tighten all accessories, mounting brackets and drive belt tensioner retaining hardware to specification. Recheck drive belt tracking.

**Belt Tensioner**

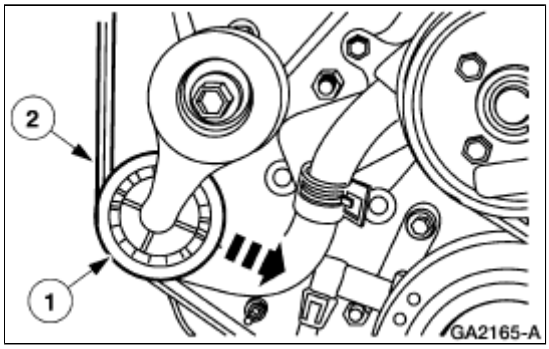
The automatic drive belt tensioner can be checked as follows:

1. With the engine running, observe the drive belt tensioner movement. The drive belt tensioner should move (respond) when the A/C clutch cycles or when the engine is accelerated rapidly. If the drive belt tensioner movement is constant without A/C clutch cycling or acceleration, a pulley or shaft is probably bent or a pulley is out of round. In rare cases, excessive drive belt rideout (uneven depth of grooves in drive belt) can cause excessive drive belt tensioner movement. This condition can be checked by installing the suspect drive belt with a known good original equipment drive belt and repeating the observation.

## Belt — 4.0L (Push Rod)

### Removal and Installation

1. Remove the air cleaner outlet tube. For additional information, refer to Section 303-12 .
2. Remove the drive belt.
    1. Rotate the drive belt tensioner counterclockwise.
    2. Remove the drive belt.




3. **NOTE:** Refer to Component Locations in this section for correct drive belt routing.

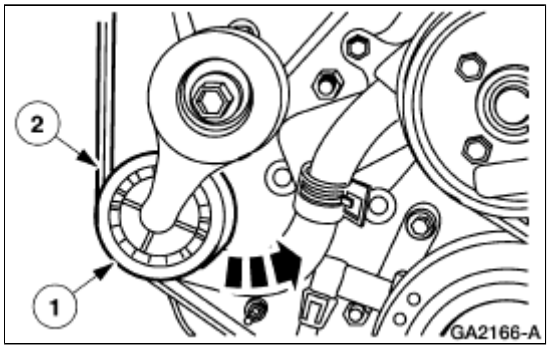
    To install, reverse the removal procedure.

## Belt — 4.0L SOHC

### Removal and Installation

1. Remove the air cleaner outlet tube. For additional information, refer to Section 303-12 .

2. Remove the drive belt.
    1. Rotate the drive belt tensioner counterclockwise.
    2. Remove the drive belt.




3. **NOTE:** Refer to Component Locations in this section for proper drive belt routing.

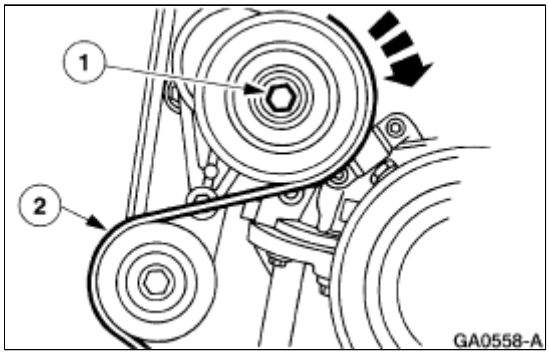
    To install, reverse the removal procedure.

## Belt — 5.0L

### Removal and Installation

1. Remove the air cleaner outlet tube. For additional information, refer to Section 303-12 .

2. Remove the drive belt.
   1. Rotate the drive belt tensioner clockwise.
   2. Remove the drive belt.



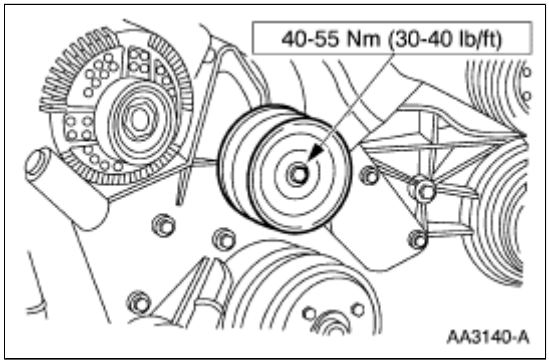

3. **NOTE:** Refer to Component Locations in this section for proper drive belt routing.

   To install, reverse the removal procedure.

## Belt Idler Pulley — 4.0L (Push Rod)

### Removal and Installation

1. Remove the drive belt. For additional information, refer to Belt— 4.0L (Push Rod) in this section.
2. Remove the belt idler pulley.

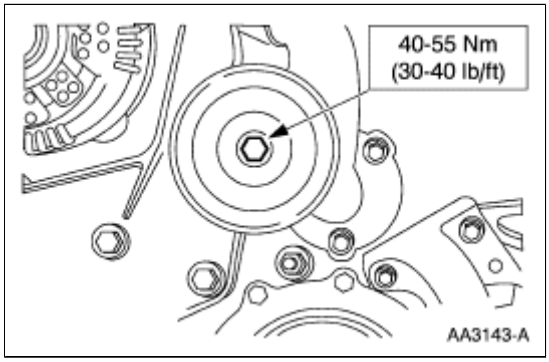



3. To install, reverse the removal procedure.

## Belt Idler Pulley — 4.0L SOHC

### Removal and Installation

1. Remove the drive belt. For additional information, refer to Belt— 4.0L SOHC in this section.
2. Remove the belt idler pulley.

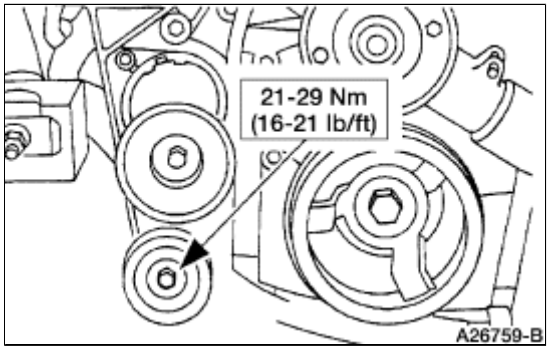



3. To install, reverse the removal procedure.

## Belt Idler Pulley — 5.0L, Lower

### Removal and Installation

1. Remove the drive belt. For additional information, refer to Belt— 5.0L in this section.
2. Remove the belt idler pulley.

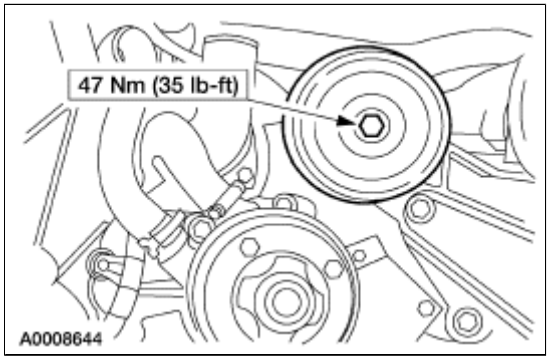



3. To install, reverse the removal procedure.

## Belt Idler Pulley — 5.0L, Upper

### Removal and Installation

1. Remove the drive belt. For additional information, refer to Belt— 5.0L in this section.
2. Remove the belt idler pulley.

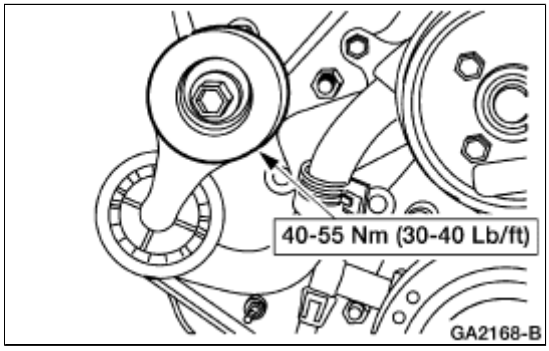



3. To install, reverse the removal procedure.

## Belt Tensioner — 4.0L (Push Rod)

### Removal and Installation

1. Remove the drive belt. For additional information, refer to Belt— 4.0L (Push Rod) in this section.
2. Remove the drive belt tensioner.

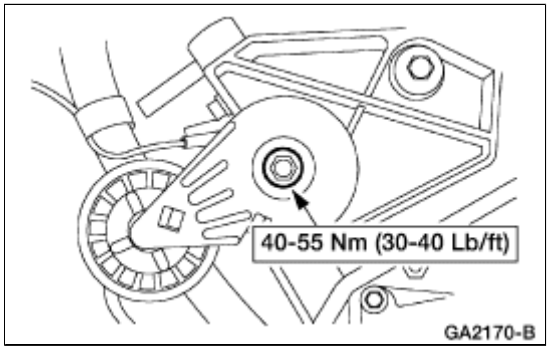



3. To install, reverse the removal procedure.

## Belt Tensioner — 4.0L SOHC

### Removal and Installation

1. Remove the drive belt. For additional information, refer to Belt— 4.0L SOHC in this section.
2. Remove the drive belt tensioner.

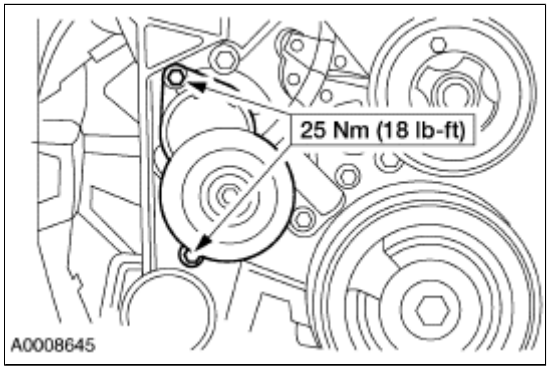



3. To install, reverse the removal procedure.

## Belt Tensioner — 5.0L

### Removal and Installation

1. Remove the drive belt. For additional information, refer to Belt— 5.0L in this section.
2. Remove the drive belt tensioner.




3. To install, reverse the removal procedure.

**General Specifications**

| Item | Specification |
|---|---|
| Normal Engine Cranking Speed rpm | 140-220 |
| Starter Motor Armature Shaft Maximum Runout mm (in) | 0.11 (0.005) |
| Starter Motor Brush Manufactured Length mm (in) | 16.8 (0.66) |
| Starter Motor Brush Spring Tension N (oz) | 18 (64) |
| Starter Motor Commutator Maximum Runout mm (in) | 0.12 (0.005) |
| Starter Motor Diameter mm (in) | 101.6 (4) |
| Starter Motor Maximum Load Amperes | 800 |
| Starter Motor Minimum Stall Torque (at 5 Volts) Nm | 14.7 |
| Starter Motor No Load Current Draw Amperes | 60-80 |
| Starter Motor Normal Load Current Draw Amperes | 130-220 |
| Starting Circuit Maximum Voltage Drop (Engine Temperature Normal) Volts | 0.5 |

**Torque Specifications**

| Description | Nm | lb-ft | lb-in |
|---|---|---|---|
| Brush Plate Bolts | 2-3 | — | 17-26 |
| Solenoid Bolts | 5-10 | — | 44-88 |
| Starter Motor Bolt | 22-28 | 16-20 | — |
| Starter Motor Stud Bolt | 22-28 | 16-20 | — |
| Starter Motor Ground Cable Nut | 20-25 | — | 14-19 |
| Starter Motor Solenoid Relay Switch Terminal Nuts | 5-11 | — | 44-97 |
| Starter Solenoid B-Terminal Nut | 10-15 | — | 88-133 |
| Starter Solenoid S-Terminal Nut | 5-7 | — | 44-62 |
| Battery Cable Clamp Bolts | 7-10 | — | 62-89 |

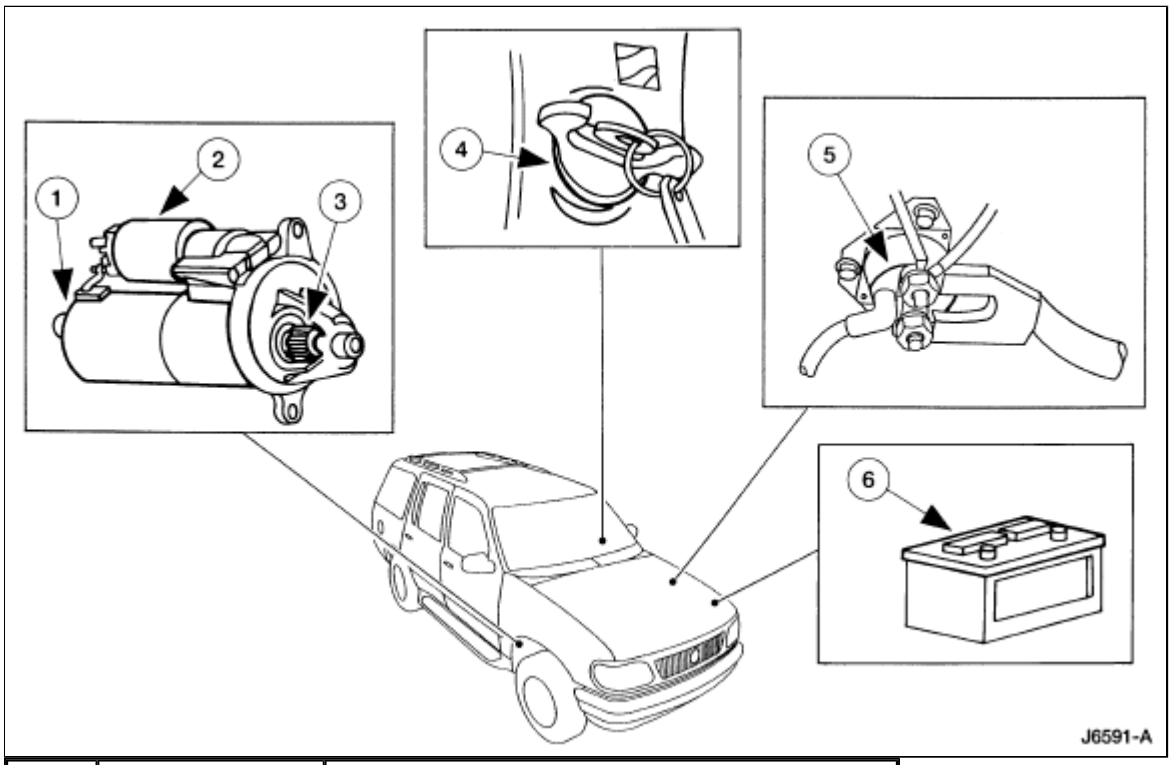
## Starting System

The starting system consists of the:

- starter motor (11002).
- starter solenoid (11390).
- starter drive (11350).
- starter motor solenoid relay switch (11450).
- ignition switch (11572).
- digital transmission range (TR) sensor.
- transmission range (TR) sensor.
- battery (10653).

The function of the starting system is to crank the engine at a speed fast enough to permit the engine to start.

**Component Locations — 5.0L Shown, 4.0L (Push Rod) and 4.0L (SOHC) Similar**




| Item | Part Number | Description |
|---|---|---|
| 1 | 11002 | Starter Motor |
| 2 | 11390 | Starter Solenoid |
| 3 | 11350 | Starter Drive |
| 4 | 11572 | Ignition Switch |
| | | |

| | | |
|---|---|---|
| 5 | 11450 | Starter Motor Solenoid Relay Switch |
| 6 | 10653 | Battery |

## Starting System

Refer to Wiring Diagrams Cell 20 , Starting System for schematic and connector information.

**Special Tool(s)**

| | |
|---|---|
|  ST1137-A | 73 Digital Multimeter<br>105-R0051 or equivalent |
|  ST1179-A | Alternator, Regulator, Battery and Starter Tester (ARBST)<br>010-00725 or equivalent |

**Inspection and Verification**

**WARNING: When servicing starter motor or performing other underhood work in the vicinity of the starter motor (11002), be aware that the heavy gauge battery input lead at the starter solenoid is "electrically hot" at all times. A protective cap or boot is provided over the terminal of this lead and must be replaced after servicing.**

**WARNING: When working in area of the starter motor, be careful to avoid touching hot exhaust components.**

**NOTE:** When working on the starter system, make sure the anti-theft system is deactivated, if equipped.

1. Verify the customer concern by operating the starting system.
2. Visually inspect for obvious signs of mechanical and electrical damage. Refer to the following chart:

**Visual Inspection Chart**

| Mechanical | Electrical |
|---|---|
| • Starter motor<br>• Starter motor relay switch<br>• Brackets<br>• Anti-theft relay | • Battery<br>• Failed fuse 24 (10A)<br>• Damaged wiring harness<br>• Loose or corroded connections |

3. If the concern is not visually evident, verify the symptom and refer to the Symptom Chart.

**Symptom Chart**

**SYMPTOM CHART**

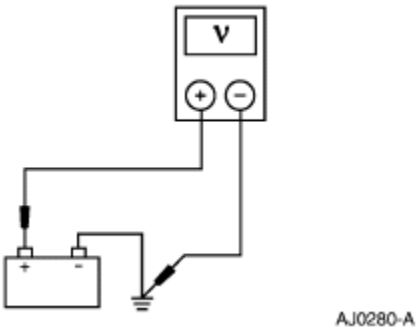
| Condition | Possible Sources | Action |
|---|---|---|
| • The Engine Does Not Crank | • Battery (10653).<br>• Starter motor<br>• Starter motor relay.<br>• Ignition switch.<br>• Damaged fuse.<br>• Anti-theft system.<br>• Circuitry. | • GO to Pinpoint Test A . |
| • The Engine Cranks Slowly | • Battery.<br>• Starter motor.<br>• Circuitry. | • PERFORM the Starter Motor—Voltage Drop Test Component Test. |
| • Unusual Starter Noise | • Starter mounting.<br>• Flywheel/ring gear.<br>• Starter motor. | • GO to Pinpoint Test B . |
| • The Starter Spins But the Engine Does Not Crank | • Starter motor.<br>• Damaged flywheel/ring gear teeth. | • INSPECT the starter motor mounting and engagement. REPLACE the starter motor.<br>• INSPECT the flywheel/ring gear for damaged, missing or worn teeth. REPAIR as required. |

**Pinpoint Tests**

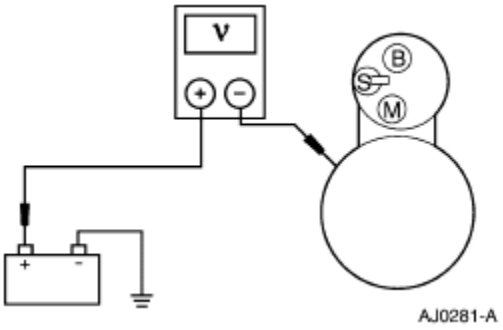
**PINPOINT TEST A: THE ENGINE DOES NOT CRANK OR RELAY CLICKS**

| CONDITIONS | DETAILS/RESULTS/ACTIONS |
|---|---|
| **A1** CHECK THE BATTERY | |
| | 1 Check the battery condition and charge; refer to Section 414-00 .<br><br>• **Is the battery OK?**<br><br>→ **Yes**<br>GO to A2 .<br><br>→ **No**<br>CHARGE or REPLACE the battery as required. TEST the system for normal operation. |
| | |

**A2** CHECK THE BATTERY GROUND CABLE

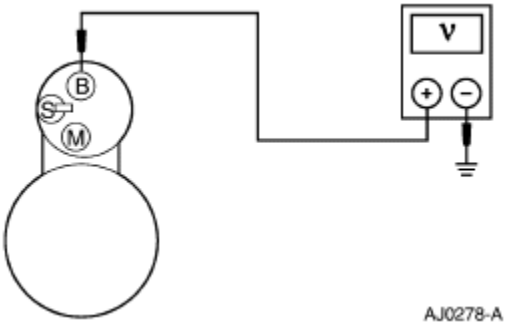
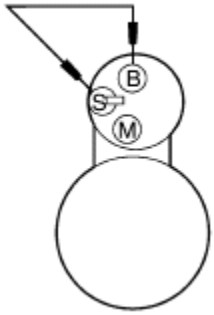
| | |
|---|---|
| 1<br>  <br> | 1 Measure the voltage between the positive battery post and the battery ground cable connection at the cylinder block (6010).<br>• **Is the voltage reading greater than 10 volts?**<br>→ **Yes**<br>GO to A3 .<br>→ **No**<br>REPLACE the battery ground cable. TEST the system for normal operation. |

**A3** CHECK THE STARTER MOTOR GROUND

| | |
|---|---|
| 1<br>  <br> | 1 Measure the voltage between the positive battery post and the starter motor case.<br>• **Is the voltage reading greater than 10 volts?**<br>→ **Yes**<br>GO to A4 .<br>→ **No**<br>CLEAN the starter motor mounting flange and make sure the starter motor is properly mounted. TEST the system for normal operation. |

**A4** CHECK THE POWER SUPPLY TO THE STARTER MOTOR

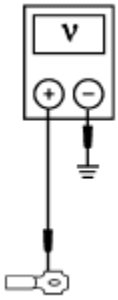
| | |
|---|---|
| 1 | |

| | |
|---|---|
|  <br>2<br>  <br>AJ0278-A | 2 Measure the voltage at the starter motor B terminal.<br><br>• **Is the voltage reading greater than 10 volts?**<br><br>→ **Yes**<br>GO to A5 .<br><br>→ **No**<br>REPLACE the positive battery cable. TEST the system for normal operation. |
| **A5** CHECK THE STARTER MOTOR | |
| 1<br>  <br>AJ0279-A | 1 Connect one end of a jumper wire to the B terminal of the starter motor and momentarily connect the other end to the starter solenoid S-terminal.<br><br>• **Does the starter motor engage and the engine crank?**<br><br>→ **Yes**<br>GO to A6 .<br><br>→ **No**<br>REPLACE the starter motor (11001). TEST the system for normal operation. |
| **A6** CHECK START INPUT TO THE STARTER MOTOR | |
| 1 | |

Starter S Connector

2 Hold the ignition switch to the START position.

3




AJ0285-A

3 Measure the voltage at the starter motor solenoid S connector.

- **Is the voltage reading greater than 10 volts?**

→ **Yes**
CLEAN the starter solenoid S terminal and connector. CHECK the wiring and the starter motor for a loose or intermittent connection. TEST the system for normal operation.

→ **No**
GO to A7 .

**A7** CHECK THE START INPUT TO THE STARTER RELAY

1

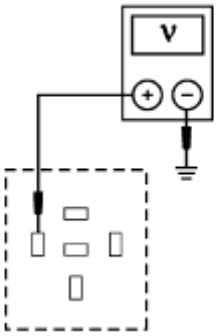
2

Starter Relay

3 Hold the ignition switch in the START position.

4

4 On vehicles equipped with a manual transmission, push in clutch pedal and hold.




5 Measure the voltage at the starter relay connector Pin 86, Circuit 1093 (T/R).

- **Is the voltage reading greater than 10 volts?**

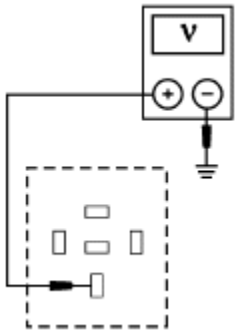
→ **Yes**
GO to A8.

→ **No**
GO to A13.

**A8** CHECK THE BATTERY SUPPLY TO THE STARTER RELAY

1

2



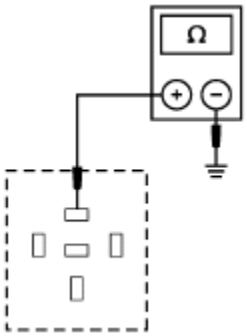
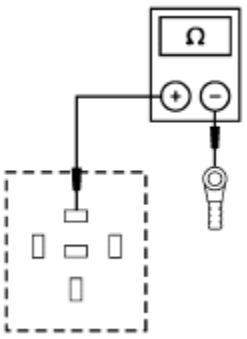

2 Measure the voltage at the starter relay connector Pin 30, Circuit 37 (Y).

- **Is the voltage reading greater than 10 volts?**

→ **Yes**
GO to A9.

→ **No**
REPAIR the open in Circuit 37 (Y). TEST the system for normal operation.

**A9** CHECK CIRCUIT 113 (Y/LB) FOR A SHORT TO GROUND

| | |
|---|---|
| 1<br>  <br>Starter S Connector<br>2<br>  <br> | 2 Measure the resistance between the starter relay connector Pin 87, Circuit 113 (Y/LB) and ground.<br>• **Is the resistance reading less than 10,000 ohms?**<br>→ **Yes**<br>REPAIR Circuit 113 (Y/LB) for a short to ground. TEST the system for normal operation.<br>→ **No**<br>GO to A10 . |
| **A10** CHECK CIRCUIT 113 (Y/LB) FOR AN OPEN | |
| 1<br>  <br> | 1 Measure the resistance of Circuit 113 (Y/LB) between the starter relay connector Pin 87 and the starter S connector.<br>• **Is the resistance reading less than 5 ohms?**<br>→ **Yes**<br>GO to A11 .<br>→ **No**<br>REPAIR Circuit 113 (Y/LB) for an open. TEST the system for normal operation. |
| **A11** CHECK THE PASSIVE ANTI-THEFT SYSTEM (PATS) | |

1

Starter Relay

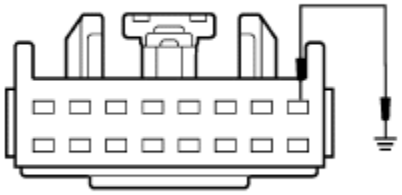
2

Starter S Terminal

3

PATS C222

4



AJ0338-B

5

4 Connect a jumper wire between the PATS module connector Pin C222-1, Circuit 325 (DB/O) and ground.

- **Did the engine crank?**

→ **Yes**
REFER to Section 419-01 to diagnose passive anti-theft system concern.

→ **No**
GO to A12 .

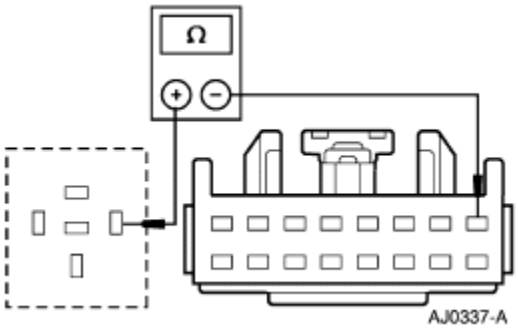
**A12** CHECK CIRCUIT 325 (DB/O) FOR AN OPEN

1

2

Starter Relay

3




3 Measure the resistance of Circuit 325 (DB/O) between the starter relay connector Pin 85 and the PATS module connector Pin C222-1.

- **Is the resistance reading less than 5 ohms?**

→ **Yes**
REPLACE the starter relay. TEST the system for normal operation.

→ **No**
REPAIR Circuit 325 (DB/O) for an open. TEST the system for normal operation.

**A13** CHECK FUSE 24 (7.5A)

1

2

Fuse 24 (7.5A)

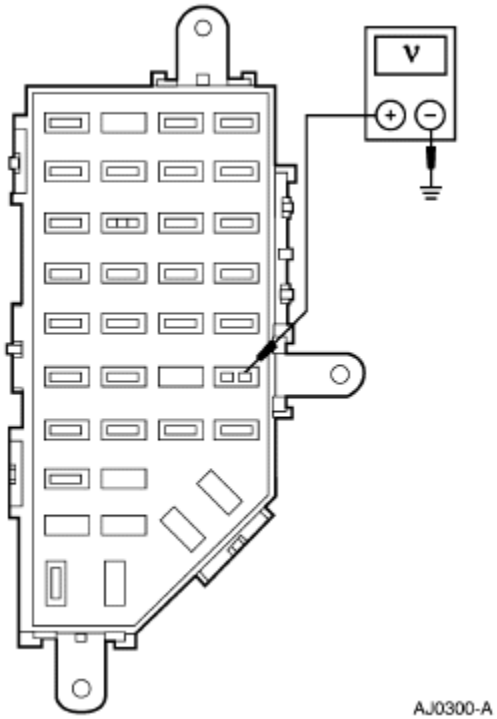
3

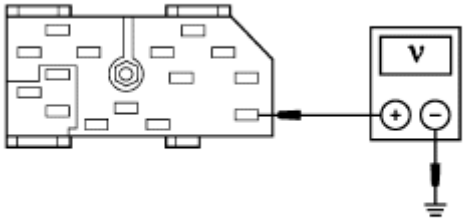

Fuse 24 (7.5A)

- **Is Fuse 24 (7.5A) OK?**

→ **Yes**
GO to A14 .

→ **No**

| | |
|---|---|
| | GO to A23. |
| **A14** CHECK THE INPUT TO FUSE 24 (7.5A) | |
| 2<br>  <br> | 1 Hold the ignition switch to the START position.<br>2 Measure the voltage at the input cavity of Fuse 24 (7.5A).<br>• **Is the voltage reading greater than 10 volts?**<br>→ **Yes**<br>If not equipped with a center console, GO to A18. If equipped with a center console, GO to A22.<br>→ **No**<br>GO to A15. |
| **A15** CHECK THE SUPPLY TO THE IGNITION SWITCH | |
| 1<br>  <br>Ignition Switch C233<br>2 | 2 Measure the voltage at the ignition switch connector Pin C233-B4, Circuit 37 (Y). |



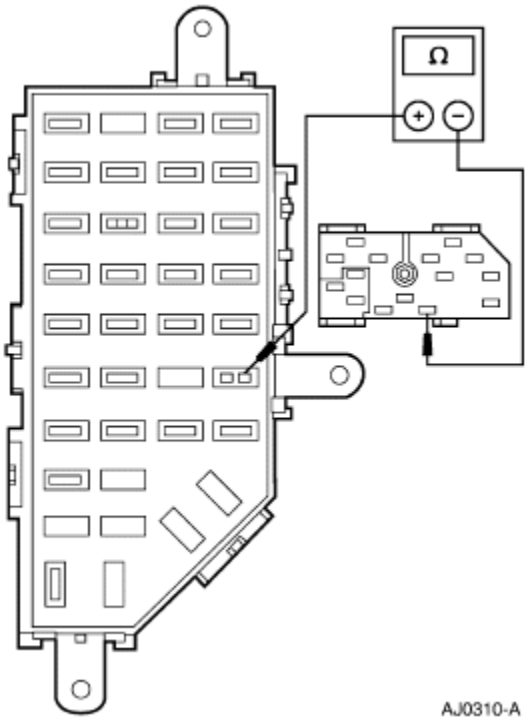

- **Is the voltage reading greater than 10 volts?**

→ **Yes**
GO to A16 .

→ **No**
REPAIR Circuit 37 (Y) for an open. TEST the system for normal operation.

**A16** CHECK CIRCUIT 32 (R/LB) FOR AN OPEN

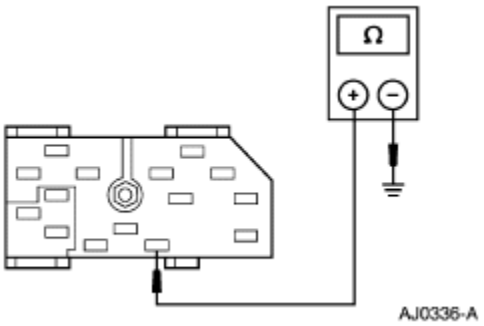
1

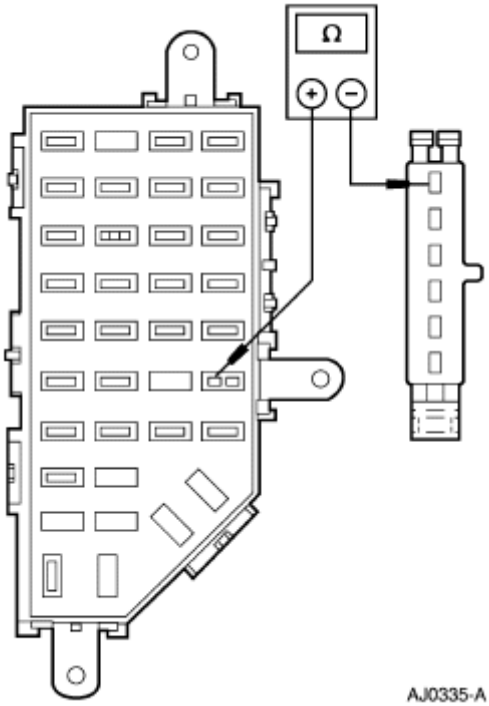



1 Measure the resistance of Circuit 32 (R/LB) between the ignition switch connector Pin C233-STA and the input cavity of Fuse 24 (7.5A).

- **Is the resistance reading less than 5 ohms?**

→ **Yes**
GO to A17 .

| | |
|---|---|
| | → **No**<br>REPAIR Circuit 32 (R/LB) for an open. TEST the system for normal operation. |
| **A17** CHECK CIRCUIT 32 (R/LB) FOR A SHORT TO GROUND | |
| 1<br>  <br> | 1 Measure the resistance between the ignition switch connector Pin C233-STA, Circuit 32 (R/LB) and ground.<br>• **Is the resistance reading less than 10,000 ohms?**<br>→ **Yes**<br>REPAIR Circuit 32 (R/LB) for a short to ground. TEST the system for normal operation.<br>→ **No**<br>REPLACE the ignition switch; refer to Section 211-05 . TEST the system for normal operation. |
| **A18** CHECK CIRCUIT 33 (W/PK) FOR AN OPEN | |
| 1<br>  <br>2 | 1 Disconnect the clutch pedal position (CPP) switch or jumper Connector C209.<br>2 Measure the resistance of Circuit 33 (W/PK) between the CPP switch or jumper connector Pin C209-6 and the fuse junction panel fuse 24 output cavity. |




- **Is the resistance reading less than 5 ohms?**

→ **Yes**
GO to A19 .

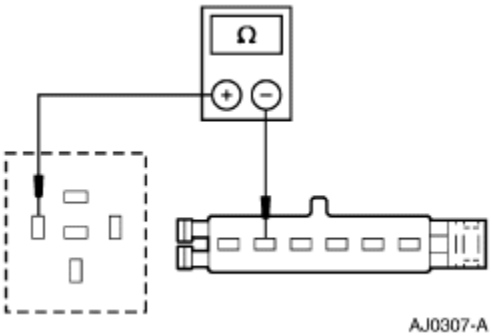
→ **No**
REPAIR Circuit 33 (W/PK) for an open. TEST the system for normal operation.

**A19** CHECK CPP OUTPUT FOR AN OPEN

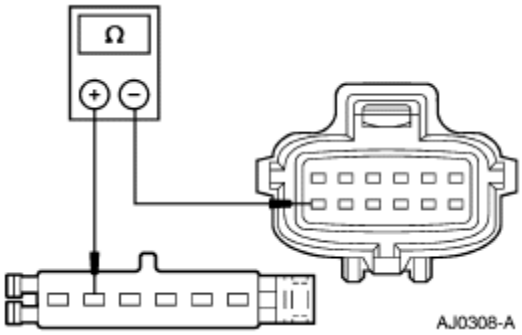
1

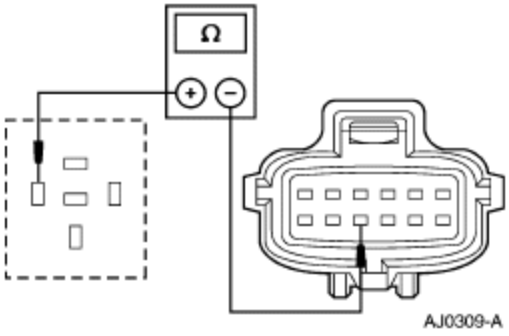
Starter Relay

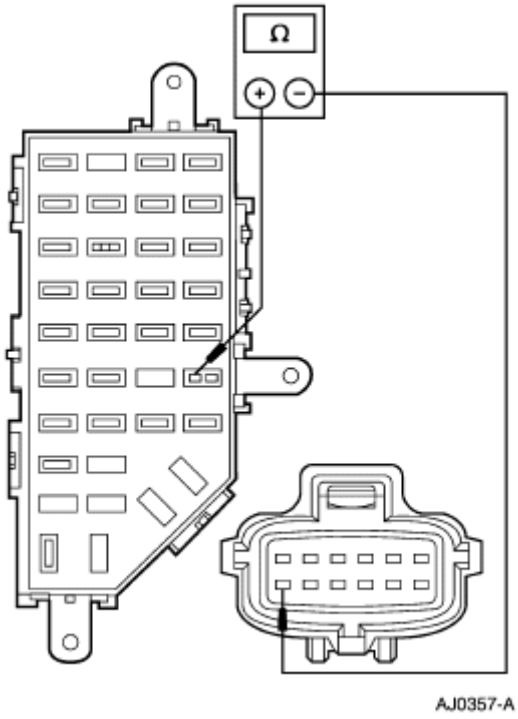
2




2 Measure the resistance between the CPP connector Pin C209-5, Circuit 329 (PK) and the starter relay connector Pin 86, Circuit 1093 (T/R).

| | |
|---|---|
| | • **Is the resistance reading less than 5 ohms?**<br><br>→ **Yes**<br>If equipped with a manual transmission, REPLACE the clutch pedal position switch or jumper. TEST the system for normal operation.<br><br>If equipped with an automatic transmission, CHECK the digital TR sensor adjustment; refer to Section 307-01A (5R55E) or Section 307-01B (4R70W). If the digital TR sensor is adjusted properly, REPLACE the digital TR sensor. TEST the system for normal operation.<br><br>→ **No**<br>If equipped with a manual transmission, REPAIR Circuit 329 (PK) or Circuit 1093 (T/R) for an open. TEST the system for normal operation.<br><br>If equipped with an automatic transmission, GO to A20. |
| **A20** CHECK CIRCUIT 329 (PK) FOR OPEN | |
| 1<br>  <br>Digital TR C112<br>2<br>  <br> | 2 Measure the resistance of Circuit 329 (PK) between the CPP connector Pin C209-5 and the digital TR sensor connector Pin C112-12.<br><br>• **Is the resistance reading less than 5 ohms?**<br><br>→ **Yes**<br>GO to A21.<br><br>→ **No**<br>REPAIR Circuit 329 (PK) for an open. TEST the system for normal operation. |
| **A21** CHECK CIRCUIT 1093 (T/R) FOR AN OPEN | |

| | |
|---|---|
| 1<br>  <br> | 1 Measure the resistance of Circuit 1093 (T/R) between the starter relay connector Pin C86 and the digital TR sensor connector Pin C112-10.<br><br>• **Is the resistance reading less than 5 ohms?**<br><br>→ **Yes**<br>CHECK the digital TR sensor adjustment; refer to Section 307-01A (5R55E) or Section 307-01B (4R70W). If the digital TR sensor is adjusted properly, REPLACE the digital TR sensor. TEST the system for normal operation.<br><br>→ **No**<br>REPAIR Circuit 1093 (T/R) for an open. TEST the system for normal operation. |
| **A22** CHECK CIRCUIT 33 (W/PK) OR CIRCUIT 329 (PK) FOR AN OPEN | |
| 1<br>  <br>Digital TR C112 | |
| 2 | 2 Measure the resistance between the digital TR sensor connector Pin C112-12, Circuit 329 (PK) and the fuse junction panel Fuse 24 output cavity, Circuit 33 (W/PK). |




- **Is the resistance reading less than 5 ohms?**

→ **Yes**
GO to A21 .

→ **No**
REPAIR Circuit 33 (W/PK) or Circuit 329 (PK) for an open. TEST the system for normal operation.

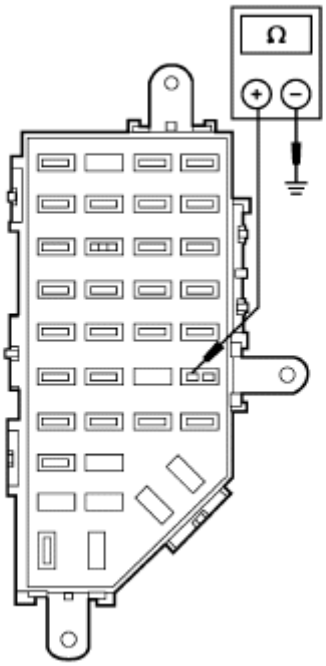
**A23** CHECK FOR A SHORTED SYSTEM

1

Starter Relay

2

2 Measure the resistance between the fuse junction panel Fuse 24 output cavity, Circuit 33 (W/PK) and ground.




AJ0333-A

3 If equipped with a manual transmission, press and hold the clutch pedal.

- **Is the resistance reading greater than 10,000 ohms?**

→ **Yes**
INSPECT all circuits and connections. CHECK for chafed wires or an intermittent connection to ground. REPLACE Fuse 24 (7.5A). TEST the system for normal operation.

→ **No**
If equipped with a center console, GO to A27 .

If not equipped with a center console, GO to A24 .

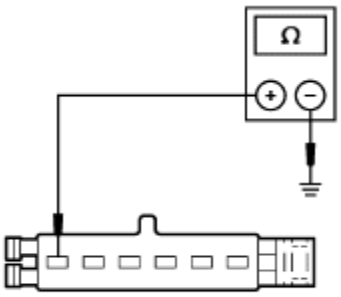
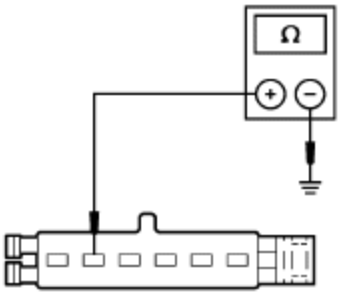
**A24** CHECK THE CPP INPUT FOR A SHORT TO GROUND

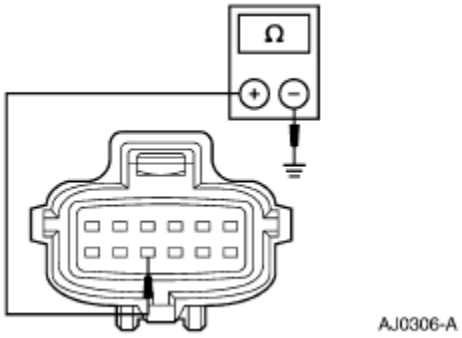
1

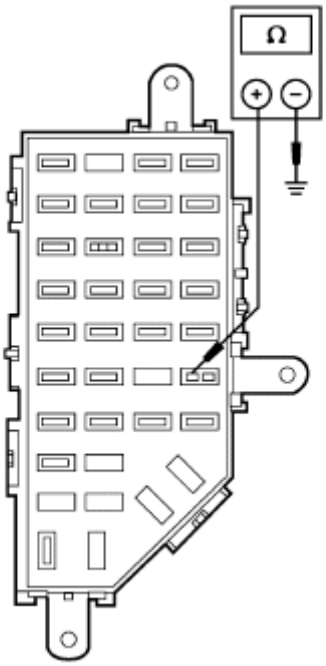
Starter Relay

2

CPP C209

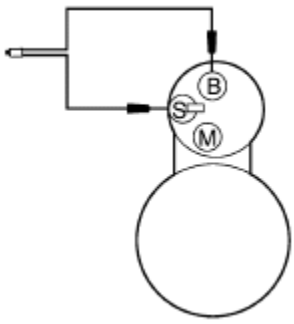
| | |
|---|---|
| 3<br>  <br>AJ0304-A | 3 Measure the resistance between the CPP switch or jumper connector Pin C209-6, Circuit 33 (W/PK) and ground.<br><br>• **Is the resistance reading greater than 10,000 ohms?**<br><br>→ **Yes**<br>If equipped with a manual transmission, REPAIR Circuit 329 (PK) or Circuit 1093 (T/R) for a short to ground. TEST the system for normal operation.<br><br>If equipped with an automatic transmission, GO to A25 .<br><br>→ **No**<br>REPAIR Circuit 33 (W/PK) for a short to ground. TEST the system for normal operation. |
| **A25** CHECK FOR A SHORTED DIGITAL TRANSMISSION RANGE (TR) SENSOR | |
| 1<br>  <br>Digital TR C1005<br><br>2<br>  <br>AJ0305-A | 2 Measure the resistance between the CPP switch or jumper connector Pin C209-5, Circuit 329 (PK) and ground.<br><br>• **Is the resistance reading greater than 10,000 ohms?**<br><br>→ **Yes**<br>GO to A26 . |

| | |
|---|---|
| | → **No**<br>REPAIR Circuit 329 (PK) for a short to ground. TEST the system for normal operation. |
| **A26** CHECK CIRCUIT 1093 (T/R) FOR A SHORT TO GROUND | |
| 1<br>  <br> | 1 Measure the resistance between the digital TR sensor connector Pin C112-10, Circuit 1093 (T/R) and ground.<br>• **Is the resistance reading greater than 10,000 ohms?**<br>→ **Yes**<br>CHECK the digital TR sensor adjustment; refer to Section 307-01A (5R55E) or Section 307-01B (4R70W). If the digital TR sensor is adjusted properly, REPLACE the digital TR sensor. TEST the system for normal operation.<br>→ **No**<br>REPAIR Circuit 1093 (T/R) for a short to ground. TEST the system for normal operation. |
| **A27** CHECK CIRCUIT 33 (W/PK) OR CIRCUIT 329 (PK) FOR A SHORT TO GROUND | |
| 1<br>  <br>Digital TR C209<br>2<br>  <br>Starter Relay<br>3 | 3 Measure the resistance between the fuse junction panel Fuse 24 output cavity, Circuit 33 (W/PK) and ground. |

| | |
|---|---|
|  | • **Is the resistance reading greater than 10,000 ohms?**<br><br>→ **Yes**<br>GO to A26 .<br><br>→ **No**<br>REPAIR circuit 329 (PK) for short to ground. TEST the system for normal operation. |

**PINPOINT TEST B: UNUSUAL STARTER NOISE**

| CONDITIONS | DETAILS/RESULTS/ACTIONS |
|---|---|
| **B1** CHECK STARTER MOUNTING | |
| | 1 Inspect the starter mounting bolts and brackets for looseness.<br><br>• **Is the starter motor mounted properly?**<br><br>→ **Yes**<br>GO to B2 .<br><br>→ **No**<br>INSTALL the starter motor properly; refer to Starter Motor—4.0L or Starter Motor—5.0L in this section. TEST the system for normal operation. |

| **B2** CHECK FOR ENGINE NOISE | |
|---|---|
| 1<br>  <br>2<br>  <br><br>AJ0286-A | 2 Connect a remote starter switch between the starter solenoid B and S terminals.<br><br>3 Engage the starter motor and verify the noise is due to the starter operation.<br><br>• **Is the noise due to the starter motor engagement?**<br><br>→ **Yes**<br>GO to B3 .<br><br>→ **No**<br>REFER to Section 303-00 to continue the diagnosis. |
| **B3** CHECK FOR UNUSUAL WEAR | |
| | 1 Remove the starter motor; refer to Starter Motor—4.0L or Starter Motor—5.0L in this section.<br><br>2 Inspect the ring gear for damaged or worn teeth.<br><br>• **Is the noise due to ring gear tooth damage?**<br><br>→ **Yes**<br>REPLACE the ring gear. EXAMINE the starter pinion teeth. If damaged, REPLACE the starter motor. TEST the system for normal operation.<br><br>→ **No**<br>REPLACE the starter motor. TEST the system for normal operation. |

**Component Tests**

**Starter Motor—Voltage Drop Test**

**WARNING: When servicing the starter motor or performing other underhood work in the vicinity of the starter motor, be aware that the heavy gauge battery input lead at the starter solenoid is "electrically hot" at all times.**

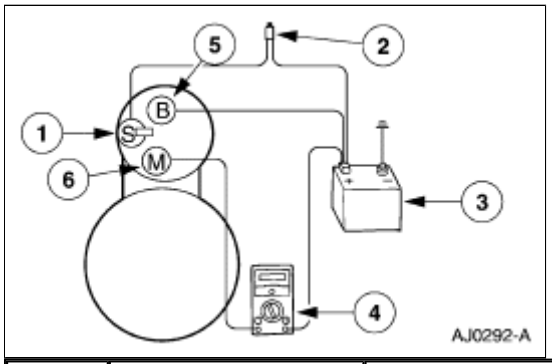
**CAUTION: A protective cap or boot is provided over the battery input terminal on all vehicle lines and must be replaced after servicing. Be sure to disconnect the battery ground cable before servicing the starter motor.**

Always make the Rotunda 73 Digital Multimeter connections at the component terminal rather than at the wiring end connector. Making a connection at the wiring end connector could result in false readings because the meter will not pick up a high resistance between the wiring connector and the component.

**Starter Motor—Motor Feed Circuit**

1. Make sure the battery is fully charged; refer to Section 414-00 .
2. Disconnect the inertia fuel shutoff switch (IFS switch) (9341)
3. Connect a remote starter switch between the starter solenoid S-terminal and the battery positive (+) terminal.
4. Connect the Rotunda 73 Digital Multimeter positive lead to the battery positive (+) post. Connect negative lead to the starter solenoid M-terminal.

**Motor Feed Circuit**



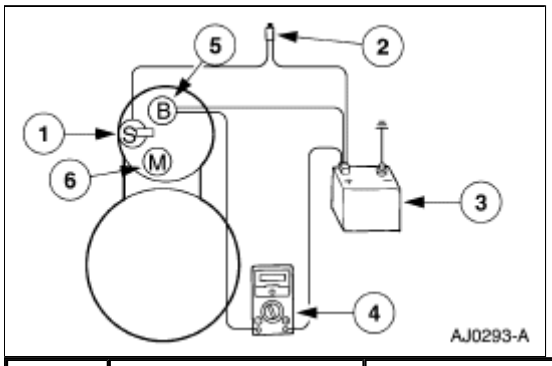

| Item | Part Number | Description |
|---|---|---|
| 1 | — | S-Terminal (Part of 11002) |
| 2 | — | Remote Starter Switch |
| 3 | 10653 | Battery |
| 4 | — | Rotunda 73 Digital Multimeter |
| 5 | — | B-Terminal (Part of 11002) |
| 6 | — | M-Terminal (Part of 11002) |

5. Engage the remote starter switch. Read and record the voltage. The voltage reading should be 0.5 volts or less.

6. If the voltage reading is 0.5 volts or less, go to the Starter Motor—Motor Ground Circuit Component Test.

7. If the voltage reading is greater than 0.5 volts, indicating excessive resistance, move the Rotunda 73 Digital Multimeter negative lead to the starter solenoid B-terminal and repeat the test. If the voltage reading at the B-terminal is lower than 0.5 volts, the concern is either in the connections at the starter solenoid or in the solenoid contacts.

**Motor Feed Circuit**




| Item | Part Number | Description |
|---|---|---|
| 1 | — | S-Terminal (Part of 11002) |
| 2 | — | Remote Starter Switch |
| 3 | 10653 | Battery |
| 4 | — | Rotunda 73 Digital Multimeter |
| 5 | — | B-Terminal (Part of 11002) |
| 6 | — | M-Terminal (Part of 11002) |

8. Remove the cables from solenoid B-, S- and M-terminals. Clean the cables and connections and reinstall the cables to the proper terminals. Repeat Steps 3 through 6. If the voltage drop reading is still greater than 0.5 volts when checked at the M-terminal or less than 0.5 volts when checked at the B-terminal, the concern is in the solenoid contacts. Replace the starter motor.

9. If the voltage reading taken at the solenoid B-terminal is still greater than 0.5 volts after cleaning the cables and connections at the solenoid, the concern is either in the positive (+) battery cable connection or in the positive battery cable itself.

10. By moving the Rotunda 73 Digital Multimeter negative lead toward the battery and checking each mechanical connection point, the excessive voltage drop can be located. When the high reading disappears, the last mechanical point that was checked is the concern. Repair or replace this connection as required.

**Starter Motor—Motor Ground Circuit**

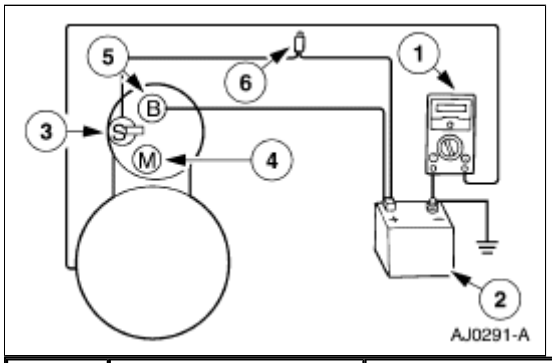
A slow cranking condition can be caused by resistance in the ground or return portion of the cranking circuit. Check the voltage drop in the ground circuit as follows:

1. Disconnect the inertia fuel shutoff switch.

2. Connect a remote starter switch between the starter solenoid S-terminal and the battery positive (+) terminal.

3. Connect the Rotunda 73 Digital Multimeter positive lead to the starter motor housing (the connection must be clean and free of rust or grease). Connect the negative lead to the negative (-) battery terminal.

**Motor Ground Circuit**




| Item | Part Number | Description |
|---|---|---|
| 1 | — | Rotunda 73 Digital Multimeter |
| 2 | 10653 | Battery |
| 3 | — | S-Terminal (Part of 11002) |
| 4 | — | M-Terminal (Part of 11002) |
| 5 | — | B-Terminal (Part of 11002) |
| 6 | — | Remote Starter Switch |

4. Engage the remote starter switch and crank the engine. Read and record the voltage reading. The reading should be 0.2 volts or less.

5. If the voltage drop is more than 0.2 volts, clean the negative cable connections at the battery and body connections, and retest.

6. If the voltage drop is greater than 0.2 volts, determine which way the current is flowing in the cable. Connect the Rotunda 73 Digital Multimeter positive lead to the end of the cable nearest battery positive.

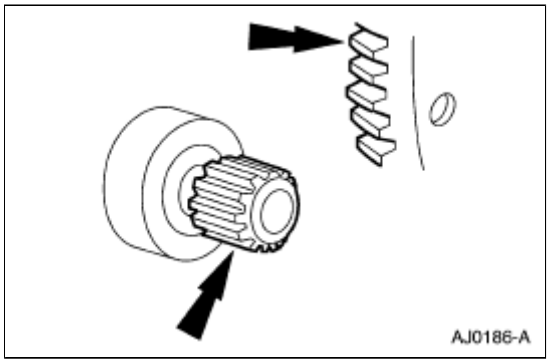
7. Connect the multimeter negative lead to the terminal at the other end of the cable.

8. Crank the engine and observe the voltage reading. The voltage reading should be 0.2 volts or lower. If the voltage drop is too high, clean the terminal ends. Retest, and if still high, replace the cable. If the voltage reading is less than 0.2 volts and the engine still cranks slowly, replace the starter motor.

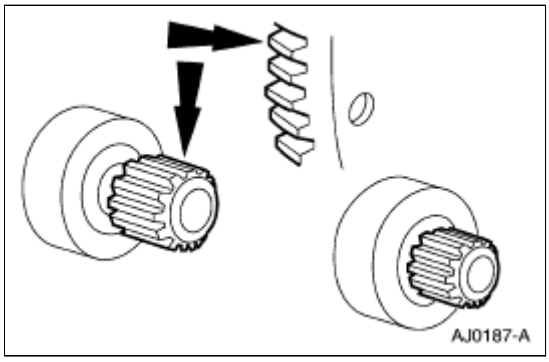
## Starter Drive and Flywheel Ring Gear Inspection

1. Remove the starter motor; refer to Starter Motor—4.0L or Starter Motor—5.0L in this section.

2. Check the wear patterns on the starter drive gear and the flywheel ring gear (6384). If the wear pattern is normal, install the starter motor; refer to Starter Motor—4.0L or Starter Motor—5.0L in this section.




3. If the starter drive gear and the flywheel ring gear are not fully meshing and both of the gears are scored or damaged, replace the starter motor; refer to Starter Motor—4.0L or Starter Motor—5.0L in this section. If necessary, replace the flywheel; refer to Section 303-01A (4.0L Push Rod), Section 303-01B (4.0L SOHC) or Section 303-01C (5.0L).



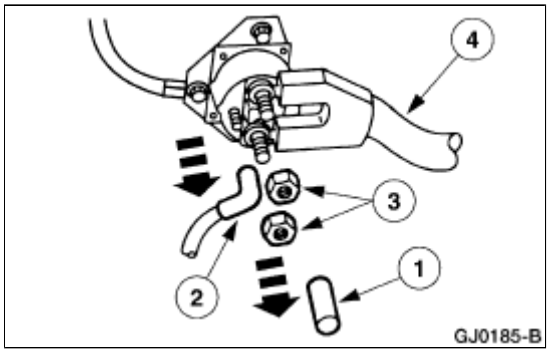
## Relay Switch —4.0L

### Removal

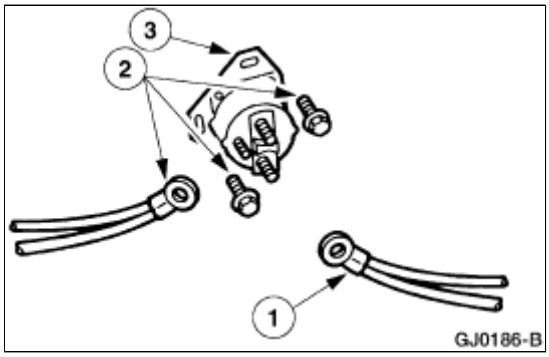
**WARNING: When performing maintenance on the starting system be aware that heavy gauge leads are connected directly to the battery (10653). Make sure protective caps are in place.**

1. Disconnect the battery ground cable (14301).

2. Disconnect the starter motor solenoid relay switch wiring.
    1. Remove the protective cover.
    2. Disconnect the push-on electrical connector.
    3. Remove the nuts.
    4. Remove the cable.

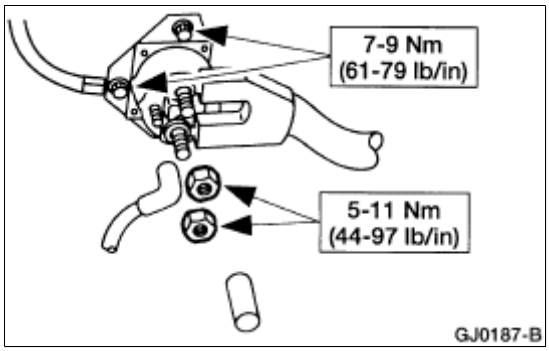



3. Remove the starter motor solenoid relay switch (11450).
    1. Remove the engine sensor/generator wires.
    2. Remove the bolts and ground wire.
    3. Remove the starter motor solenoid relay switch.




### Installation

1. Follow the removal procedure in reverse order.

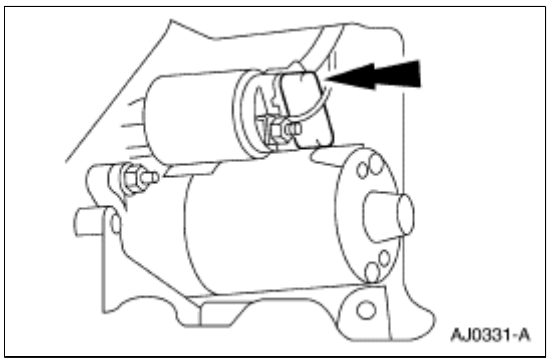

7-9 Nm
(61-79 lb/in)
5-11 Nm
(44-97 lb/in)
GJ0187-B

## Starter Motor —4.0L

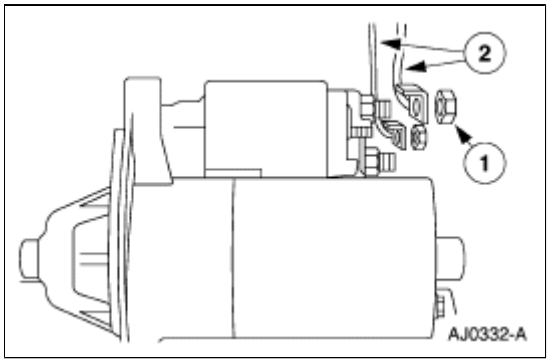
### Removal

**WARNING: When performing maintenance on the starting system be aware that heavy gauge leads are connected directly to the battery. Make sure protective caps are in place when maintenance is completed.**

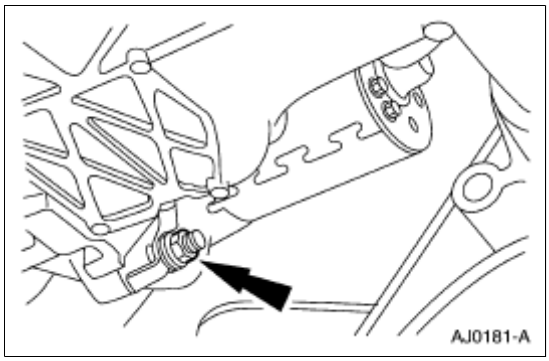
1. Disconnect the battery ground cable (14301).
2. Raise and support the vehicle; refer to Section 100-02 .
3. Remove the starter motor solenoid terminal cover.



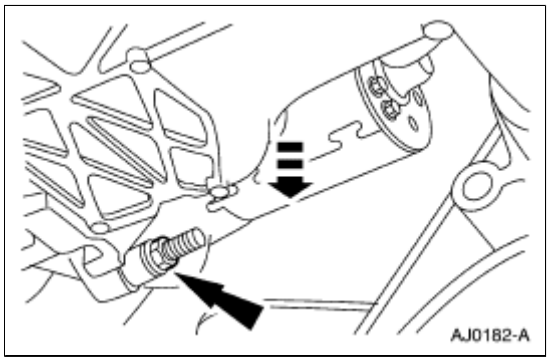

4. Disconnect the starter wires.
    1. Remove the nuts.
    2. Disconnect the wires.




5. Remove the nut and the starter ground cable.

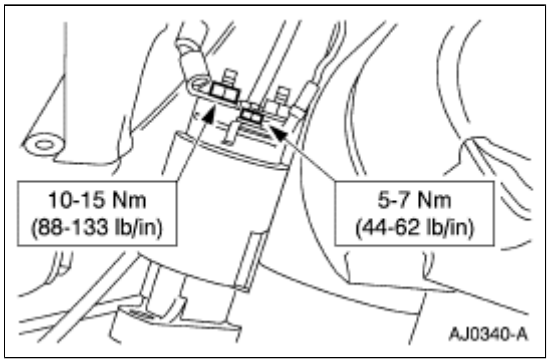


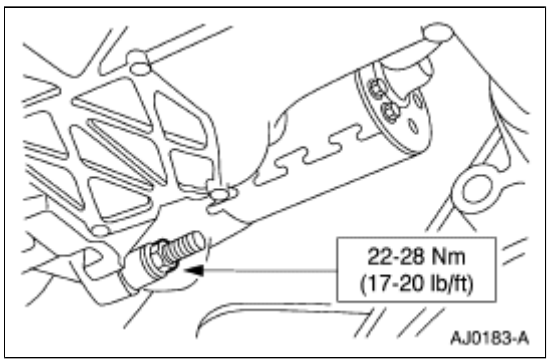

6. Remove the bolt and the starter motor (11002).

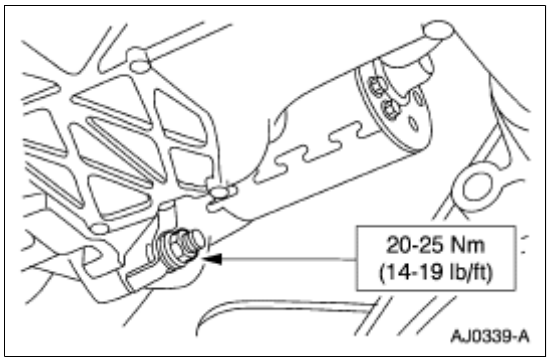



**Installation**

1. Follow the removal procedure in reverse order.



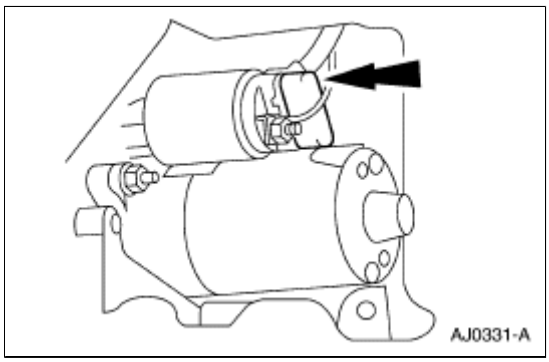

20-25 Nm
(14-19 lb/ft)
AJ0339-A

## Starter Motor —5.0L

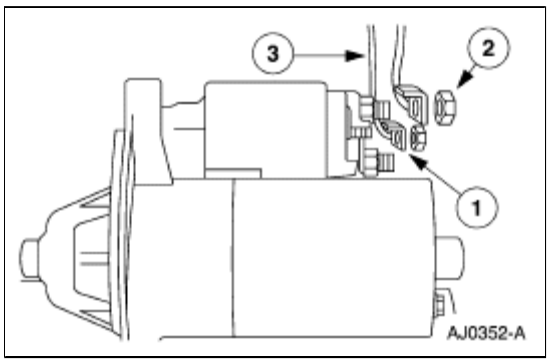
### Removal

**WARNING: When performing maintenance on the starting system be aware that the heavy gauge leads are connected directly to the battery. Make sure the protective caps are in place when maintenance is completed.**

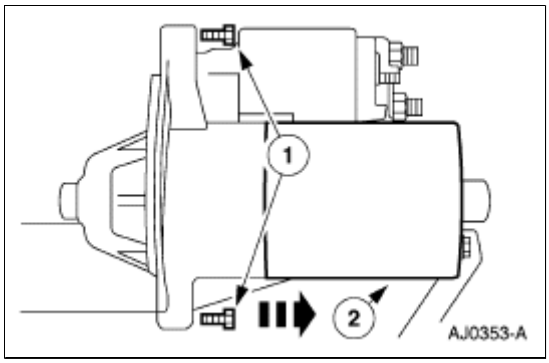
1. Disconnect the battery ground cable (14301).
2. Raise and support the vehicle; refer to Section 100-02 .
3. Remove the starter motor solenoid terminal cover.




4. Disconnect the starter wires.
    1. Disconnect the starter solenoid wire.
    2. Remove the nuts.
    3. Remove the battery cable.

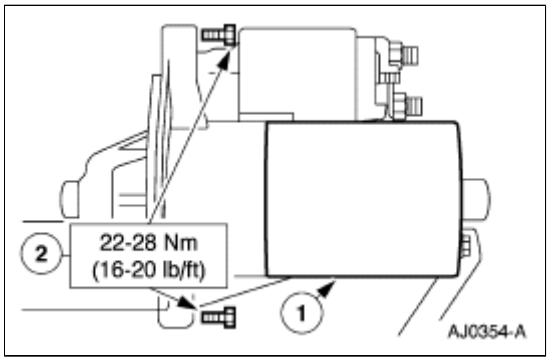



5. Remove the starter motor (11002).
    1. Remove the bolts.
    2. Remove the starter motor.

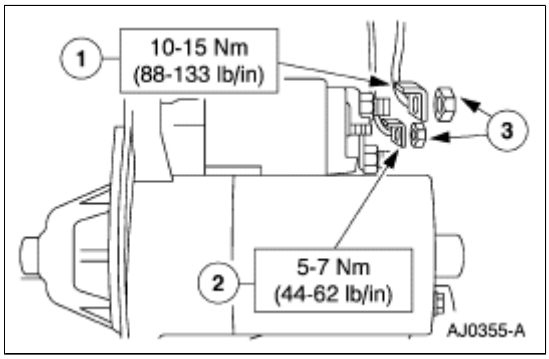



**Installation**

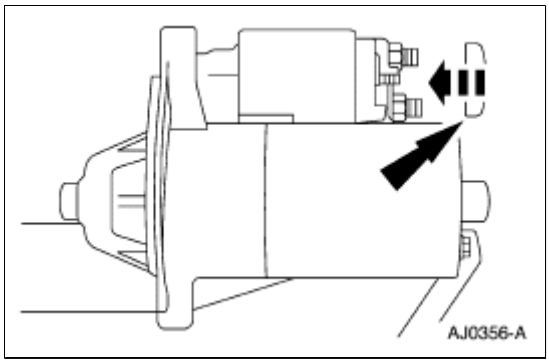
1. Position the starter motor and install the bolts.




2. Connect the starter wiring.
    1. Position the battery cable.
    2. Position the starter solenoid wire.
    3. Install the nuts.




3. Install the starter motor solenoid terminal cover.


AJ0356-A

**General Specifications**

| Item | Specification |
|---|---|
| Base timing | 10 degrees; BTDC Non-adjustable |
| Firing order | 1-4-2-5-3-6 |
| Spark plug gap | 1.3-1.4 mm (.052-.056 in) |
| RH original spark plug | AGRF22PG |
| LH original spark plug | AGRF22P |
| New spark plug (either side) | AGSF22PP |
| **Lubrication** | |
| Silicone Brake Caliper Grease and Dielectric Compound D7AZ-19A331-A | ESE-M1C171-A |

**Torque Specifications**

| Description | Nm | lb-ft | lb-in |
|---|---|---|---|
| Ignition coil bolts | 6 | — | 53 |
| Spark plugs | 20 | 15 | — |

## Engine Ignition

The 4.0L (push rod) engine ignition system consists of the:

- crankshaft position (CKP) sensor
- ignition coil
- spark plug wire
- spark plugs

The ignition system:

- is an electronic ignition system controlled by an electronic engine control integrated into the powertrain control module (PCM).
- base timing is set at 10 degrees before top dead center (BTDC) and is not adjustable.

The crankshaft position (CKP) sensor :

- is a variable reluctance sensor.
- senses a missing tooth on the crankshaft damper pulse ring.
- generates a crankshaft position signal which is sent to the PCM. The PCM counts this signal for engine rpm.

For additional information on the CKP sensor, Refer to Section 303-14 .

The ignition coil :

- changes low voltage pulses from the PCM to high voltage pulses.
- has three transformers.

The spark plug wires carry high voltage pulses from the ignition coil to the spark plugs.

The spark plugs :

- change high voltage pulses into spark at the gap, which ignites the fuel and air mixture.
- have a platinum-enhanced active electrode for long life. The active electrode is different for LH and RH sides.
- have replacements (with both electrodes platinum-enhanced) so they can be used on either side.

## Engine Ignition

Refer to the Powertrain Control/Emissions Diagnosis (PC/ED) manual.

## Ignition Coil

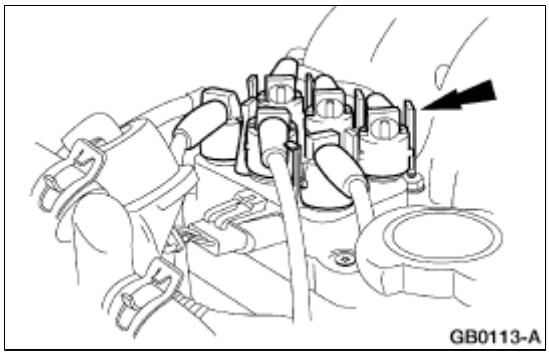
### Removal and Installation

1. Disconnect the battery ground cable. For additional information, refer to Section 414-01 .

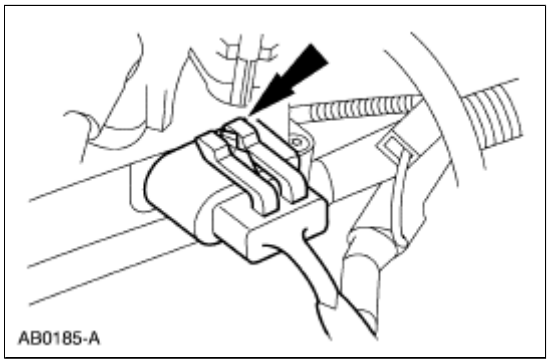
2. **NOTE:** Spark plug wires must be connected to the correct ignition coil terminal. Mark spark plug wire locations before removing them.

   **NOTE:** It is important to twist the spark plug wire boots while pulling upward to avoid possible damage to the spark plug wire.

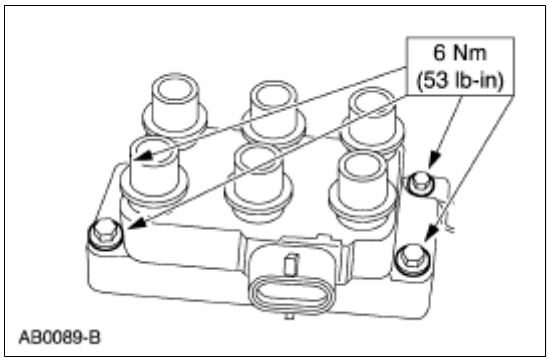
   Squeeze the locking tabs and twist while pulling upward to disconnect the six spark plug wires.




3. Disconnect the ignition coil electrical connector.




4. Remove the ignition coil.




5. **NOTE:** Apply Silicone Brake Caliper Grease and Dielectric Compound D7AZ-19A331-A or equivalent meeting Ford specification ESE-M1C171-A to the inside of the spark plug wire coil boot.

   **NOTE:** Be sure to reinstall the radio ignition interference capacitor under the correct mounting bolt.

   To install, reverse the removal procedure.

## Spark Plug Wire

**Special Tool(s)**

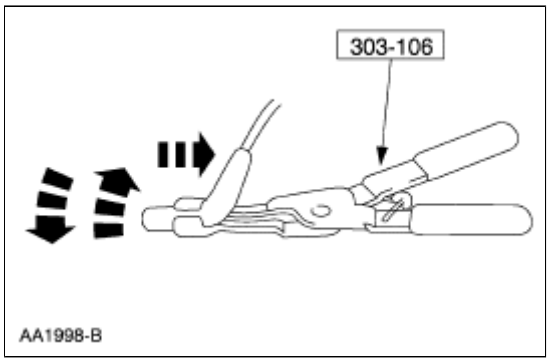
| | |
|---|---|
|  ST1394-A | Spark Plug Wire Remover 303-106 (T74P-6666A) |

**Removal and Installation**

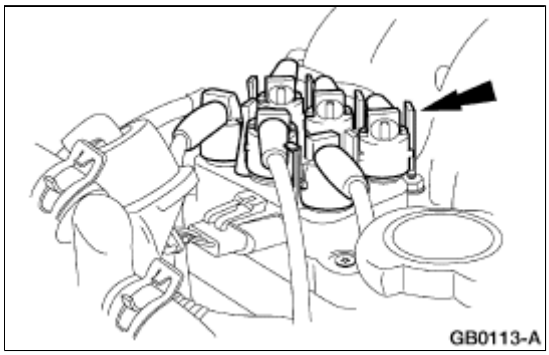
**CAUTION: Spark plug wires must be connected to the correct ignition coil terminal. Mark spark plug wire locations before removing them.**

**NOTE:** It is important to twist the spark plug wire boots while pulling upward to avoid possible damage to the spark plug wire.

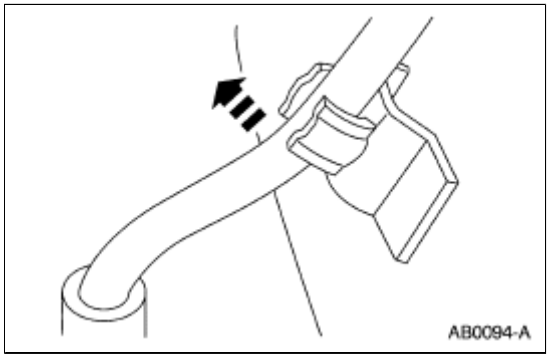
1. Use the special tool with a twisting motion to pull the spark plug wire off the spark plug.




2. Squeeze the locking tabs and twist while pulling upward to disconnect the spark plug wires from the ignition coil.



3. Remove the spark plug wires from the retaining brackets and remove the spark plug wires.




4. **NOTE:** Be sure to orient the spark plug boots so the spark plug wires do not contact the exhaust manifold.

   **NOTE:** Apply Silicone Brake Caliper Grease and Dielectric Compound D7AZ-19A331-A or equivalent meeting Ford specification ESE-M1C171A to the inside of spark plug and ignition coil boots of the spark plug wire.

   To install, reverse the removal procedure.

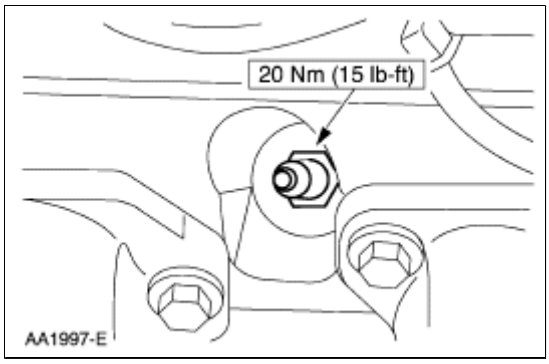
## Spark Plug

### Removal and Installation

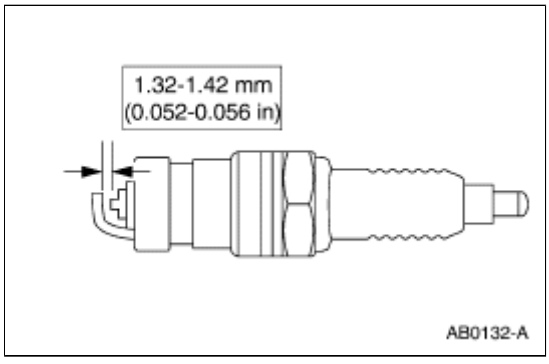
1. Remove the spark plug wires. For additional information, refer to Spark Plug Wire in this section.
2. **NOTE:** Use compressed air to remove any foreign material in the spark plug well before removing the spark plugs.

   **NOTE:** If an original spark plug is reused, make sure it is installed in the same cylinder from which it was taken. New spark plugs can be used in any cylinder.

   Remove the spark plugs.




3. Inspect the spark plugs. For additional information, refer to Section 303-00 .
4. Use a suitable spark plug gap tool to check and adjust the spark plug gap.




5. To install, reverse the removal procedure.

**General Specifications**

| Item | Specification |
|---|---|
| Base timing | 10° BTDC<br>Non-adjustable |
| Firing order | 1-4-2-5-3-6 |
| Spark plug gap | 1.3-1.4 mm (.052-.056 in) |
| RH original spark plug | AGRF22PG |
| LH original spark plug | AGRF22P |
| New spark plug (either side) | AGSF22PP |
| Silicone Brake Caliper Grease and Dielectric Compound D7AZ-19A331-A or equivalent | ESE-M1C171-A |

**Torque Specifications**

| Description | Nm | lb-ft | lb-in |
|---|---|---|---|
| Ignition coil bolts | 6 | — | 53 |
| Spark plugs | 20 | 15 | — |

## Engine Ignition

The ignition system consists of the following:

- crankshaft position (CKP) sensor
- ignition coil
- spark plug wire
- spark plug

The ignition system is:

- an electronic distributorless ignition system (EDIS) is controlled by an electronic engine control integrated into the powertrain control module (PCM).
- set at 10 degrees before top dead center (BTDC) for base timing, and is not adjustable.

The crankshaft position (CKP) sensor:

- is a variable reluctance sensor.
- senses a missing tooth on the crankshaft damper pulse ring.
- generates a crankshaft position signal which is sent to the PCM. The PCM counts this signal for engine rpm.

For additional information on the CKP sensor, refer to Section 303-14 .

The ignition coil:

- changes low voltage pulses from the PCM to high voltage pulses.
- has three transformers.
- fires two spark plugs simultaneously.

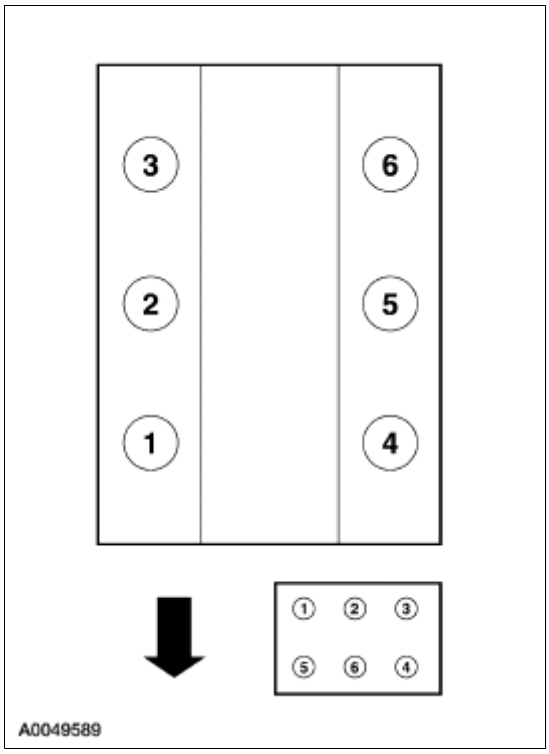
Spark plug wires carry high voltage pulses from the ignition coil to the spark plugs.

The spark plugs:

- change high voltage pulses to spark at the gap, which ignites the fuel and air mixture.

The firing order is: 1-4-2-5-3-6.

**Coil Terminal-To-Cylinder Relationship**


3
6
2
5
1
4
1 2 3
5 6 4
A0049589

## Engine Ignition

Refer to the Powertrain Control/Emissions Diagnosis (PC/ED) manual.

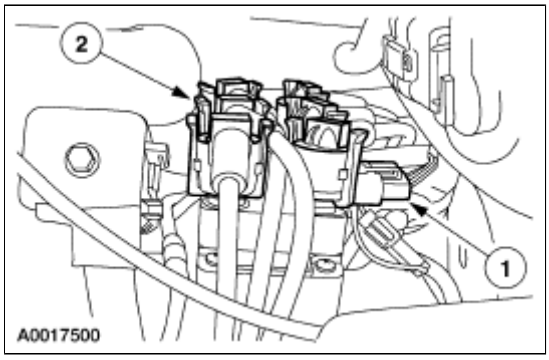
## Ignition Coil

### Removal and Installation

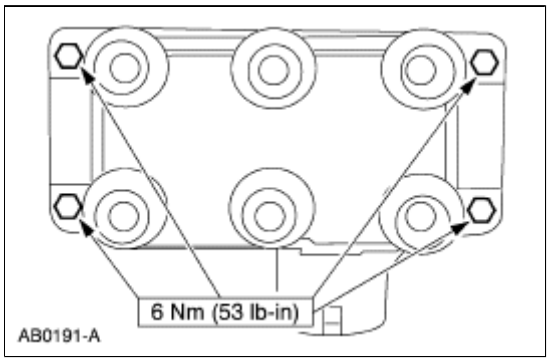
1. Disconnect the battery ground cable. For additional information, refer to Section 414-01 .
2. Disconnect the ignition coil electrical connections.
   1. Disconnect the ignition coil electrical connector.
   2. **CAUTION: It is important to twist the spark plug wire boots while pulling upward to avoid possible damage to the spark plug wire.**

      **NOTE:** Spark plug wires must be connected to the correct ignition coil terminal. Mark spark plug wire locations before removing them.

      Squeeze the locking tabs and twist while pulling upward to disconnect the six spark plug wires.




3. Remove the bolts and the ignition coil.




4. **NOTE:** Apply Silicone Brake Caliper Grease and Dielectric Compound D7AZ-19A331-A or equivalent meeting Ford specification ESE-M1C171-A to the inside of the spark plug wire coil boots.

   **NOTE:** Be sure to reinstall the radio ignition interference capacitor under the correct ignition coil mounting bolt.

   To install, reverse the removal procedure.

## Spark Plug Wire

**Special Tool(s)**

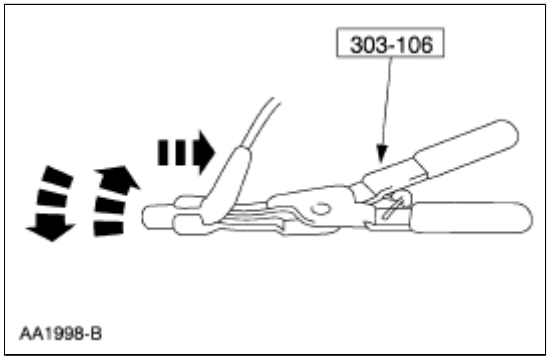
| | |
|---|---|
|  ST1394-A | Spark Plug Wire Remover 303-106 (T74P-6666-A) |

**Removal and Installation**

1. Remove the right front tire. For additional information, refer to Section 204-04 .
2. Remove the right front fenderwell splash shield.
3. **CAUTION: Spark plug wires must be connected correctly. Mark the spark plug wires before removing them.**

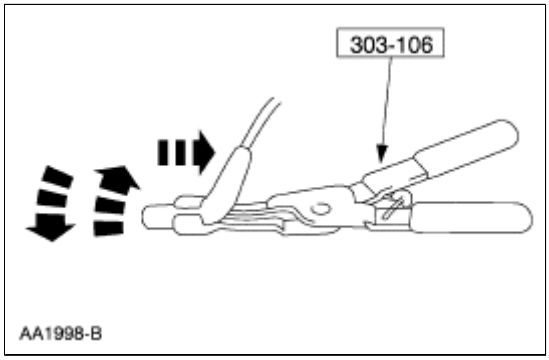
   **CAUTION: It is important to twist the spark plug wire boots while pulling upward to avoid possible damage to the spark plug wire.**

   With a twisting motion, use the special tool to pull the spark plug wires from the right side of the engine.

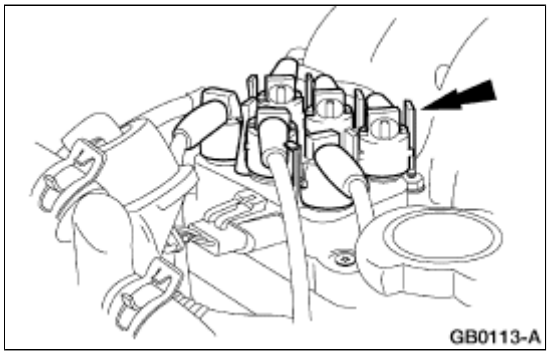
   
   
4. Lower the vehicle.
5. **CAUTION: Spark plug wires must be connected correctly. Mark the spark plug wires before removing them.**

   **CAUTION: It is important to twist the spark plug wire boots while pulling upward to avoid possible damage to the spark plug wire.**

With a twisting motion, use the special tool to pull the spark plug wires from the left side of the engine.




6. Squeeze the locking tabs and twist while pulling upward to remove the spark plug wires from the ignition coil.




7. Disconnect the spark plug wires from the separators and remove the spark plug wires.

8. **CAUTION: Be sure to orient the spark plug boots so the spark plug wires do not contact the exhaust manifold.**

**NOTE:** Apply Silicone Brake Caliper Grease and Dielectric Compound D7AZ-19A331-A or equivalent meeting Ford specification ESE-M1C171-A to the inside of the spark plug and ignition coil boots of the spark plug wire.

To install, reverse the removal procedure.

## Spark Plug

**Special Tool(s)**

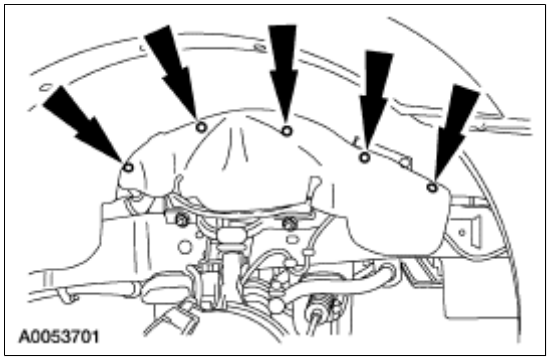
| | |
|---|---|
|  ST1394-A | Spark Plug Wire Remover 303-106 (T74P-6666-A) |

**Material**

| Item | Specification |
|---|---|
| Silicone Brake Caliper Grease and Dielectric Compound D7AZ-19A331-A or equivalent | ESE-M1C171-A |

**Removal and Installation**

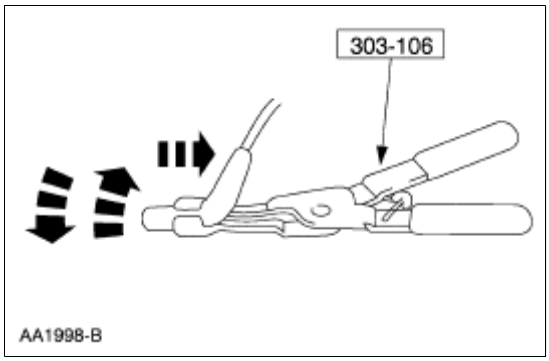
1. Remove the right front tire and wheel. For additional information, refer to Section 204-04 .
2. Remove the right front fenderwell splash shield.




3. **CAUTION: Spark plug wires must be connected correctly. Mark the spark plug wires before removing them.**

   **CAUTION: It is important to twist the spark plug wire boots while pulling upwards, to avoid possible damage to the spark plug wires.**

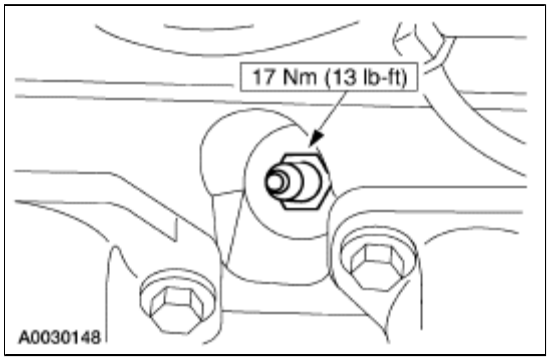
   With a twisting motion, use the special tool to pull the spark plug wires from the right side of the engine.




4. **NOTE:** Use compressed air to remove any foreign material in the spark plug wells before removing the spark plugs.

   **NOTE:** If an original spark plug is reused, make sure it is installed in the same cylinder it was taken from. New spark plugs can be used in any cylinder.

   Remove the RH spark plugs.

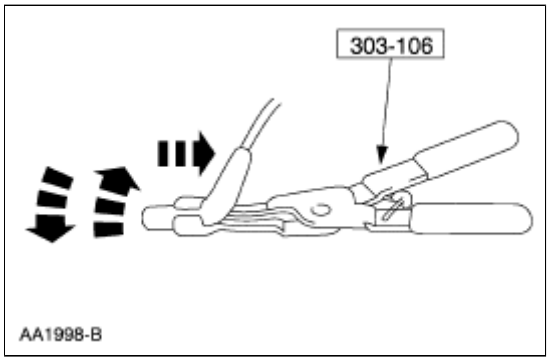



5. Lower the vehicle.

6. **CAUTION: Spark plug wires must be connected correctly. Mark the spark plug wires before removing them.**

   **CAUTION: It is important to twist the spark plug wire boots while pulling upwards, to avoid possible damage to the spark plug wires.**

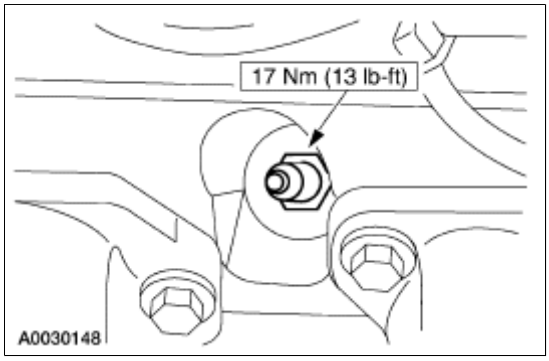
   With a twisting motion, use the special tool to pull the spark plug wires from the left side of the engine.



7. **NOTE:** Use compressed air to remove any foreign material in the spark plug wells before removing the spark plugs.

   **NOTE:** If an original spark plug is reused, make sure it is installed in the same cylinder it was taken from. New spark plugs can be used in any cylinder.

   Remove the LH spark plugs.




8. Inspect the spark plugs. For additional information, refer to Section 303-00 .

9. Use a suitable spark plug gap tool to check and adjust the spark plug gap.

10. To install, reverse the removal procedure.
    - Apply silicone dielectric compound to the inside of the spark plug wire boots.

**General Specifications**

| Item | Specification |
|---|---|
| Base timing | 10° BTDC<br>Non-adjustable |
| Firing order | 1-3-7-2-6-5-4-8 |
| Spark plug gap | 1.3-1.4 mm (.052-.056 in) |
| RH original spark plug | AWSF32EG |
| LH original spark plug | AWSF32E |
| New spark plug (either side) | AWSF32EE |
| **Lubricant** | |
| Silicone Brake Caliper Grease and Dielectric Compound D7AZ-19A331-A | ESE-M1C171-A |

**Torque Specifications**

| Description | Nm | lb-ft | lb-in |
|---|---|---|---|
| Ignition coil bolts | 6 | — | 53 |
| Spark plugs | 20 | 15 | — |

## Engine Ignition

The 5.0L ignition system consists of the:

- crankshaft position (CKP) sensor
- ignition coil
- spark plug wire
- spark plugs

The ignition system is:

- an electronic distributorless ignition system (EDIS) controlled by an electronic engine control integrated into the powertrain control module (PCM).
- set at 10 degrees before top dead center (BTDC) for base timing and it is not adjustable.

The crankshaft position sensor:

- is a variable-reluctance sensor.
- senses a missing tooth on crankshaft damper pulse ring.
- generates a crankshaft position signal which is sent to the powertrain control module. The powertrain control module counts this signal for engine rpm and spark advance.

For additional information on the CKP sensor, refer to Section 303-14 .

The ignition coil:

- changes low voltage pulses from the powertrain control module to high voltage pulses.
- has two transformers.

Spark plug wires:

- carry high voltage pulses from the ignition coil to the spark plugs.

The spark plugs:

- change high voltage pulses to spark at gap which ignites fuel and air mixture.
- have a platinum-enhanced active electrode for long life. The active electrode is different for LH and RH sides.
- have replacements with both electrodes platinum-enhanced so they can be used on either side.

## Engine Ignition

Refer to the Powertrain Control/Emissions Diagnosis (PC/ED) manual.

## Ignition Coil

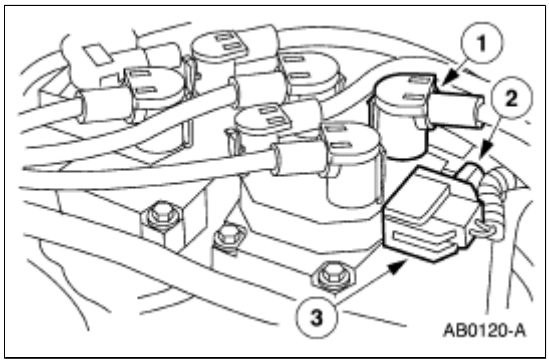
### Removal and Installation

1. Disconnect the battery ground cable. For additional information, refer to Section 414-01 .

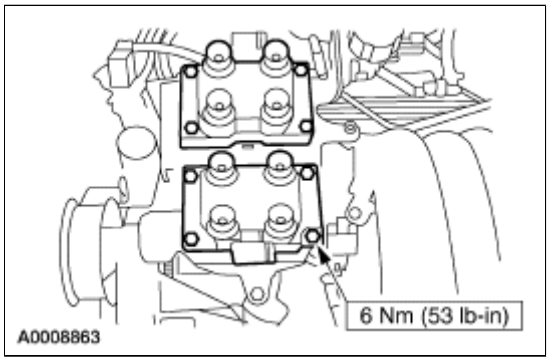
2. **CAUTION: The spark plug wires must be connected to the correct ignition coil terminal. Mark spark plug wire locations before removing them.**

   **CAUTION: It is important to twist the spark plug wire boots while pulling upward to avoid possible damage to the spark plug wire.**

   Disconnect the ignition coil electrical connections.
   1. Squeeze the locking tab and twist while pulling upward to disconnect the eight spark plug wires.
   2. Disconnect the radio ignition interference capacitor electrical connector.
   3. Disconnect the two ignition coil electrical connectors.




3. Remove the ignition coils.




4. **NOTE:** Apply Silicone Brake Caliper Grease and Dielectric Compound D7AZ-19A331-A or equivalent meeting Ford specification ESE-M1C171-A to the inside of the spark plug wire ignition coil boots.

   To install, reverse the removal procedure.

## Spark Plug Wire

**Special Tool(s)**

| | |
|---|---|
|  ST1394-A | Spark Plug Wire Remover 303-106 (T74P-6666-A) |

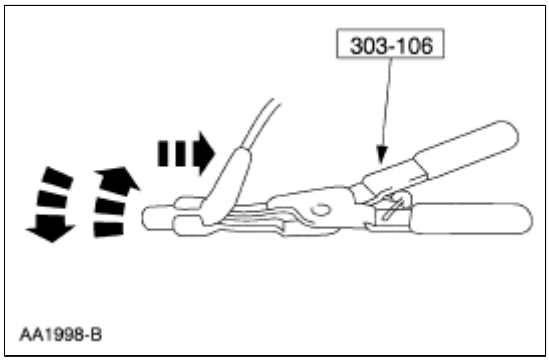
**Removal**

**CAUTION: The spark plug wires must be connected correctly. Mark the spark plug wires before removing them from the spark plugs.**

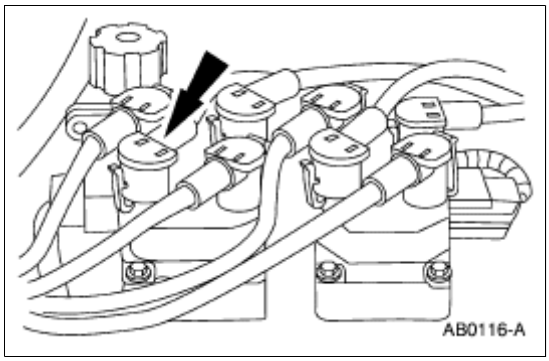
**CAUTION: It is important to twist the spark plug wire boots while pulling upward to avoid possible damage to the spark plug wire.**

**CAUTION: Do not use special tool on spark plug wire boots with metal heat shields. Damage to the spark plug wire boots may occur.**

1. Use the special tool to pull the spark plug wire off the spark plug with a twisting motion.



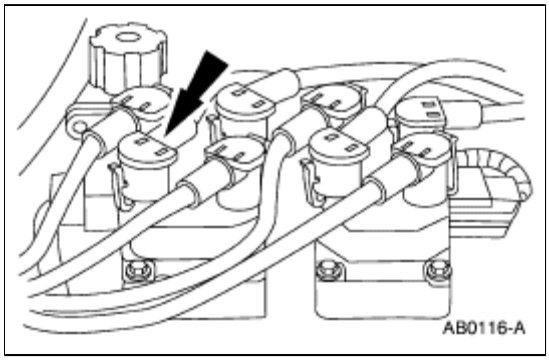

2. Squeeze the locking tab and twist while pulling upward to remove the spark plug wires from the ignition coils.




**Installation**

1. **NOTE:** Apply Silicone Brake Caliper Grease and Dielectric Compound D7AZ-19A331-A or equivalent meeting Ford specification ESE-M1C171-A to the inside of spark plug and ignition coil boots of the spark plug wire.

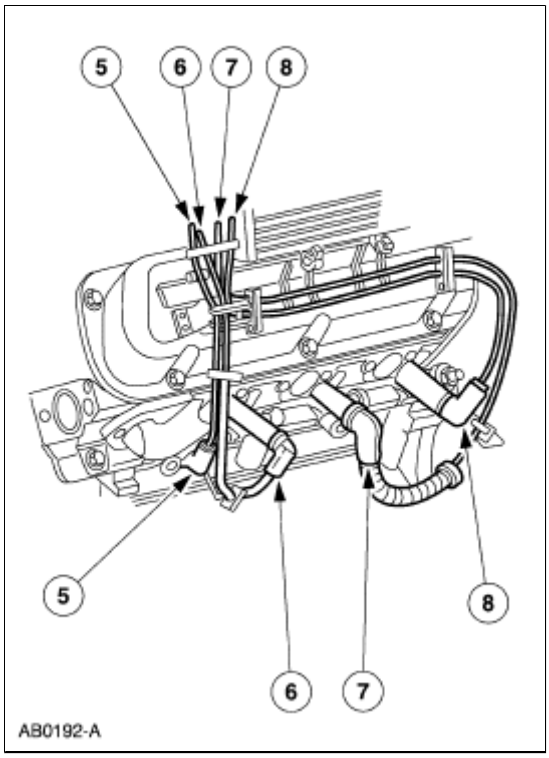
   Connect the spark plug wires to the ignition coils.




2. **CAUTION: Be sure to orient the spark plug boots so the spark plug wires do not contact the exhaust manifold.**

   Install the LH spark plug wire.

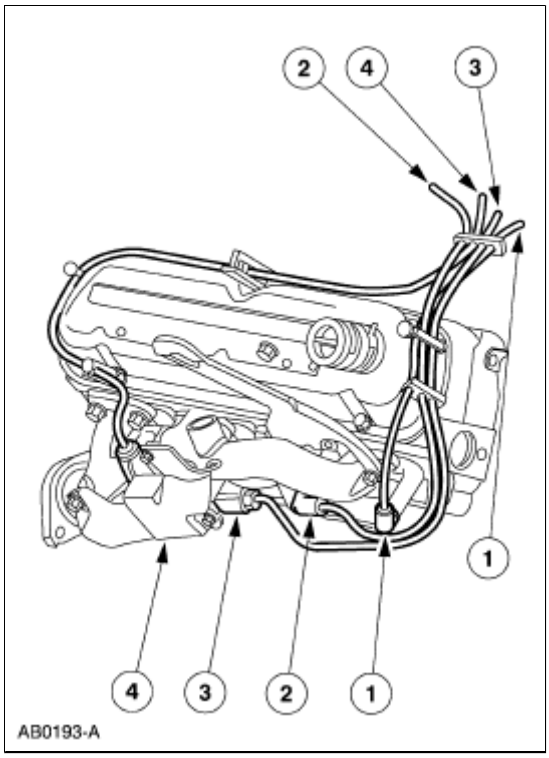
| Item | Orientation |
|---|---|
| 5 | 12 o'clock |
| 6 | 8 o'clock |
| 7 | 4 o'clock |
| 8 | 1 o'clock |




3. **CAUTION: Be sure to orient the spark plug boots so the spark plug wires do not contact the exhaust manifold.**

   Install the RH spark plug wire.

| Item | Orientation |
|---|---|
| 1 | 1 o'clock |
| 2 | 3 o'clock |
| 3 | 3 o'clock |
| 4 | 12 o'clock |


2
4
3
1
4
3
2
1
AB0193-A

## Spark Plug

**Special Tool(s)**

| | |
|---|---|
|  ST1394-A | Spark Plug Wire Remover 303-106 (T74P-6666-A) |

**Material**

| Item | Specification |
|---|---|
| Silicone Brake Caliper Grease and Dielectric Compound D7AZ-19A331-A or equivalent | ESE-M1C171-A |

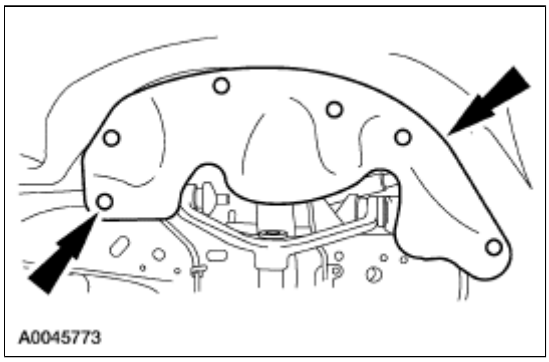
**Removal and Installation**

**CAUTION: The spark plug wires must be connected correctly. Mark the spark plug wires before removing them from the spark plugs.**

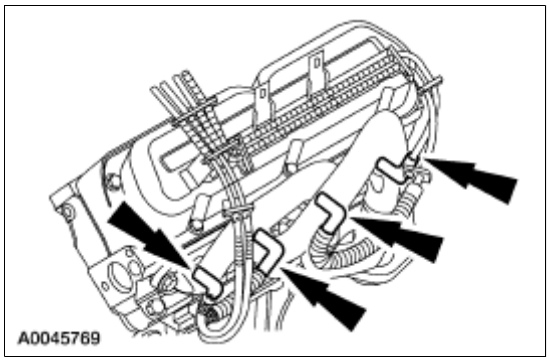
**CAUTION: It is important to twist the spark plug wire boots while pulling upward to avoid possible damage to the spark plug wires.**

**CAUTION: Do not use a special tool on spark plug wire boots with metal heat shields. Damage to the spark plug wire boots can occur.**

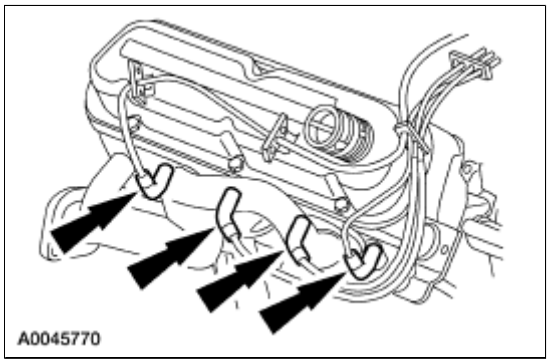
1. Raise and support the vehicle. For additional information, refer to Section 100-02 .
2. Remove the pushpins and the LH and RH front wheel well splash shields.




3. Disconnect the left side spark plug wires.



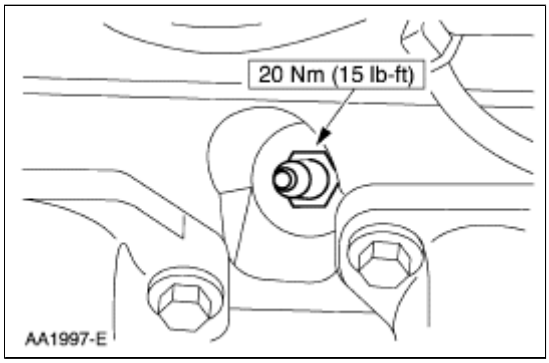

4. Disconnect the right side spark plug wires.




5. **NOTE:** Use compressed air to remove any foreign material from the spark plug well before removing the spark plugs.

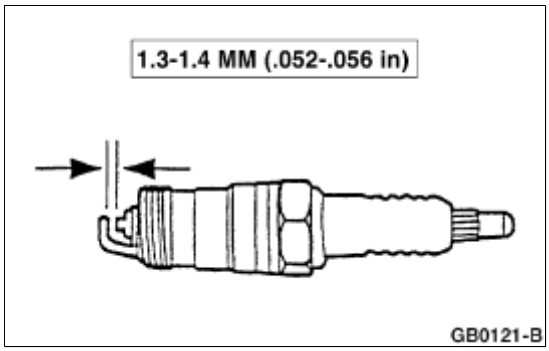
   **NOTE:** If an original spark plug is reused, make sure it is installed in the same cylinder it was taken from. New spark plugs can be used in any cylinder.

   Remove the spark plugs.




6. Inspect the spark plugs. For additional information, refer to Section 303-00 .

7. Use a suitable spark plug gap tool to check and adjust the spark plug gap.




8. To install, reverse the removal procedure.
    - Lightly coat the inside of the spark plug boots with brake caliper grease.

**Torque Specifications**

| Description | Nm | lb-ft | lb-in |
|---|---|---|---|
| **5.0L** | | | |
| Differential pressure feedback EGR nuts | 4.5-7 | — | 41-62 |
| EGR tube fittings | 34-48 | 26-35 | — |
| EGR valve bolts | 20 | 15 | — |
| EGR vacuum regulator solenoid nuts | 8-12 | — | 71-106 |
| **4.0L (Push Rod)** | | | |
| Differential pressure feedback EGR screws | 8-10 | — | 72-89 |
| EGR tube bracket (upper) stud | 40 | 30-40 | — |
| EGR tube fittings (lower) | 34-46 | 25-33 | — |
| EGR valve bolts | 20 | 15 | — |
| EGR vacuum regulator solenoid nuts | 8-12 | — | 71-106 |
| Oil level indicator tube nut | 20-30 | 15-22 | — |
| Upper EGR tube retaining stud bolt | 40-55 | 30-40 | — |
| **4.0L SOHC** | | | |
| Differential pressure feedback EGR bolts | 8-10 | — | 72-89 |
| EGR tube bracket (upper) bolt | 7.6-10.4 | — | 68-92 |
| EGR tube fittings (lower) | 34-46 | 25-33 | — |
| EGR tube fittings (upper) | 34-46 | 25-33 | — |
| EGR valve bolts | 20 | 15 | — |
| EGR vacuum regulator solenoid nuts | 8-12 | — | 71-106 |
| Power steering bracket bolts | 7.6-10.4 | — | 68-92 |
| Engine accessory bracket bolts | 40.3-54.7 | 30-40 | — |

## Engine Emission Control

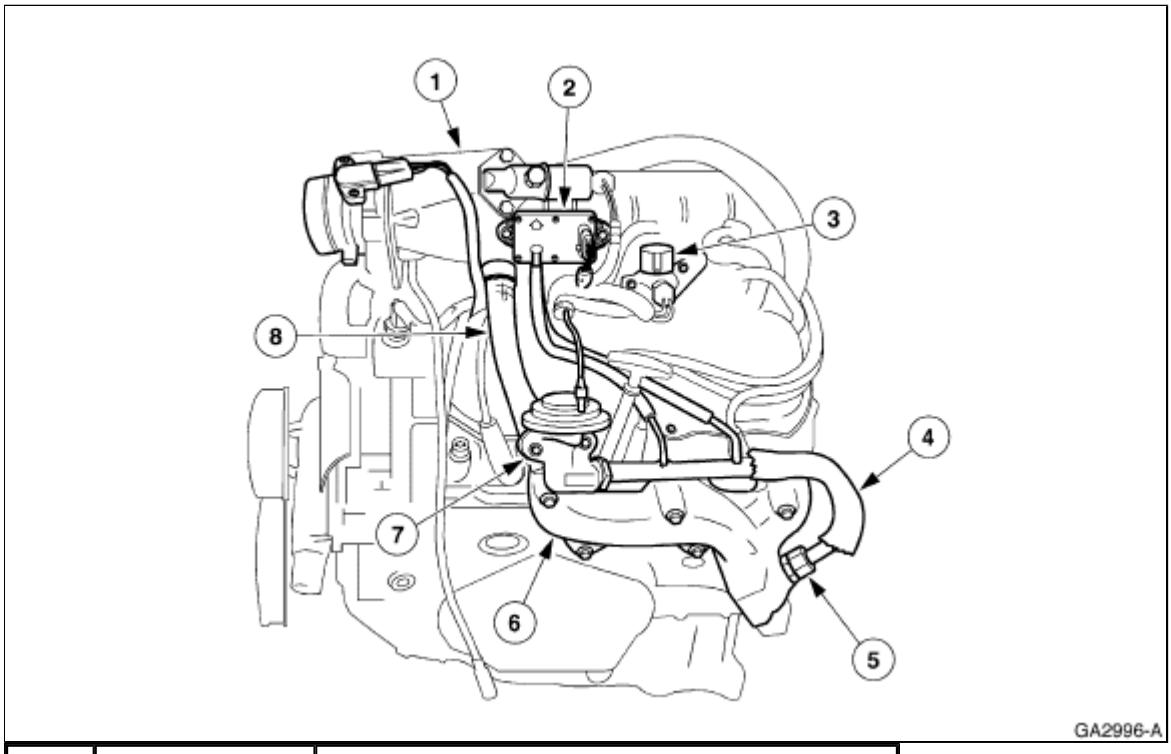
The engine emission control system consists of the:

- EGR valve (EGR valve) (9D475)
- differential pressure feedback EGR
- EGR vacuum regulator solenoid (9J459)
- EGR tube

The engine emissions control system:

- cycles crankcase gases back through the engine intake system.
- regulates ventilating air and blow-by fuel vapors.
- reintroduces exhaust gases into the combustion cycle.
- assists in the reduction of nitrogen oxides.

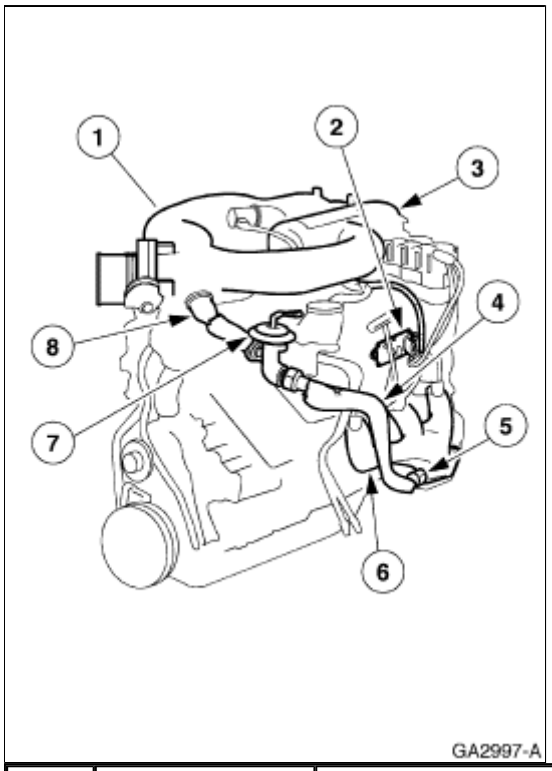
**4.0L (Push Rod)**




| Item | Part Number | Description |
|---|---|---|
| 1 | 9424 | Intake manifold |
| 2 | 9J433 | Differential pressure feedback EGR |
| 3 | 9J459 | EGR vacuum regulator solenoid |
| 4 | 9E469 | EGR tube, lower |
| 5 | 9F485 | EGR valve tube to manifold connector |

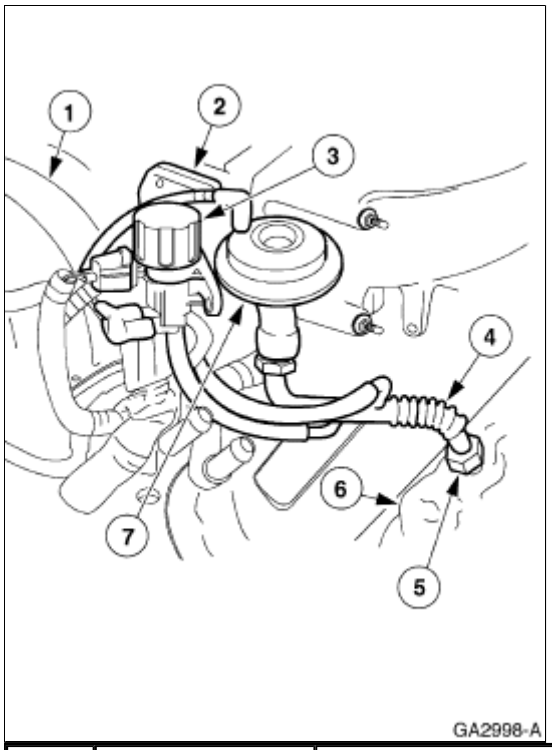
| | | |
|---|---|---|
| 6 | 9430 | Exhaust manifold |
| 7 | 9D475 | EGR valve |
| 8 | 9E469 | EGR tube, upper |

**4.0L SOHC**




| Item | Part Number | Description |
|---|---|---|
| 1 | 9424 | Intake manifold |
| 2 | 9J433 | Differential pressure feedback EGR |
| 3 | 9J459 | EGR vacuum regulator solenoid |
| 4 | 9E469 | EGR tube, lower |
| 5 | 9F485 | EGR valve tube to manifold connector |
| 6 | 9430 | Exhaust manifold |
| 7 | 9D475 | EGR valve |
| 8 | 9E469 | EGR tube, upper |

**5.0L**




| Item | Part Number | Description |
|---|---|---|
| 1 | 9424 | Intake manifold |
| 2 | 9J433 | Differential pressure feedback EGR |
| 3 | 9J459 | EGR vacuum regulator solenoid |
| 4 | 9D477 | EGR tube |
| 5 | 9F485 | EGR valve tube to manifold connector |
| 6 | 9430 | Exhaust manifold |
| 7 | 9D475 | EGR valve |

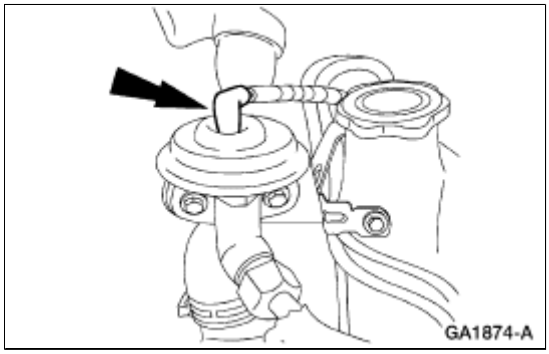
## Engine Emission Control

Refer to the Powertrain Control/Emissions Diagnosis (PC/ED) manual.

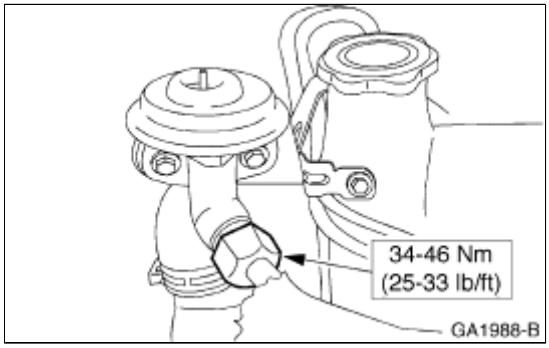
## EGR Valve —4.0L SOHC

### Removal and Installation

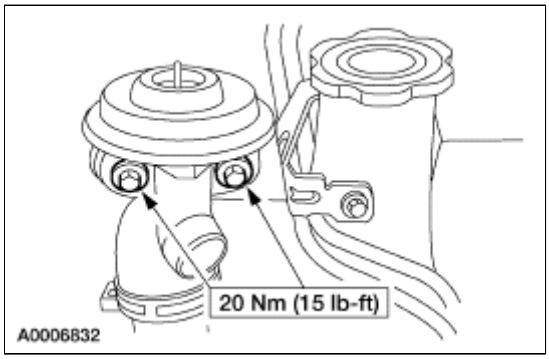
1. Disconnect the EGR valve vacuum connection.




2. Disconnect the EGR tube upper fitting.




3. Remove the EGR valve bolts and the EGR valve.



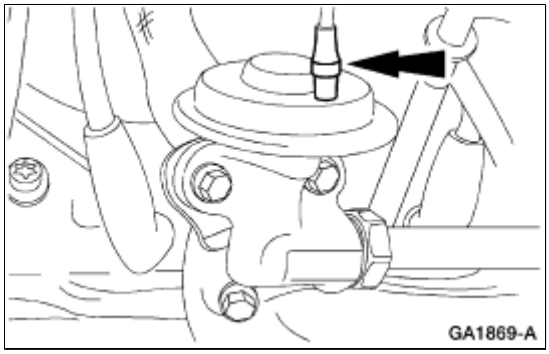

4. **NOTE:** The EGR valve sealing surfaces are soft metals.

   To install, reverse the removal procedure.
   - Carefully clean all sealing surfaces and install a new EGR valve gasket.

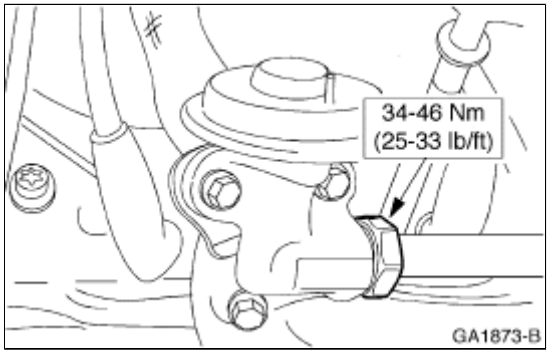
## EGR Valve —4.0L (Push Rod)

### Removal and Installation

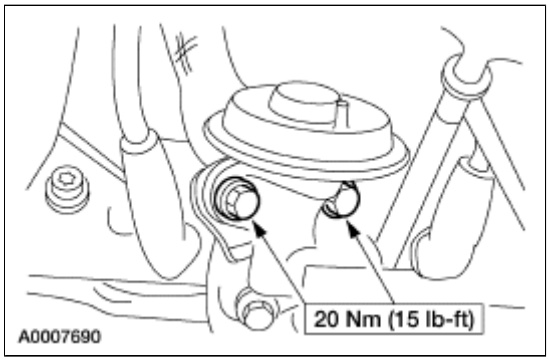
1. Disconnect the EGR valve vacuum connection.




2. Disconnect the lower EGR tube upper fitting.




3. Remove the EGR valve bolts and the EGR valve.



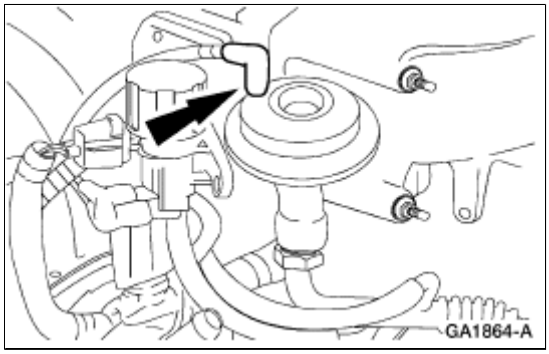

4. **NOTE:** The EGR valve sealing surfaces are soft metals.

   To install, reverse the removal procedure.
   - Carefully clean all sealing surfaces and install a new EGR valve gasket.

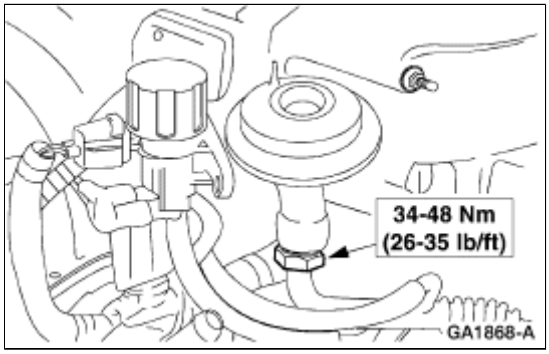
## EGR Valve —5.0L

### Removal and Installation

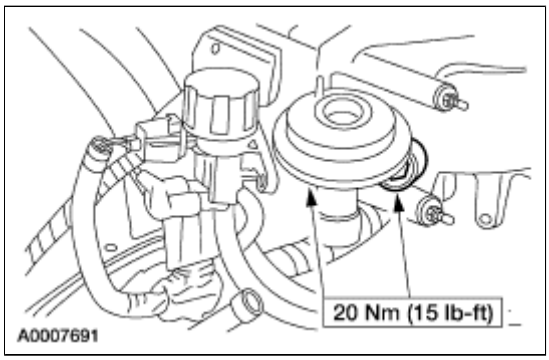
1. Disconnect the EGR valve vacuum connection.




2. Disconnect the EGR tube upper fitting.




3. Remove the two bolts and the EGR valve.



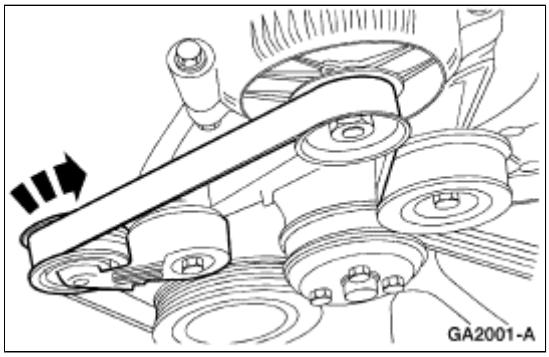

4. **NOTE:** The EGR valve sealing surfaces are soft metals.

   To install, reverse the removal procedure.
   - Carefully clean all sealing surfaces and install a new EGR valve gasket.

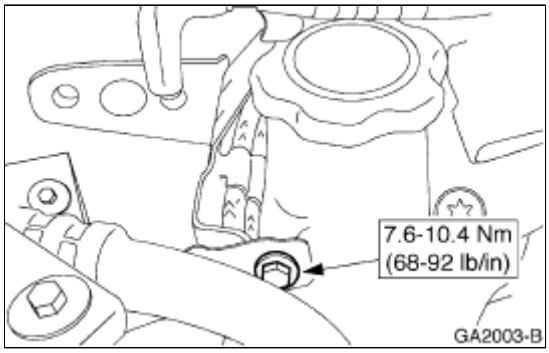
## EGR Valve Tube —Upper, 4.0L SOHC

### Removal and Installation

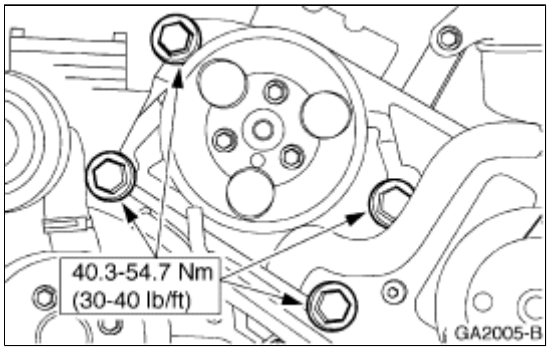
1. Remove the EGR valve. For additional information, refer to EGR Valve—4.0L SOHC in this section.
2. Remove the air cleaner outlet tube. For additional information, refer to Section 303-12 .
3. Release the tension on the accessory drive belt and position the belt aside.



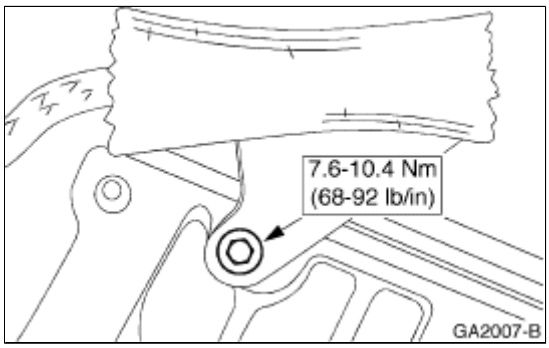

4. Remove the bolt.



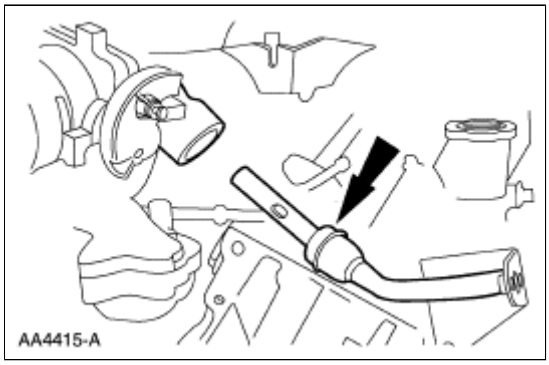

5. Remove the bolts and positon the engine accessory bracket forward.



6. Remove the bolt.




7. Remove the upper EGR tube.
    1. Inspect the O-ring seal and install a new O-ring seal if necessary.



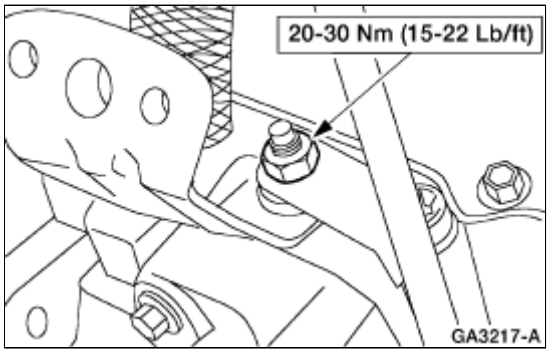

8. To install, reverse the removal procedure.

## EGR Valve Tube —Upper, 4.0L (Push Rod)

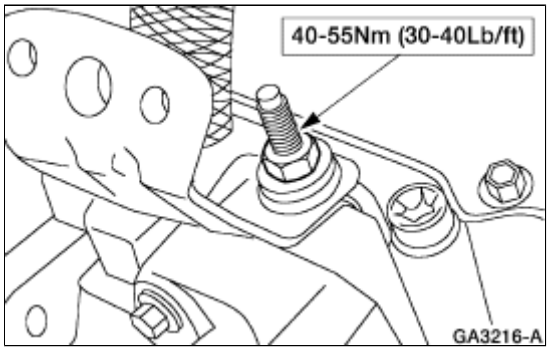
### Removal and Installation

1. Remove the EGR valve. For additional information, refer to EGR Valve—4.0L (Push Rod) in this section.

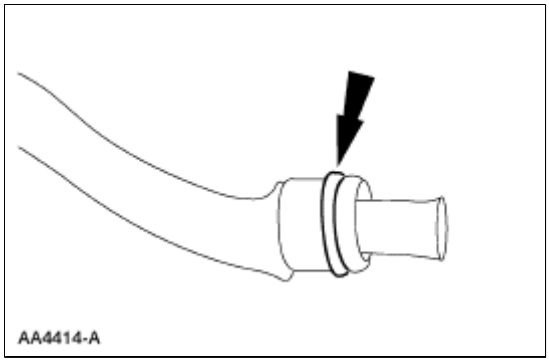
2. Remove the nut and position the oil level indicator tube aside.




3. Remove the upper EGR tube retaining stud bolt.




4. Remove the upper EGR tube.
   - Inspect the O-ring seal and install a new O-ring seal if necessary.

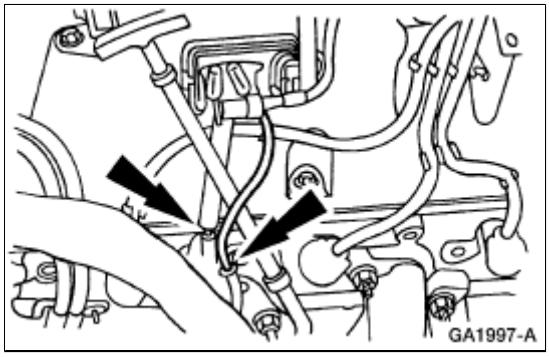


5. To install, reverse the removal procedure.

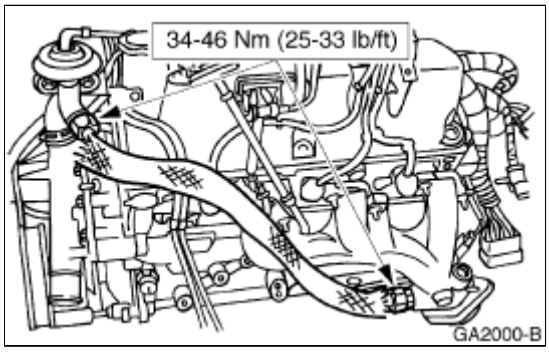
## EGR Valve Tube —Lower, 4.0L SOHC

### Removal and Installation

1. Disconnect the EGR pressure transducer hoses.




2. Disconnect the lower EGR tube fittings.

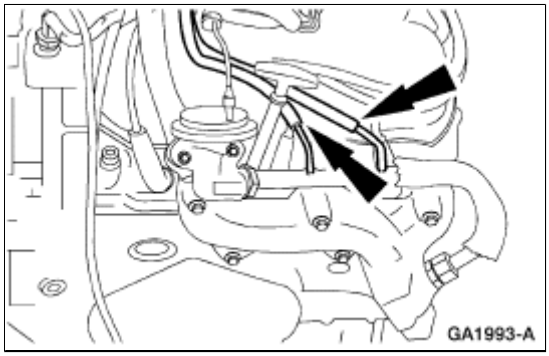



3. To install, reverse the removal procedure.

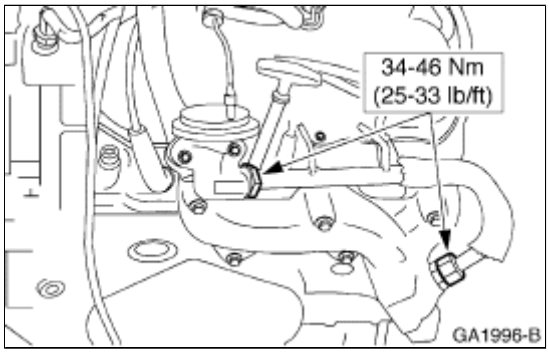
## EGR Valve Tube —Lower, 4.0L (Push Rod)

### Removal and Installation

1. Disconnect the EGR pressure transducer hoses.




2. Disconnect the lower EGR tube fittings.

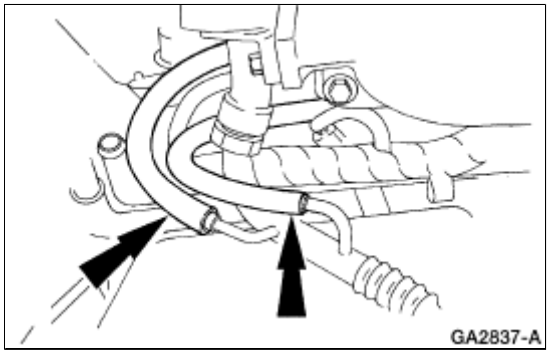



3. To install, reverse the removal procedure.

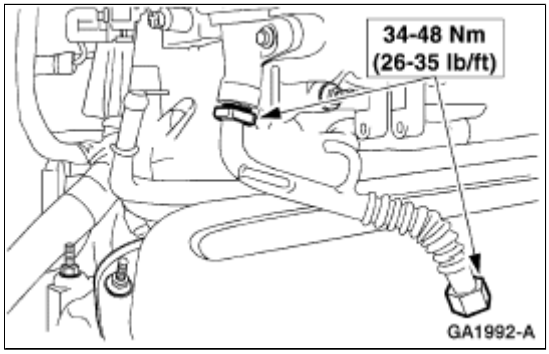
## EGR Valve Tube —5.0L

### Removal and Installation

1. Disconnect the EGR pressure transducer hoses.




2. Disconnect the EGR tube fittings.

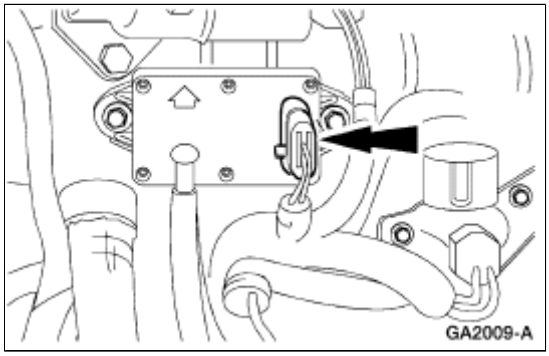



3. To install, reverse the removal procedure.

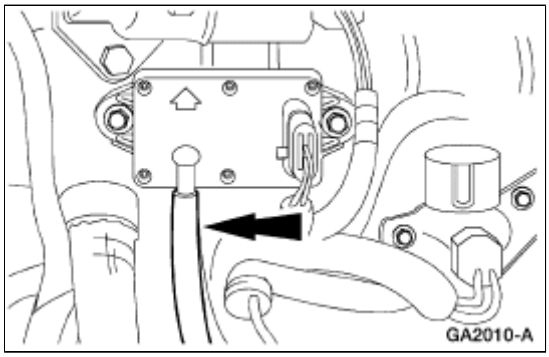
## Differential Pressure Feedback EGR

### Removal

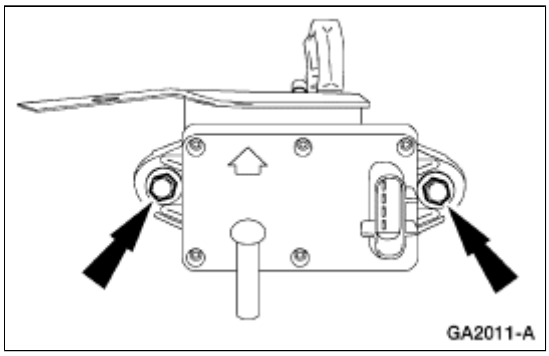
1. Disconnect the battery ground cable. For additional information, refer to Section 414-01 .
2. Disconnect the differential pressure feedback EGR electrical connector.




3. Disconnect the differential pressure feedback EGR hoses.

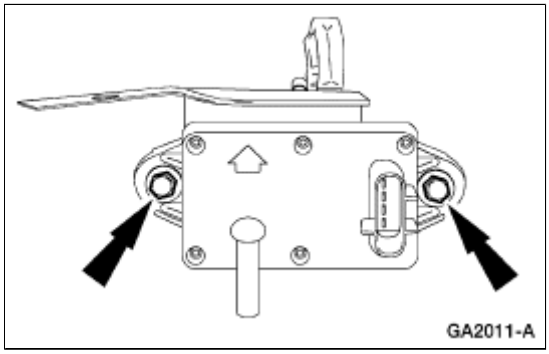



4. Remove the bolts and the differential pressure feedback EGR.

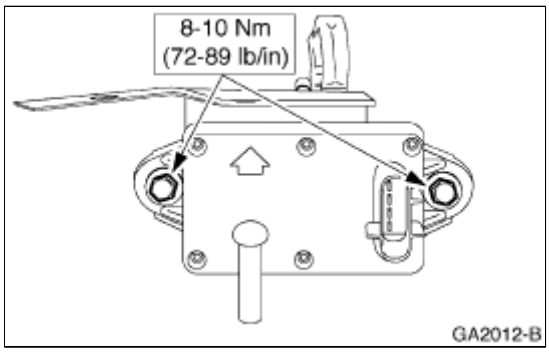



### Installation

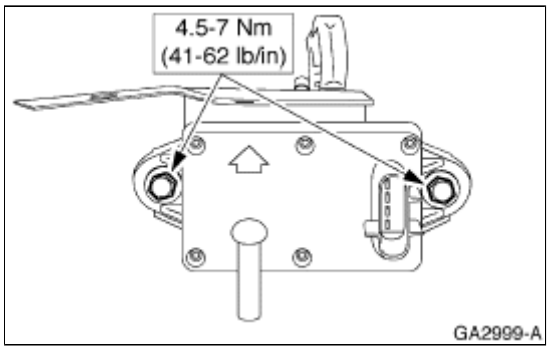
1. Fit the differential pressure feedback EGR and loosely install the bolts.



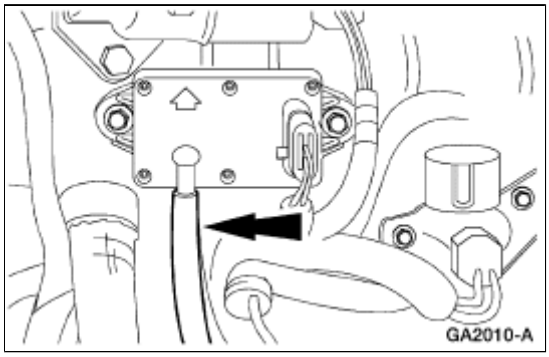

2. If the vehicle is equipped with the 4.0L engine, tighten the bolts.



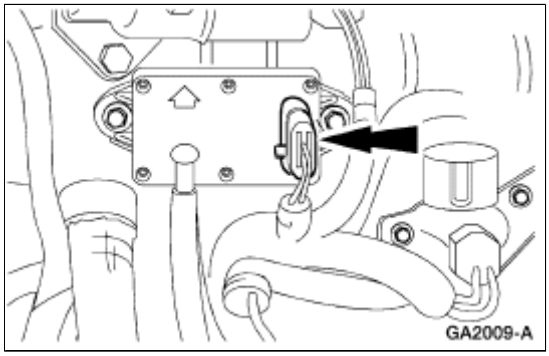

3. If the vehicle is equipped with the 5.0L engine, tighten the bolts.




4. Connect the differential pressure feedback EGR hoses.



5. Connect the differential pressure feedback EGR electrical connector.

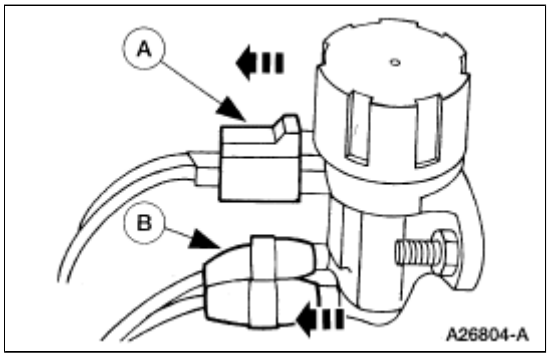



6. Connect the battery ground cable.

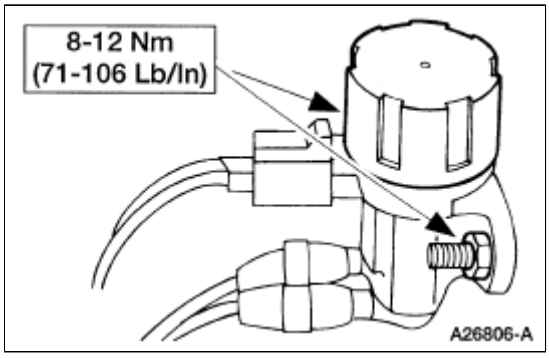
## Exhaust Gas Recirculation (EGR) Vacuum Regulator Solenoid

### Removal and Installation

1. Disconnect the battery ground cable. For additional information, refer to Section 414-01 .
2. Disconnect the (A) electrical connector and the (B) vacuum hoses from the exhaust gas recirculation (EGR) vacuum regulator solenoid.




3. Remove the nuts and the EGR vacuum regulator solenoid.




4. To install, reverse the removal procedure.

## Intake Air Distribution and Filtering

The intake air system consists of the:

- engine air cleaner (ACL) (9600)
- air cleaner outlet tube (9B659)
- mass air flow (MAF) sensor (12B579)
- air cleaner (ACL) element (9601)
- engine air cleaner support insulator (9P686)
- air cleaner clamp
- mass air flow sensor plate

The intake air system:

- filters intake air with a replaceable, dry-type air cleaner element.
- measures air flow and air temperature with a mass air flow sensor.

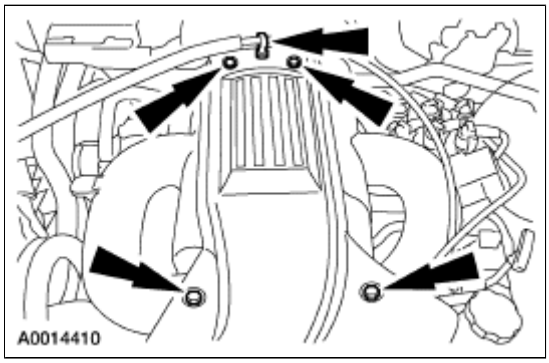
## Intake Air Distribution and Filtering

Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual.

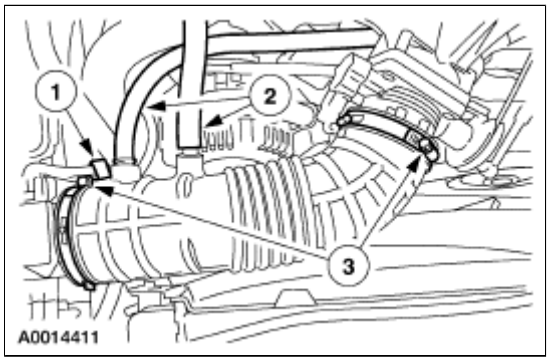
## Air Cleaner Outlet Pipe — 4.0L SOHC

### Removal and Installation

1. Remove the engine appearance cover.
   - Disconnect the speed control cable (if equipped).
   - Remove the bolts.




2. Remove the air cleaner outlet tube.
   1. Unclip the wire harness
   2. Disconnect the crankcase ventilation tubes.
   3. Loosen the air cleaner outlet tube clamps and remove the air cleaner outlet tube.




3. **NOTE:** Make sure the screw clamps do not interfere with the throttle body cam.

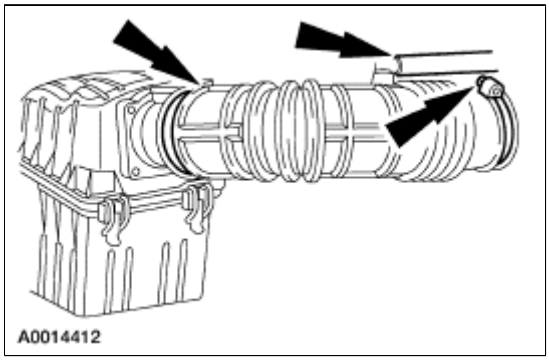
   To install, reverse the removal procedure.

## Air Cleaner Outlet Pipe — 5.0L and 4.0L (Push Rod)

### Removal and Installation

**NOTE:** The 5.0L engine is shown, the 4.0L (push rod) engine is similar.

1. Remove the air cleaner outlet tube.
   - Loosen the clamps.
   - Disconnect the vent hose.



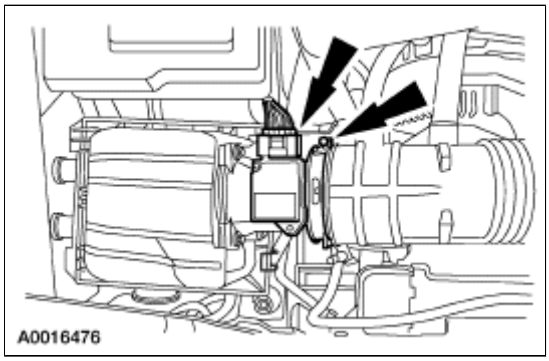

2. **NOTE:** Make sure the screw clamps do not interfere with the throttle body cam.

   To install, reverse the removal procedure.

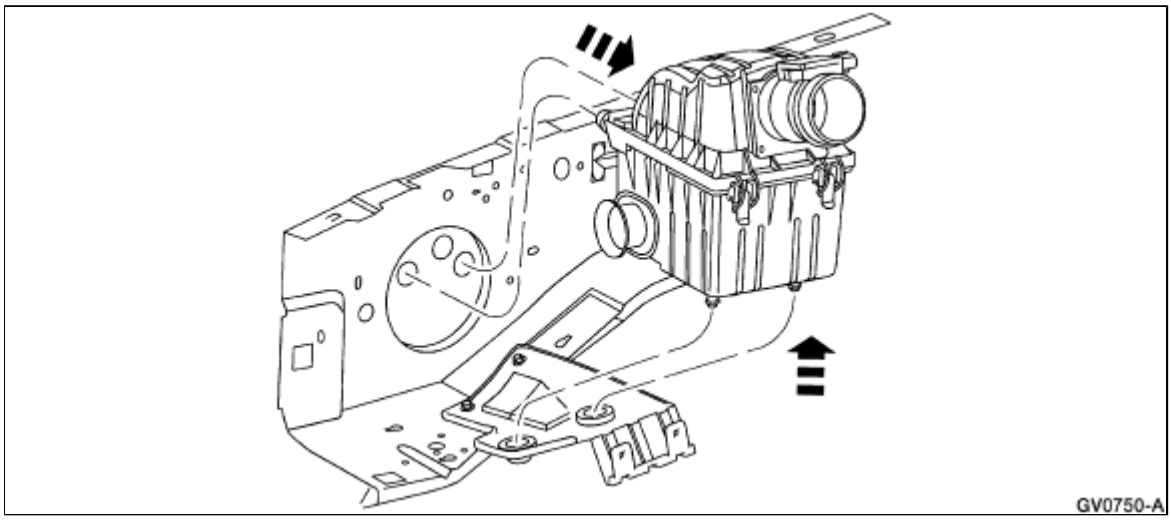
## Air Cleaner

### Removal and Installation

1. Disconnect the air cleaner assembly.
   - Loosen the clamp and disconnect the outlet tube.
   - Disconnect the mass air flow (MAF) sensor electrical connector.




2. Remove the air cleaner assembly.




3. To install, reverse the removal procedure.

**Torque Specifications**

| Description | Nm | lb-ft |
|---|---|---|
| Canister purge valve bracket retaining bolt | 25 | 18 |
| Evaporative emissions canister bolts | 25 | 18 |

**General Specifications**

| Item | Specification |
|---|---|
| MERPOL® O-Ring Seal Lubricant | ESE-M99B144-B |

## Evaporative Emissions

**The evaporative emission (EVAP) system:**

- prevents hydrocarbon emissions from reaching the atmosphere.
- stores fuel vapors in the EVAP canister that are generated during vehicle operation or hot soak, until they can be consumed by the engine during normal engine operation.
- routes the stored fuel vapors to the engine during engine operation.
- is controlled by the powertrain control module (PCM) which, using various sensor inputs, calculates the desired amount of purge flow. The PCM regulates the purge flow, induced by the application of intake manifold vacuum, by varying the duty cycle applied to the EVAP canister purge valve.
- has an EVAP test port for test purposes.

**The fuel vapors are routed:**

- from the fuel tank (9002) through the fill limit valve and fuel vapor vent valve.
- to the EVAP canister(s) (9D653) through a vapor line.
- to the engine when the EVAP canister purge valve (9C915) is opened by the PCM (12A650).

**The fuel tank pressure (FTP) sensor (9C052):**

- monitors the pressure levels in the fuel tank.
- communicates the pressure reading to the PCM during the OBD II leak test.

**The evaporative emissions (EVAP) canister (9E857):**

- is located under the rear of the vehicle.
- contains activated carbon.
- stores fuel vapors.

**The fuel tank filler cap (9030):**

- relieves system pressure above 14 kPa (56.21 inches $H_2O$).
- relieves system vacuum below 3.8 kPa (15.26 inches $H_2O$).

**The canister vent solenoid (9F945):**

- is normally open.
- seals the evaporative emissions system for the inspection and maintenance (I/M 240) test and OBD II leak and pressure tests.
- is mounted to the evaporative emissions canister bracket.

**The evaporative emission (EVAP) canister purge valve (9C915):**

- is normally closed.
- regulates the purging of the EVAP canister.
- is controlled by the PCM.

**The evaporative emission (EVAP) system test port:**

- is located on the EVAP canister purge outlet tube near the EVAP canister purge valve.
- is used to connect the Evaporative Emissions System Leak Tester to the EVAP system.

**The evaporative emission dust separator (9B328):**

- is located on the EVAP canister bracket assembly.
- prevents suspended dust and dirt particles from entering the evaporative emission system.
- is serviced as a separate item.

**The evaporative emission system monitor:**

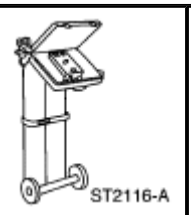
- is a self-test strategy within the PCM which tests the integrity of the EVAP system.
- monitors the EVAP system for leaks.
- monitors electronic EVAP components for irrationally high or low voltages.
- monitors for correct EVAP system operation.
- uses negative and positive leak test methods to test and activate the EVAP system.

**The EVAP Running Loss System leak test:**

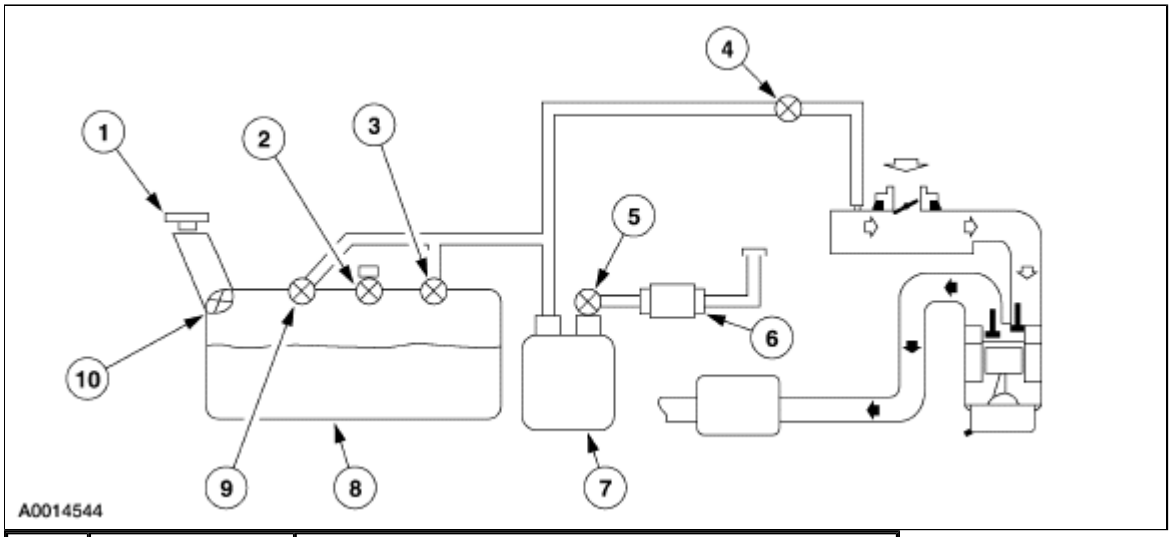
- utilizes intake manifold vacuum to test the system and involves several stages.

## Evaporative Emissions

**Special Tool(s)**

| | |
|---|---|
|  ST2116-A | Evaporative Emission System Leak Tester<br>310-F007 (134-00056) or equivalent |
|  ST2332-A | Worldwide Diagnostic System (WDS)<br>418–F224,<br><br>New Generation STAR (NGS) Tester<br>418–F052, or equivalent scan tool |

**Evaporative Emission System**




| Item | Part Number | Description |
|---|---|---|
| 1 | 9030 | Fuel filler cap |
| 2 | 9C052 | Fuel tank pressure sensor |
| 3 | 9B593 | Fuel vapor vent valve |
| 4 | 9C915 | Evaporative emission canister purge valve |
| 5 | 9F945 | Canister vent solenoid |
| 6 | 9B328 | Evaporative emission dust separator |
| 7 | 9D653 | Evaporative emission canister |
| 8 | 9002 | Fuel tank |

| | | |
|---|---|---|
| 9 | 9B593 | Fuel vapor vent valve |
| 10 | 9189 | Fuel filler pipe check valve |

**Principles of Operation**

**Evaporative Emission (EVAP) Canister Purge Valve**

The EVAP canister purge valve is controlled by the powertrain control module (PCM). The EVAP canister purge valve controls the flow of fuel vapors from the EVAP canister to the engine intake manifold during various engine operating modes. The EVAP canister purge valve is normally closed.

**Evaporative Emission (EVAP) Canister**

Fuel vapors from the fuel tank are stored in the EVAP canister. When the engine is running, the vapors are purged from the EVAP canister for combustion. OBD II vehicles sometimes use multiple canisters, which is dependent upon the size and number of the fuel tanks used on a specific vehicle.

**Canister Vent Solenoid**

During the Evaporative Emission Running Loss System Monitor Test, Evaporative Emissions Repair Verification Drive Cycle, and the Evaporative Emission System Leak Test, the canister vent solenoid is closed to allow either a vacuum to be drawn on the fuel tank or to hold a specified pressure in the system. The canister vent solenoid is normally open.

**Fuel Tank Pressure (FTP) Sensor**

The fuel tank pressure sensor is used to measure the fuel tank pressure during the Evaporative Emissions monitor test. It is also used to control excessive fuel tank pressures by forcing the EVAP system to purge. The fuel tank pressure sensor is tank mounted.

**Fuel Vapor Vent Valve (FVV) Assembly**

The fuel vapor vent valve (FVV) assembly is mounted on the top of the fuel tank. It is used to control the flow of fuel vapors entering the EVAP system. The head portion of the assembly prevents the fuel tank from overfilling during refueling. The assembly also has a spring float, which prevents liquid fuel from entering the vapor delivery system under severe handling or vehicle rollover conditions. In the upright position, the open bottom of the float will lift and shut off the orifice. Under severe handling conditions, the spring will push the float closed when angles allow liquid fuel to reach the orifice. In a rollover condition, the weight of the open bottom float and spring pressure will close the orifice.

**Fuel Filler Pipe Check Valve**

The fuel filler pipe check valve is an integral part of the fuel tank or the fuel filler pipe. It is intended to prevent liquid fuel from re-entering the fuel filler pipe from the fuel tank on refueling or rollover conditions.

**Fuel Filler Cap**

The fuel filler cap is used to prevent fuel spill and to close the EVAP system to the atmosphere.

**Evaporative Emission System Monitor**

When a fault occurs, the EVAP system monitor is reset to NO and a diagnostic trouble code (DTC) is set in the PCM memory. After the DTC is repaired, the vehicle drive cycle must be completed to reset the monitor

in preparation for inspection and maintenance testing.

**EVAP Running Loss System Leak Test**

To start the testing, conditions of stable purging and vehicle speed must be satisfied. During the first stage, the EVAP canister vent solenoid is closed, while the EVAP canister purge valve remains open, applying and building vacuum in the system as indicated by the FTP sensor. This phase checks for major leaks in the EVAP system.

In the second stage, the EVAP canister purge valve closes and the system looks for minimal decay rate in the EVAP vacuum, indicating the absence of any small EVAP system leaks.

The last stage is entered only if the second stage of the leak test has failed. The last stage checks whether the failed test was due to excess vapor generation. It monitors fuel vapor generation rate. Initially, the canister vent solenoid is opened to equalize EVAP system pressure to atmosphere. Then the canister vent solenoid is closed, allowing pressure to build if vapor generation is present in sufficient quantity. If the rate of generation is found to be too high, the EVAP running loss system leak test is aborted. If not, then a small leak is diagnosed.

**Inspection and Verification**

1. Verify the customer concern is with the evaporative emission (EVAP) system.

2. Visually inspect for the following obvious signs of mechanical damage.

**Visual Inspection Chart**

| Mechanical |
| --- |
| • Fuel filler cap<br>• EVAP test port<br>• EVAP canister or vent solenoid<br>• EVAP lines and hoses<br>• Vacuum lines or hoses |

3. If the concern remains after the inspection, connect the scan tool to the data link connector (DLC) located beneath the instrument panel and select the vehicle to be tested from the scan tool menu. If the scan tool does not communicate with the vehicle:

- check that the program card is correctly installed.
- check the connections to the vehicle.
- check the ignition switch position.

4. If the scan tool still does not communicate with the vehicle, refer to the scan tool manual.

5. Carry out the DATA LINK DIAGNOSTICS test. If the scan tool responds with:

- CKT914, CKT915 or CKT70 = ALL ECUS NO RESP/NOT EQUIP, refer to Section 418-00 .
- NO RESP/NOT EQUIP for PCM, refer to the Powertrain Control/Emissions Diagnosis (PC/ED) manual.
- SYSTEM PASSED, retrieve and record the continuous diagnostic trouble codes (DTCs), erase the

continuous DTCs and carry out the PCM KOEO self-test.

6. If the DTCs retrieved are related to the concern, go to the PCM Diagnostic Trouble Code (DTC) Index to continue diagnostics.

7. If the concern remains after the inspection, determine the symptom and proceed to the Symptom Chart.

**PCM Diagnostics Trouble Code (DTC) Index**

| DTC | Description | Source | Action |
|---|---|---|---|
| P0442 | Small Leak Detected in EVAP System (as small as 1.02 mm [0.040 inch]) | PCM | GO to Pinpoint Test A . |
| P0455 | Major Leak or No Flow Detected | PCM | GO to Pinpoint Test B . |
| P1443 | Very Small or No Purge Flow Detected | PCM | GO to Pinpoint Test B . |
| P1450 | Excessive Vacuum Detected in the Fuel Tank | PCM | GO to Pinpoint Test C . |
| — | Any Other PCM DTC | PCM | REFER to the Powertrain Control/Emissions Diagnosis (PC/ED) manual. |

**Symptom Chart**

**SYMPTOM CHART**

| Condition | Possible Sources | Action |
|---|---|---|
| • Hissing sound when removing fuel cap | • Canister vent solenoid.<br>• Evaporative emissions canister.<br>• EVAP canister tube.<br>• EVAP canister purge outlet tube. | • GO to Pinpoint Test D . |
| • Excessive fuel odor | • Canister vent solenoid.<br>• Evaporative emissions canister.<br>• Evaporative emissions test port.<br>• EVAP canister purge outlet tube. | • GO to Pinpoint Test E . |

**Pinpoint Tests**

**NOTE:** Reinstall or install new evaporative emission hose clamps removed or damaged during testing procedures.

**PINPOINT TEST A: DTC P0442 SMALL LEAK IN EVAP SYSTEM**

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| CONDITIONS | DETAILS/RESULTS/ACTIONS |
|---|---|
| **NOTE:** Condition P0442 DTC set: less than 0.625 kPa (2.5 inches $H_2O$) bleed-up over 15 seconds at 75% fuel fill. Vapor generation limit: more than 0.625 kPa (2.5 inches $H_2O$) over 120 seconds. | |
| **A1** VISUALLY INSPECT THE COMPONENTS FOR SMALL LEAKS | |
| | 1 Check for the presence of a fuel filler cap. Do not tighten or check for correct installation at this time.<br>2 Verify the canister vent solenoid is correctly seated on the EVAP canister.<br>3 Check for cut or loose connections to fuel vapor hoses, tubes and connections in the following locations:<br>• EVAP canister to EVAP canister purge valve<br>• EVAP canister to fuel vapor vent valve assembly<br>4 Check the fuel filler pipe for damage.<br>• **Is a concern with a hose, tube, connection or valve visually evident?**<br>→ **Yes**<br>REPAIR or INSTALL new components as necessary. GO to A2.<br>→ **No**<br>GO to A2. |
| **A2** CHECK AT THE EVAP TEST PORT FOR SMALL SYSTEM LEAKS | |
| | 1 Disconnect and plug the evaporative emission return tube at the intake manifold.<br>2 Complete the evaporative emission system leak test. Refer to Evaporative Emission System Leak Test in this section.<br>• **Does the system pass the leak test?**<br>→ **Yes**<br>GO to A3.<br>→ **No**<br>GO to A4. |
| **A3** VISUALLY INSPECT THE FUEL FILLER CAP | |
| | 1 Visually inspect the fuel filler cap for damage.<br>• **Is the fuel filler cap damaged?**<br>→ **Yes**<br>INSTALL a new fuel filler cap. GO to A4.<br>→ **No**<br>GO to A4. |
| **A4** CHECK FOR SMALL LEAKS AT THE FUEL FILLER CAP AND EVAP TEST PORT | |
| | 1 Connect the Evaporative Emission System Leak Tester to the fuel filler pipe. |

| | |
|---|---|
| 2  | 3 Close the canister vent solenoid. Refer to Canister Vent Solenoid Closing Procedure in this section.<br>4 Pressurize the EVAP system to 3.48 kPa (14 inches $H_2O$).<br>5 Using the ultrasonic leak detector, check the fuel filler cap and EVAP test port for leaks.<br>• **Is a leak detected?**<br>→ **Yes**<br>REPAIR or INSTALL new components as necessary. GO to A5.<br>→ **No**<br>INSTALL the fuel filler cap. CARRY OUT the evaporative emission system leak test. REFER to Evaporative Emission System Leak Test in this section. If the system passes the leak test, CARRY OUT the evaporative emissions repair verification drive cycle. REFER to Evaporative Emission Repair Verification Drive Cycle in this section. |
| **A5** CHECK FOR CONCERN OTHER THAN THE FUEL FILLER CAP | |
| | 1 Refer to previous test results.<br>• **Did the system pass the evaporative emission system leak test carried out in Step A2?**<br>→ **Yes**<br>CARRY OUT the evaporative emission system leak test. REFER to Evaporative Emission System Leak Test in this section. If the system passes the leak test, CARRY OUT the evaporative emission repair verification drive cycle. REFER to Evaporative Emission Repair Verification Drive Cycle in this section.<br>→ **No**<br>INSTALL the fuel filler cap. GO to A6. |
| **A6** CHECK FOR SMALL LEAK WITH TESTER SET AT FILL POSITION | |
| 2  | 1 Connect the Evaporative Emission System Leak Tester to the EVAP test port.<br>3 Close the canister vent solenoid. Refer to Canister Vent Solenoid Closing Procedure in this section.<br>4 Turn the selector on the Evaporative Emission System Leak Tester to the FILL position.<br>5 Pressurize the EVAP system to 3.48 kPa (14 inches $H_2O$). |

- **Does the pressure on the EVAP system hold between 3.43 kPa and 3.53 kPa (13.80 inches and 14.20 inches $H_2O$)?**

→ **Yes**
GO to A7 .

→ **No**
DISCONTINUE pressurizing the system. GO to A8 .

**A7** CHECK FOR LEAKS IN THE COMPLETE EVAP SYSTEM

1 Connect the Evaporative Emission System Leak Tester to the EVAP test port.

2

3 Close the canister vent solenoid. Refer to Canister Vent Solenoid Closing Procedure in this section.

4 Pressurize the EVAP system to 3.48 kPa (14 inches $H_2O$).

5 Using the ultrasonic leak detector, check the following EVAP system locations:

- EVAP return tube to EVAP canister purge valve
- EVAP canister purge valve to EVAP canister— canister vent solenoid assembly
- EVAP canister — canister vent solenoid assembly to fuel tank
- fuel filler cap and fuel filler tube

- **Is a leak detected at EVAP return tube, EVAP canister purge outlet tube or EVAP canister tube or associated hose?**

→ **Yes**
REPAIR or INSTALL new components as necessary. CARRY OUT the evaporative emission system leak test. REFER to Evaporative Emission System Leak Test in this section. If the system passes the leak test, CARRY OUT the evaporative emissions repair verification drive cycle. REFER to Evaporative Emission Repair Verification Drive Cycle in this section.

→ **No**
DISCONTINUE pressurizing the system. GO to A8 .

**A8** CHECK FOR SMALL LEAK FROM THE EVAP RETURN TUBE TO THE EVAP CANISTER

1 Disconnect the fuel tank vapor tube (9C047) at the fuel vapor tee. Plug the opening in the tee.

2 Connect the Evaporative Emission System Leak Tester to the EVAP test port.

3

4 Close the canister vent solenoid. Refer to Canister Vent Solenoid Closing

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| | Procedure in this section.<br>5 Pressurize the EVAP system to 3.48 kPa (14 inches $H_2O$).<br>6 Using the ultrasonic leak detector, check the EVAP system from the intake manifold to the EVAP canister vent solenoid.<br>• **Is a leak detected?**<br>→ **Yes**<br>REPAIR or INSTALL new components as necessary. REPEAT Step A6 to verify the repair. GO to A9.<br>→ **No**<br>OPEN the canister vent solenoid. GO to A9. |
| **A9** CHECK FOR SMALL LEAK BETWEEN FUEL TANK VAPOR TUBE (9C047) AND FUEL TANK FILLER PIPE | |
| | 1 Connect the Evaporative Emission System Leak Tester to the fuel filler pipe.<br>2 Transfer the plug from the fuel vapor tee to the fuel tank vapor tube (9C047).<br>3 Turn the Evaporative Emission System Leak Tester selector to the FILL position.<br>4 Pressurize the EVAP system to 3.48 kPa (14 inches $H_2O$).<br>5 Using the ultrasonic leak detector, check the fuel tank vapor tube to the fuel tank for leaks. Check the fuel tank pressure sensor, fuel tank vapor tube and the fuel filler pipe.<br>• **Is a leak detected?**<br>→ **Yes**<br>REPAIR or INSTALL new components as necessary.<br>GO to A10.<br>→ **No**<br>GO to A10. |
| **A10** CHECK EVAP SYSTEM AT FUEL FILLER PIPE | |
| | 1 Reconnect the fuel tank vapor tube (9C047) to the fuel vapor tee.<br>2 Complete the evaporative emission system leak test. Refer to Evaporative Emission System Leak Test in this section.<br>• **Does the EVAP system pass the leak test?**<br>→ **Yes**<br>RESTORE the system to normal operation. CARRY OUT the evaporative emission system leak test. REFER to Evaporative Emission System Leak Test in this section. If the system passes the leak test, CARRY OUT the evaporative emissions repair verification drive cycle. REFER to Evaporative Emission Repair Verification Drive Cycle in this section. |

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| | → **No**<br>GO to A6 . |

**PINPOINT TEST B: DTC P0455 MAJOR LEAK OR NO FLOW DETECTED OR DTC P1443 VERY SMALL OR NO PURGE FLOW DETECTED IN SYSTEM**

| CONDITIONS | DETAILS/RESULTS/ACTIONS |
|---|---|
| **NOTE:** Condition DTC P0455 set: –1.74 kPa (-7.0 inches $H_2O$) over 30 seconds.<br>**NOTE:** Condition DTC P1443 set: –1.74 kPa (-7.0 inches $H_2O$) over 30 seconds with more than 0.02 lb/min vapor flow. | |
| **B1** CHECK FOR DIAGNOSTIC TROUBLE CODE P0455 OR P1443 | |
| | 1 Use the recorded results from the PCM DTCs.<br>• **Is DTC P0455 present?**<br>→ **Yes**<br>GO to B2 .<br>→ **No**<br>GO to B3 . |
| **B2** VISUALLY CHECK FOR GROSS EVAP SYSTEM LEAKS | |
| | 1 Check for the presence of a fuel filler cap. Do not tighten or check for correct installation at this time.<br>2 Check that the input port vacuum and EVAP return tubes are connected to the EVAP canister purge valve.<br>3 Check that the canister vent solenoid is correctly attached to the EVAP canister.<br>4 Check for disconnected or cracked fuel vapor hoses or tubes between the intake manifold and following components:<br>• EVAP canister purge valve<br>• EVAP canister<br>• fuel vapor vent valve assembly<br>5 Check for damaged fuel tank or fuel filler pipe.<br>• **Is a concern with a hose, tube, connection or valve visually evident?**<br>→ **Yes**<br>REPAIR or INSTALL new EVAP components as necessary. GO to B3 .<br>→ **No**<br>GO to B3 . |
| **B3** CHECK FOR EVAP SYSTEM LEAKS | |
| | 1 Disconnect the EVAP return tube from the intake manifold and plug the EVAP return tube. |

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|---|---|
| | 2 Connect the Evaporative Emissions System Leak Tester to the EVAP test port.<br>3 Carry out the evaporative emissions system leak test. Refer to Evaporative Emission System Leak Test in this section.<br>• **Does the system pressure stay above 1.99 kPa (8 inches $H_2O$)?**<br>→ **Yes**<br>GO to B4 .<br>→ **No**<br>VERIFY that the fuel filler cap is installed correctly. REPAIR or INSTALL new components as necessary. CARRY OUT the evaporative emission system leak test. REFER to Evaporative Emission System Leak Test in this section. If the system passes the leak test, CARRY OUT the evaporative emission repair verification drive cycle. REFER to Evaporative Emission Repair Verification Drive Cycle in this section. |
| **B4** CHECK FOR BLOCKAGE BETWEEN THE EVAP CANISTER PURGE VALVE AND FUEL VAPOR TEE | |
| 1  | 2 Close the canister vent solenoid. Refer to Canister Vent Solenoid Closing Procedure in this section.<br>3 Pressurize the EVAP system to 3.48 kPa (14 inches $H_2O$).<br>4 Open the canister vent solenoid.<br>• **Does the pressure drop immediately?**<br>→ **Yes**<br>GO to B5 .<br>→ **No**<br>INSTALL a new vapor line between the EVAP canister purge valve and the fuel vapor tee. CARRY OUT the evaporative emission system leak test. REFER to Evaporative Emission System Leak Test in this section. If the system passes the leak test, CARRY OUT the evaporative emission repair verification drive cycle. REFER to Evaporative Emission Repair Verification Drive Cycle in this section. |
| **B5** CHECK FOR BLOCKAGE BETWEEN FUEL FILLER PIPE AND THE FUEL VAPOR TEE | |
| | 1 Connect the Evaporative Emissions System Leak Tester to the fuel filler pipe.<br>2 Pressurize the EVAP system to 6.47 to 6.97 kPa (26 to 28 inches $H_2O$).<br>• **Does the pressure drop immediately?**<br>→ **Yes**<br>GO to B6 . |

| | |
|---|---|
| | → **No**<br>INSTALL new fuel tank vapor line(s). REPEAT Step B5 to verify the repair. CARRY OUT the evaporative emission system leak test. REFER to Evaporative Emission System Leak Test in this section. If the system passes the leak test, CARRY OUT the evaporative emission repair verification drive cycle. REFER to Evaporative Emission Repair Verification Drive Cycle in this section. |
| **B6** CHECK FOR FAILED EVAP CANISTER PURGE VALVE OR FUEL TANK PRESSURE SENSOR | |
| | 1 Use the recorded results from the PCM DTCs.<br>• **Are DTC codes P0455 and P1443 present?**<br>→ **Yes**<br>INSTALL a new EVAP canister purge valve. REFER to Evaporative Emission Canister Purge Valve in this section. CARRY OUT the evaporative emission system leak test. REFER to Evaporative Emission System Leak Test in this section. If no leak is detected, CARRY OUT the evaporative emissions repair verification drive cycle. REFER to Evaporative Emission Repair Verification Drive Cycle in this section.<br>→ **No**<br>INSTALL a new fuel tank pressure sensor. REFER to Fuel Tank Pressure Sensor in this section. CARRY OUT the evaporative emission system leak test. REFER to Evaporative Emission System Leak Test in this section. If the system passes the leak test, CARRY out the evaporative emission repair verification drive cycle. REFER to Evaporative Emission Repair Verification Drive Cycle in this section. |

**PINPOINT TEST C: DTC P1450 EXCESSIVE VACUUM DETECTED IN THE FUEL TANK**

| CONDITIONS | DETAILS/RESULTS/ACTIONS |
|---|---|
| **NOTE:** Condition P1450 DTC set: More than -1.79 kPa (-7.2 inches $H_2O$) over 30 seconds. | |
| **C1** CHECK FOR VISUAL CAUSES OF EXCESSIVE FUEL TANK VACUUM | |
| | 1 Check for kinks or bends in the fuel vapor hoses and tubes.<br>2 Visually check the EVAP canister inlet port, canister vent solenoid filter or outlet hose for contamination or foreign material.<br>3 Check the canister vent solenoid for blockage or contamination.<br>• **Is a concern with a hose, tube, connection or component visually evident?**<br>→ **Yes**<br>REMOVE any contamination or foreign material around fuel vapor hoses and tubes. REPAIR the hoses, tubes or components as necessary. After all visual concerns are repaired, GO to C2. |

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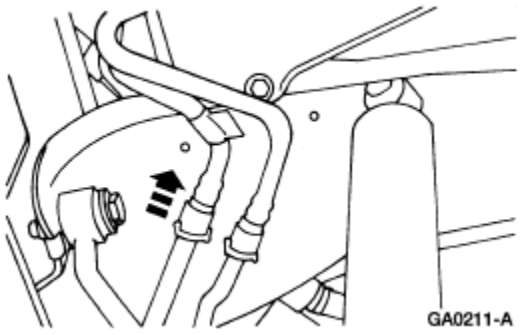
| | → **No**<br>GO to C2 . |
| **C2** CHECK FOR BLOCKAGE BETWEEN EVAP TEST PORT AND CANISTER VENT SOLENOID | |
| | 1 Disconnect and plug the EVAP return tube at the intake manifold.<br>2 Connect the Evaporative Emissions System Leak Tester to the EVAP test port.<br>3 Pressurize the EVAP system to 3.48 kPa (14 inches $H_2O$).<br>• **Does the pressure drop immediately?**<br>→ **Yes**<br>GO to C3 .<br>→ **No**<br>GO to Pinpoint Test D . |
| **C3** CHECK FOR BLOCKAGE BETWEEN THE FUEL FILLER PIPE AND THE FUEL VAPOR TEE | |
| | 1 Connect the Evaporative Emission System Leak Tester to the fuel filler pipe.<br>2 Pressurize the EVAP system to 3.48 kPa (14 inches $H_2O$).<br>• **Does the pressure drop immediately?**<br>→ **Yes**<br>GO to C4 .<br>→ **No**<br>GO to Pinpoint Test D . |
| **C4** CHECK FOR FUEL TANK PRESSURE SENSOR PID WITHOUT PRESSURE APPLIED | |
| 1<br>  <br><br>2 | 1 Disconnect the EVAP canister outlet tube at the EVAP canister. |

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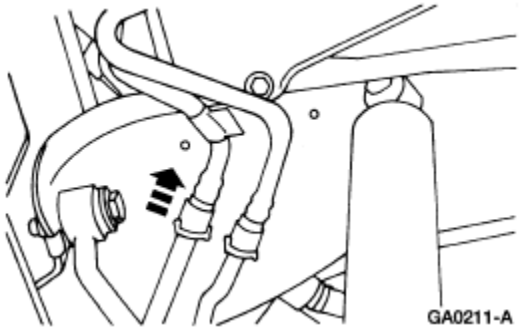
|  | 3 Access PCM PID FTP V.<br>4 Record the reading.<br>• **Is PID FTP V reading between 2.40 and 2.80 volts?**<br>→ **Yes**<br>GO to C5 .<br>→ **No**<br>REFER to Powertrain Control/Emissions Diagnosis (PC/ED) manual to continue diagnosis. |
| **C5** CHECK FOR STUCK OPEN EVAP CANISTER PURGE VALVE CONDITION AT IDLE | |
| 1<br>  <br><br>4<br>  | 1 Connect the EVAP canister outlet tube.<br>2 Remove the plug from the EVAP return tube and reconnect the tube to the intake manifold.<br>3 Verify that the fuel filler cap is correctly installed.<br>5 Access PCM PIDs FTP V and EVAPPDC.<br>6 Start the engine and allow to idle.<br>7 Monitor the FTP V and EVAPPDC PIDs.<br>• **When PID EVAPPDC is zero, is PID FTP V reading below 2.40 volts?**<br>→ **Yes**<br>INSTALL a new EVAP canister purge valve.<br>REFER to Evaporative Emission Canister |

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| | Purge Valve in this section. CARRY OUT an EVAP system leak test. REFER to Evaporative Emission System Leak Test in this section. If the system passes the leak test, CARRY OUT an evaporative emissions repair verification drive cycle. REFER to Evaporative Emission Repair Verification Drive Cycle in this section.<br><br>→ **No**<br>CARRY OUT the EVAP system leak test. REFER to Evaporative Emission System Leak Test in this section. If the system passes the leak test, CARRY OUT the evaporative emissions repair verification drive cycle. REFER to Evaporative Emission Repair Verification Drive Cycle in this section. |

**PINPOINT TEST D: HISS WHEN OPENING FUEL CAP**

| CONDITIONS | DETAILS/RESULTS/ACTIONS |
|---|---|
| **D1** TEST FOR EVAP CANISTER, CANISTER VENT SOLENOID AND CANISTER VENT HOSE ASSEMBLY BLOCKAGE | |
| | 1 Connect the Evaporative Emission System Leak Tester to the fuel filler cap.<br>2 Pressurize the EVAP system to 3.48 kPa (14 inches $H_2O$).<br><br>• **Does the pressure drop immediately?**<br><br>→ **Yes**<br>The EVAP system has passed the EVAP canister and bracket assembly blockage test. GO to D6.<br><br>→ **No**<br>For vehicles equipped with a canister vent hose assembly, GO to D2.<br><br>For vehicles equipped with a canister vent solenoid, GO to D3.<br><br>For all others, GO to D4. |
| **D2** TEST FOR CANISTER VENT HOSE ASSEMBLY BLOCKAGE | |
| | 1 Disconnect the EVAP canister vent hose assembly from the EVAP canister.<br>2 Connect the Evaporative Emission System Leak Tester to the fuel filler pipe.<br>3 Pressurize the EVAP system to 3.48 kPa (14 inches $H_2O$).<br><br>• **Does the pressure drop immediately?**<br><br>→ **Yes**<br>INSTALL a new EVAP canister vent solenoid vent hose assembly. CARRY OUT the evaporative emission system leak test. REFER to Evaporative Emission System Leak Test in this section. If the system passes the leak test, CARRY OUT |

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| | the evaporative emission repair verification drive cycle. REFER to Evaporative Emission Repair Verification Drive Cycle in this section.<br><br>→ **No**<br>GO to D4. |
| **D3** TEST FOR CANISTER VENT SOLENOID BLOCKAGE | |
| | 1 Remove the canister vent solenoid from the EVAP canister.<br>2 Connect the Evaporative Emission System Leak Tester to the fuel filler pipe.<br>3 Pressurize the EVAP system to 3.48 kPa (14 inches $H_2O$).<br><br>• **Does the pressure drop immediately?**<br><br>→ **Yes**<br>INSTALL a new canister vent solenoid. REFER to Evaporative Emission Canister Vent Solenoid in this section. CARRY OUT the evaporative emission system leak test. REFER to Evaporative Emission System Leak Test in this section. If the system passes the leak test, CARRY OUT the evaporative emission repair verification drive cycle. REFER to Evaporative Emission Repair Verification Drive Cycle in this section.<br><br>→ **No**<br>GO to D4. |
| **D4** TEST FOR EVAP CANISTER BLOCKAGE | |
| | 1 Disconnect the EVAP canister tube (from the fuel tank) at the F-fitting from the EVAP canister.<br>2 Connect the Evaporative Emission System Leak Tester to the fuel filler pipe.<br>3 Pressurize the EVAP system to 3.48 kPa (14 inches $H_2O$).<br><br>• **Does the pressure drop immediately?**<br><br>→ **Yes**<br>INSTALL a new EVAP canister. REFER to Evaporative Emission Canister in this section. CARRY OUT the evaporative emission system leak test. REFER to Evaporative Emission System Leak Test in this section. If the system passes the leak test, CARRY OUT the evaporative emission repair verification drive cycle. REFER to Evaporative Emission Repair Verification Drive Cycle in this section.<br><br>→ **No**<br>GO to D5. |
| **D5** TEST FOR EVAP CANISTER TUBE OR FUEL VAPOR VENT VALVE ASSEMBLY BLOCKAGE | |
| | 1 Disconnect the fuel vapor vent valve assembly from the EVAP canister tube.<br>2 Connect the Evaporative Emission System Leak Tester to the fuel filler pipe.<br>3 Pressurize the EVAP system to 3.48 kPa (14 inches $H_2O$).<br><br>• **Does the pressure drop immediately?** |

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| | → **Yes**<br>INSTALL a new EVAP canister tube and/or fuel vapor tube(s) between the fuel tank and the EVAP canister and bracket assembly. CARRY OUT the evaporative emission system leak test. REFER to Evaporative Emission System Leak Test in this section. If the system passes the leak test, CARRY OUT the evaporative emission repair verification drive cycle. REFER to Evaporative Emission Repair Verification Drive Cycle in this section.<br><br>→ **No**<br>INSTALL a new fuel vapor vent valve(s) or assembly. REFER to Fuel Vapor Vent Valve in this section. CARRY OUT the evaporative emission system leak test. REFER to Evaporative Emission System Leak Test in this section. If the system passes the leak test, CARRY OUT the evaporative emission repair verification drive cycle. REFER to Evaporative Emission Repair Verification Drive Cycle in this section. |
| **D6** TEST FOR BLOCKAGE BETWEEN THE EVAP CANISTER PURGE VALVE AND THE FUEL TANK | |
| 3<br>  | 1 Remove the fuel vapor hose (from the fuel tank) at the EVAP canister purge valve.<br>2 Connect the Evaporative Emission System Leak Tester to the fuel filler pipe.<br>4 For vehicles equipped with a canister vent solenoid, close the canister vent solenoid. Refer to Canister Vent Solenoid Closing Procedure in this section.<br>5 For vehicles without a canister vent solenoid, plug the canister vent hose assembly or plug the canister vent cap.<br>6 Pressurize the EVAP system to 3.48 kPa (14 inches $H_2O$).<br><br>• **Does the pressure drop immediately?**<br><br>→ **Yes**<br>The EVAP system has passed all the blockage tests. RECONNECT all components.<br><br>For vehicles equipped with a canister vent solenoid, CARRY OUT the evaporative emission system leak test. REFER to Evaporative Emission System Leak Test in this section. If the system passes the leak test, CARRY OUT the evaporative emission repair verification drive cycle. REFER to Evaporative Emission Repair Verification Drive Cycle in this section.<br><br>For vehicles equipped without a canister vent solenoid, PLUG the canister vent hose assembly or the canister vent cap. CARRY OUT the evaporative emission system leak test. REFER to Evaporative Emission System Leak Test in this section. If the system passes the leak test, CARRY OUT the evaporative emission repair verification drive cycle. REFER to Evaporative Emission Repair Verification Drive Cycle in this section.<br><br>→ **No**<br>INSTALL a new fuel vapor hose. CARRY OUT the evaporative emission system leak test. REFER to Evaporative Emission System Leak Test in this section. If the |

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| | system passes the leak test, CARRY OUT the evaporative emission repair verification drive cycle. REFER to Evaporative Emission Repair Verification Drive Cycle in this section. |

**PINPOINT TEST E: EXCESSIVE FUEL ODOR**

| CONDITIONS | DETAILS/RESULTS/ACTIONS |
|---|---|
| **E1** TEST THE EVAPORATIVE EMISSION (EVAP) RUNNING LOSS SYSTEM MONITOR | |
| | 1 Complete the evaporative emission repair verification drive cycle. Refer to Evaporative Emission Repair Verification Drive Cycle in this section.<br>• **Are PCM DTCs retrieved?**<br>→ **Yes**<br>For DTC P0442, P0455, P1443 or P1450 REFER to the Diagnostic Trouble Code Index in this section. For all other DTCs REFER to the Powertrain Control/Emissions Diagnosis (PC/ED) manual for diagnosis of DTCs.<br>→ **No**<br>GO to E2 . |
| **E2** TEST FOR RESTRICTIONS IN THE EVAP SYSTEM FROM THE EVAPORATIVE EMISSION TEST PORT THROUGH THE CANISTER VENT SOLENOID | |
| | 1 Connect the Evaporative Emission System Leak Tester to the evaporative emissions test port.<br>2 Attempt to pressurize the EVAP system to 3.48 kPa (14 inches $H_2O$).<br>• **Does the pressure drop immediately?**<br>→ **Yes**<br>CARRY OUT the evaporative emission system leak test. REFER to Evaporative Emission System Leak Test in this section. If the system passes the leak test, CARRY OUT the evaporative emission repair verification drive cycle. REFER to Evaporative Emission Repair Verification Drive Cycle in this section.GO to E3 .<br>→ **No**<br>GO to Pinpoint Test **D** . |
| **E3** TEST FOR A RESTRICTED TUBE BETWEEN THE FUEL TANK AND THE EVAPORATIVE EMISSION CANISTER | |
| | 1 Connect the Evaporative Emission System Leak Tester to the fuel filler pipe.<br>2 Attempt to pressurize the EVAP system to 3.48 kPa (14 inches $H_2O$).<br>• **Does the pressure drop immediately?**<br>→ **Yes**<br>CARRY OUT the evaporative emission system leak test. REFER to Evaporative Emission System Leak Test in this section. If the system passes the leak test, CARRY OUT the evaporative emission repair verification drive cycle. REFER to |

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| | Evaporative Emission Repair Verification Drive Cycle in this section.<br><br>→ **No**<br>GO to E4 . |
| **E4** TEST FOR EVAP CANISTER TUBE OR FUEL VAPOR VENT VALVE ASSEMBLY BLOCKAGE | |
| | 1 Disconnect the fuel vapor vent valve assembly from the EVAP canister tube.<br>2 Connect the EVAP System Leak Tester to the fuel filler pipe.<br>3 Pressurize the EVAP system to 3.48 kPa (14 inches $H_2O$).<br><br>• **Does the pressure drop immediately?**<br><br>→ **Yes**<br>INSTALL a new EVAP canister tube and/or fuel vapor tube(s) between the fuel tank and the EVAP canister and bracket assembly. CARRY OUT the evaporative emission system leak test. REFER to Evaporative Emission System Leak Test in this section. If the system passes the leak test, CARRY OUT the evaporative emission repair verification drive cycle. REFER to Evaporative Emission Repair Verification Drive Cycle in this section.<br><br>→ **No**<br>INSTALL a new fuel vapor vent valve(s) or assembly. REFER to Fuel Vapor Vent Valve in this section. CARRY OUT the evaporative emission system leak test. REFER to Evaporative Emission System Leak Test in this section. If the system passes the leak test, CARRY OUT the evaporative emission repair verification drive cycle. REFER to Evaporative Emission Repair Verification Drive Cycle in this section. |

## Canister Vent Solenoid Closing Procedure

**Special Tool(s)**

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|---|---|
|  ST2332-A | Worldwide Diagnostic System (WDS)<br>418-F224,<br><br>New Generation STAR (NGS) Tester<br>418-F052, or equivalent scan tool |

**CAUTION: The canister vent solenoid must not be energized for more than nine minutes at one time. Once the canister vent solenoid is energized and de-energized, adequate time must be allowed for the component to cool adequately. Failure to allow the component to cool may create a false failure in the diagnostics, causing unnecessary repairs.**

1. Connect the scan tool and select the output test mode.
2. If PID monitors are not active, select PIDs.
3. Select the fuel tank pressure (FTP) and the volts (V) parameter identification (PID) for monitoring.
4. Select the ALL OFF mode.
5. Close the canister vent solenoid by pushing the START button on the scan tool.

## Evaporative Emission System Leak Test

**Special Tool(s)**

| | |
|---|---|
|  ST2116-A | Evaporative Emission System Tester 310-F007 (134-00056) or equivalent |
|  ST2332-A | Worldwide Diagnostic System (WDS) 418-F224,<br><br>New Generation STAR (NGS) Tester 418-F052, or equivalent scan tool |

**CAUTION: The evaporative emission system must not be pressurized to more than 3.48 kPa (14 inches $H_2O$) or damage to the evaporative emission system may occur.**

1. Connect the Evaporative Emission System Leak Tester to the evaporative emission test port.
2. Close the canister vent solenoid. For additional information, refer to Canister Vent Solenoid Closing Procedure in this section.
3. Pressurize the evaporative emission system to 3.48 kPa (14 inches $H_2O$).
4. Monitor the system for two minutes. The system fails the leak test if the pressure falls below 2.0 kPa (8 inches $H_2O$).
5. Repair any leaks as necessary.
6. Repeat the leak test until the system remains above 2.0 kPa (8 inches $H_2O$) after the two-minute test period.

## Evaporative Emission Repair Verification Drive Cycle

**Special Tool(s)**

| | |
|---|---|
|  ST2332-A | Worldwide Diagnostic System (WDS)<br>418-F224,<br><br>New Generation STAR (NGS) Tester<br>418-F052, or equivalent scan tool |

### Drive Cycle Recommendations

**NOTE:** The following procedure is designed to execute and complete the evaporative emission repair verification drive cycle and to clear the Ford P1000, inspection and maintenance (I/M) readiness code. When the ambient air temperature is below 4.4°C (40°F) or above 37.8°C (100°F), or the altitude is above 2,438 meters (8,000 feet), the EVAP monitor will not run. If the P1000 must be cleared in these conditions, the powertrain control module (PCM) must detect them once (twice on some applications) before the EVAP monitor can be bypassed and the P1000 cleared. The EVAP bypassing procedure is described in the following drive cycle.

1. Most OBD II monitors will complete more readily using a steady foot driving style during cruise or acceleration modes. Operating the throttle in a smooth fashion will minimize the time necessary for monitor completion.

2. Fuel tank level should be between one-half and three-quarters full with three-quarters full being the most desirable.

3. The evaporative monitor can only operate during the first 30 minutes of engine operation. When executing the procedure for this monitor, stay in part throttle mode and drive in a smooth fashion to minimize fuel slosh.

### Drive Cycle Preparation

**NOTE:** For best results, follow each of the following steps as accurately as possible.

4. **NOTE:** This step bypasses the engine soak timer and resets OBD II monitor status.

   Install the scan tool. Turn the key ON with the engine OFF. Cycle the key off, then on. Select the appropriate vehicle and engine qualifier. Clear all diagnostic trouble codes (DTCs) and carry out a PCM reset.

5. Begin to monitor the following PIDs: ECT, EVAPDC, FLI (if available) and TP MODE. Press Diagnostic Data Link, PCM, PID/Data monitor and record, press trigger to select each PID, then start.

6. Start the engine without returning the key to the OFF position.

### Preparation for Monitor Entry

**WARNING: Strict observance of posted speed limits and attention to driving conditions are mandatory when proceeding through the following drive cycle.**

7. **NOTE:** This step allows engine warm-up and provides intake air temperature (IAT) input to the PCM.

   Idle the vehicle for 15 seconds. Drive at 64 km/h (40 mph) until the ECT is at least 76.7°C (170°F).

8. Is IAT above 4.4°C (40°F) and below 37.8°C (100°F)? If not, continue with the following steps but note that the EVAP Monitor Bypass portion of the drive cycle (Step 13) will be required to bypass the EVAP monitor and clear the P1000.

9. **NOTE:** This step executes the heated oxygen sensor (HO2S) monitor.

   Cruise at 64 km/h (40 mph) for 60 seconds.

10. **NOTE:** This executes the EVAP monitor if IAT is above 4.4°C (40°F) and below 37.8°C (100°F).

    **NOTE:** To initiate the monitor, TP MODE should equal PT, EVAPDC must be greater than 75%, and FLI must be between 15 and 85%.

    **NOTE:** Avoid sharp turns and hills.

    Cruise at 72 to 104 km/h (45 to 65 mph) for 10 minutes.

11. **NOTE:** This step executes the ISC portion of the Secondary Air/CCM.

    Bring the vehicle to a stop. Idle with the transmission in DRIVE (for automatic transmission) or NEUTRAL (for manual transmission) for two minutes.

**Pending Code and EVAP Monitor Bypass Check**

12. **NOTE:** This determines if a pending code is preventing the clearing of P1000.

    **NOTE:** If the EVAP monitor is not complete and IAT was below 4.4°C (40°F) or above 37.8°C (100°F) temperature range in Step 8, or the altitude is above 2,438 meters (8,000 feet), the EVAP Monitor Bypass (Step 13) must be carried out.

    Using the scan tool, check for pending codes. Conduct normal repair procedures for any pending code concerns. Rerun any incomplete monitor.

**EVAP Monitor Bypass**

13. **NOTE:** This allows the bypass counter to increment to two.

    **NOTE:** Do not repeat Step 4.

    Park the vehicle for a minimum of eight hours. Repeat Steps 5 through 12.

## Evaporative Emission Canister

### Removal and Installation

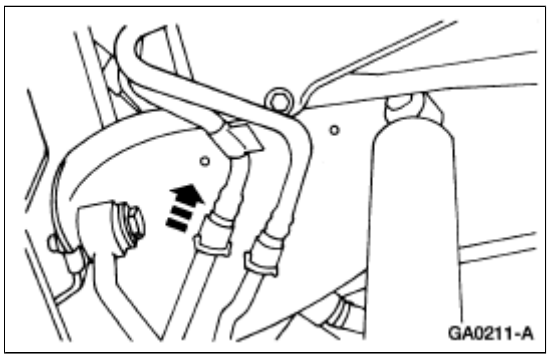
1. Open the liftgate, lower and remove the spare tire.

2. **WARNING: The evaporative emissions system contains fuel vapor and condensed fuel vapor. Although not present in large quantities, it still presents the danger of explosion or fire. Disconnect the battery ground cable from the battery to minimize the possibility of an electrical spark occurring, possibly causing a fire or explosion if fuel vapor or liquid fuel are present in the area. Failure to follow these instructions may result in personal injury.**

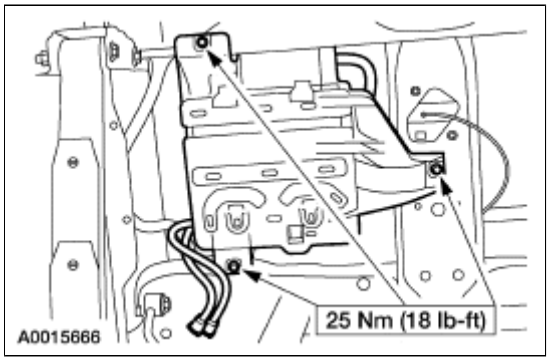
   Disconnect the battery ground cable. For additional information refer to Section 414-01 .

3. **WARNING: Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in personal injury.**

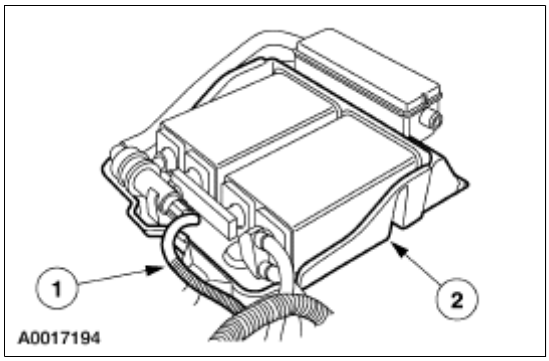
   Disconnect the two chassis emissions lines from the evaporative emission tube.



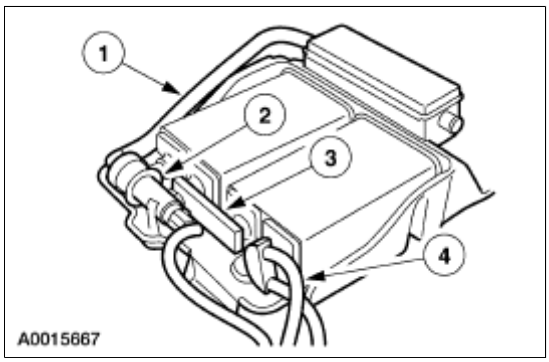

4. Remove the evaporative emissions canister bolts.



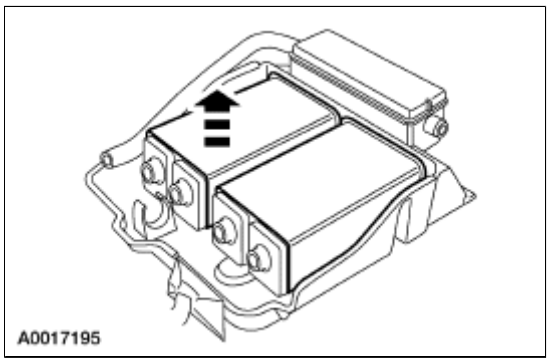

5. Remove the evaporative emission canister with bracket assembly (9E857).
   1. Disconnect the canister vent solenoid electrical connector.
   2. Remove the EVAP canister with bracket assembly.




6. Remove the canister vent solenoid and the evaporative emission tube.
    1. Disconnect the canister vent solenoid hose from the canister vent solenoid.
    2. Remove the canister vent solenoid.
    3. Remove the evaporative emission canister purge sleeve.
    4. Remove the evaporative emission tube.




7. Remove the evaporative emission canister from the evaporative emission canister bracket.




8. **NOTE:** Lubricate all O-ring seals with MERPOL® O-ring Seal Lubricant or equivalent meeting Ford specification ESE-M99B144-B.

To install, reverse removal procedure.

- Leak test the evaporative emissions system. For additional information, refer to Evaporative Emission System Leak Test in this section.
- Carry out the evaporative emission repair verification drive cycle. For additional information, refer to Evaporative Emission Repair Verification Drive Cycle in this section.

## Evaporative Emission Canister Purge Valve

### Removal and Installation

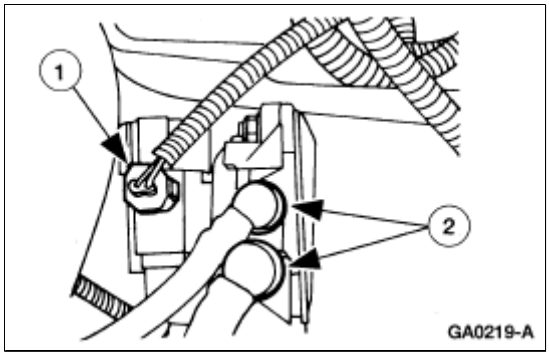
1. **WARNING: The evaporative emissions system contains fuel vapor and condensed fuel vapor. Although not present in large quantities, it still presents the danger of explosion or fire. Disconnect the battery ground cable from the battery to minimize the possibility of an electrical spark occurring, possibly causing a fire or explosion if fuel vapor or liquid fuel are present in the area. Failure to follow these instructions may result in personal injury.**

   Disconnect the battery ground cable. For additional information, refer to Section 414-01 .

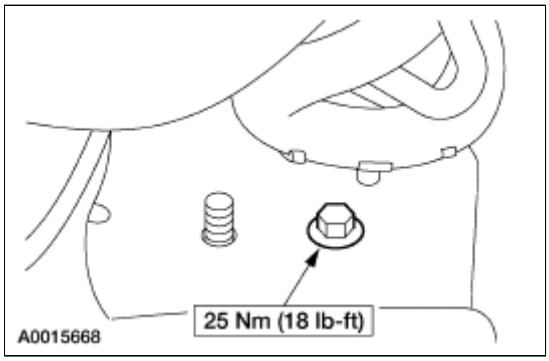
2. Remove the battery tray. For additional information, refer to Section 414-01 .

3. **WARNING: Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in personal injury.**

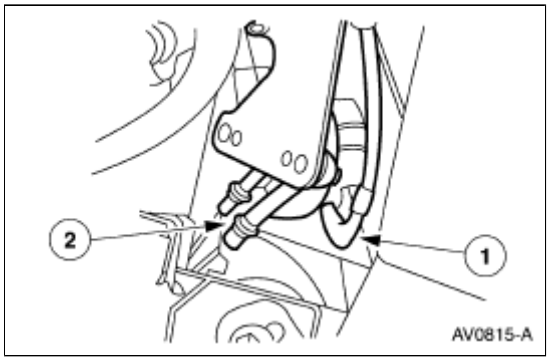
   Disconnect the tubes.
   1. Disconnect the electrical connector.
   2. Disconnect the tubes from the evaporative emission canister purge valve (EVAP canister purge valve).




4. Disconnect the evaporative emission canister purge valve and bracket.
   - Remove the bolt.



5. Remove the evaporative emission canister purge valve.
    1. Disconnect the vacuum line from the evaporative emission canister purge valve.
    2. Remove the evaporative emission canister purge valve.




6. To install, reverse the removal procedure.
    - Leak test the evaporative emissions system. For additional information, refer to Evaporative Emission System Leak Test in this section.
    - Carry out the evaporative emission repair verification drive cycle. For additional information, refer to Evaporative Emission Repair Verification Drive Cycle in this section.

## Fuel Vapor Vent Valve

### Removal and Installation

1. **WARNING: The evaporative emissions system contains fuel vapor and condensed fuel vapor. Although not present in large quantities, it still presents the danger of explosion or fire. Disconnect the battery ground cable from the battery to minimize the possibility of an electrical spark occurring, possibly causing a fire or explosion if fuel vapor or liquid fuel are present in the area. Failure to follow these instructions may result in personal injury.**

   Disconnect the battery ground cable. For additional information, refer to Section 414-01 .

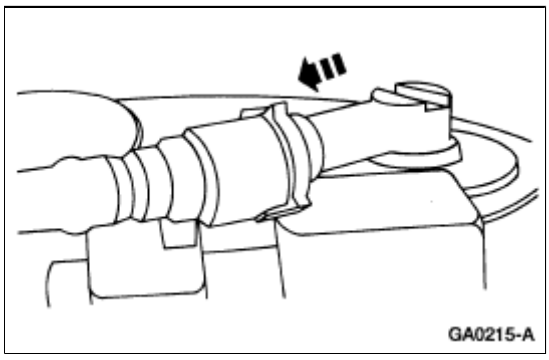
2. **WARNING: Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related component. Highly flammable mixtures are always present and may be ignited, resulting in possible personal injury. Failure to follow these instructions may result in personal injury.**

   Raise and support the vehicle. For additional information, refer to Section 100-02 .

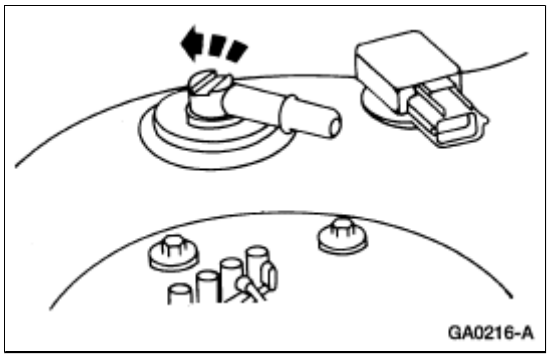
3. Drain the fuel tank. For additional information, refer to Section 310-00 .

4. Lower the fuel tank. For additional information, refer to Section 310-01 .

5. Remove the EVAP canister tube from the fuel vapor vent valve.




6. Remove the fuel vapor vent valve.
   - Press down and rotate the fuel vapor vent valve counterclockwise and remove it from the fuel tank.




7. To install, reverse the removal procedure.
    - Leak test the evaporative emissions system. For additional information, refer to Evaporative Emission System Leak Test in this section.
    - Carry out the evaporative emission repair verification drive cycle. For additional information, refer to Evaporative Emission Repair Verification Drive Cycle in this section.

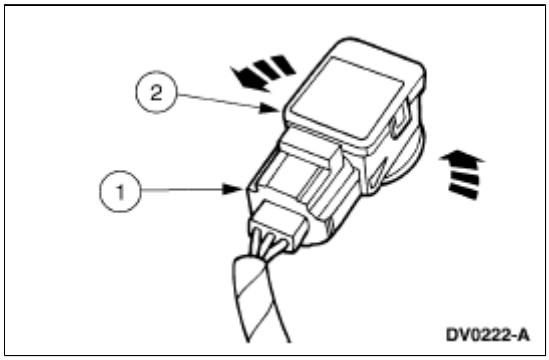
## Fuel Tank Pressure Sensor

### Removal and Installation

1. Remove the fuel tank. For additional information, refer to Section 310-01 .

2. **CAUTION: The fuel tank pressure sensor must be disengaged from the fuel tank before it can be removed. Push down and rotate the fuel tank pressure sensor counterclockwise to disengage it from the fuel tank. Failure to do so can cause damage to the fuel tank pressure sensor or the fuel tank.**

   Remove the fuel tank pressure sensor.
   1. Disconnect the electrical connector.
   2. Press down and rotate the fuel tank pressure sensor counterclockwise and remove it from the fuel tank.

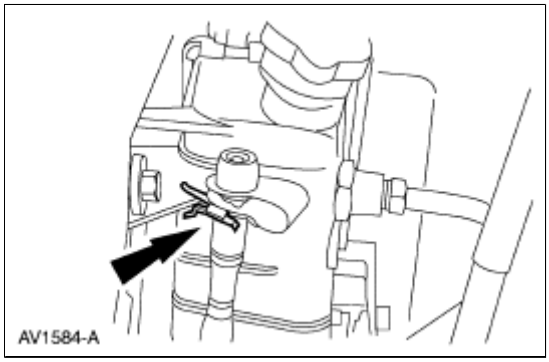



3. To install, reverse removal procedure.
   - Leak test the evaporative emission system. For additional information, refer to Evaporative Emission System Leak Test System in this section.
   - Carry out the evaporative emissions repair verification drive cycle. For additional information, refer to Evaporative Emission Repair Verification Drive Cycle in this section.

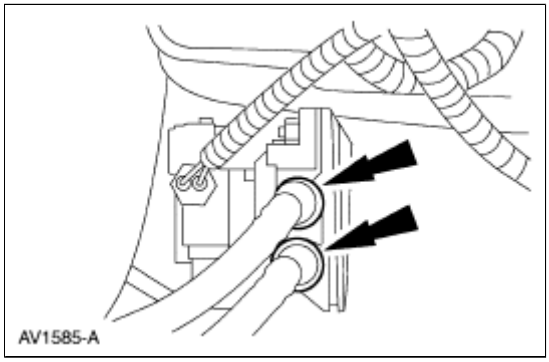
## Evaporative Emission Test Port

### Removal and Installation

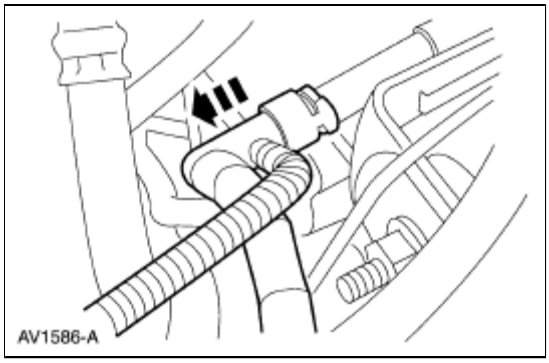
1. Remove the clip.




2. Disconnect the hoses.




3. Remove the test port assembly.
   - Disconnect the fitting.
   - Remove the test port assembly.




4. To install, reverse the removal procedure.

- Leak test the evaporative emissions system. For additional information, refer to Evaporative Emission System Leak Test in this section.
- Carry out the evaporative emission repair verification drive cycle. For additional information, refer to Evaporative Emission Repair Verification Drive Cycle in this section.

## Evaporative Emission Canister Vent Solenoid

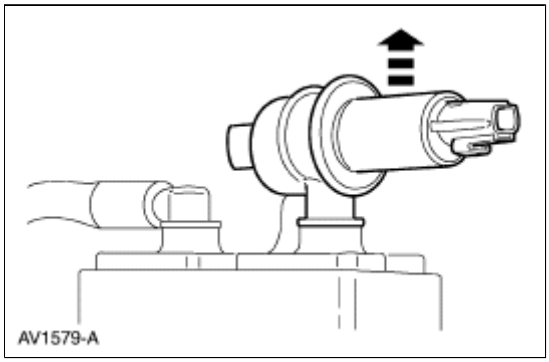
### Removal and Installation

1. **WARNING: The evaporative emission system contains fuel vapor and condensed fuel vapor. Although not present in large quantities, it still presents the danger of explosion or fire. Disconnect the battery ground cable from the battery to minimize the possibility of an electrical spark occurring possibly causing a fire or explosion if fuel vapor or fuel liquid is present in the area. Failure to follow these instructions may result in personal injury.**

   Disconnect the battery ground cable. For additional information, refer to Section 414-01 .

2. Remove the evaporative emissions (EVAP) canister. For additional information, refer to Evaporative Emission Canister in this section.

3. Remove the canister vent solenoid.




4. To install, reverse the removal procedure.
   - Leak test the evaporative emission canister and bracket assembly. For additional information, refer to Evaporative Emission System Leak Test in this section.
   - Carry out the evaporative emission repair verification drive cycle. For additional information, refer to Evaporative Emission Repair Verification Drive Cycle in this section.

## Dust Separator

### Removal and Installation

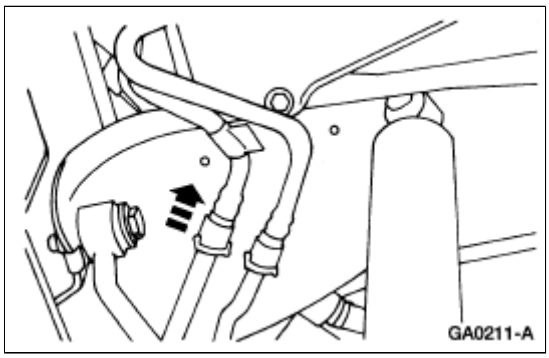
1. Open the liftgate, lower and remove the spare tire.

2. **WARNING: The evaporative emissions system contains fuel vapor and condensed fuel vapor. Although not present in large quantities, it still presents the danger of explosion or fire. Disconnect the battery ground cable from the battery to minimize the possibility of an electrical spark occurring, possibly causing a fire or explosion if fuel vapor or liquid fuel are present in the area. Failure to follow these instructions may result in personal injury.**

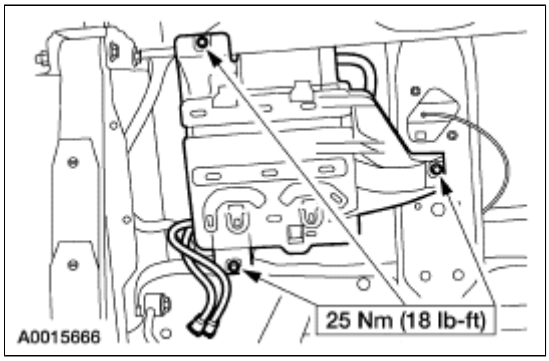
   Disconnect the battery ground cable. For additional information refer to Section 414-01 .

3. **WARNING: Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in personal injury.**

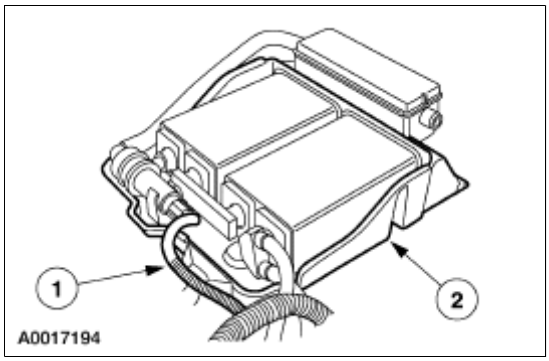
   Disconnect the two chassis emissions lines from the evaporative emission tube.



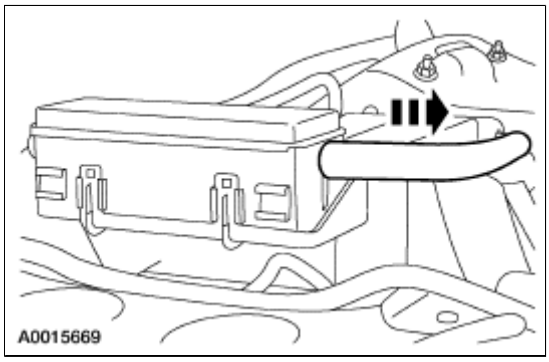

4. Remove the evaporative emissions canister bolts.



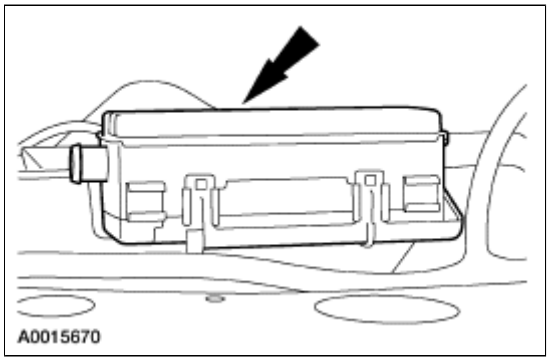

5. Remove the evaporative emission canister with bracket assembly (9E857).
   1. Disconnect the canister vent solenoid electrical connector.
   2. Remove the EVAP canister with bracket assembly.




6. Disconnect the canister vent hose.




7. Remove the evaporative emission dust separator.




8. To install, reverse the removal procedure.
   - Leak test the evaporative emission system. For additional information, refer to Evaporative Emission System Leak Test in this section.
   - Carry out the evaporative emission repair verification drive cycle. For additional information, refer to Evaporative Emission Repair Verification Drive Cycle in this section.

**General Specifications**

| Item | Specification |
|---|---|
| Penetrating and Lock Lubricant E8AZ-19A501-B | — |
| High Temperature Nickel Anti-Seize Lubricant F6AZ-9L494-AA | ESE-M12A4-A |

**Torque Specifications**

| Description | Nm | lb-ft | lb-in |
|---|---|---|---|
| Camshaft position synchronizer bolt, 4.0L (push rod) and 5.0L engines | 19 | 14 | — |
| Camshaft position sensor, stud bolt 4.0L SOHC | 19 | 14 | — |
| Crankshaft position sensor bolts | 10 | — | 89 |
| Engine coolant temperature sensor 4.0L | 15 | 11 | — |
| Engine coolant temperature sensor 5.0L | 20 | 15 | — |
| Heated oxygen sensor | 41 | 30 | — |
| Idle air control valve bolts | 10 | — | 89 |
| Knock sensor bolt | 25 | 18 | — |
| Mass air flow sensor nuts and bolts | 10 | — | 89 |
| Powertrain control module connector bolt | 7 | — | 62 |
| Skid plate bolts (4x4) | 10 | — | 89 |

## Electronic Engine Controls

The electronic engine controls consist of the following:

- powertrain control module (PCM)
- throttle position (TP) sensor
- idle air control (IAC) valve
- engine coolant temperature (ECT) sensor
- camshaft position (CMP) sensor
- camshaft synchronizer
- crankshaft position (CKP) sensor
- mass air flow (MAF) sensor
- intake air temperature (IAT) sensor
- heated oxygen sensor (HO2S)
- knock sensor (KS)

The PCM performs the following functions:

- accepts input from various engine sensors to compute the required fuel flow rate necessary to maintain a prescribed air/fuel ratio throughout the entire engine operational range.
- outputs a command to the fuel injectors to meter the appropriate quantity of fuel.
- determines and compensates for the age of the vehicle and its uniqueness, also automatically senses and compensates for changes in altitude.

The TP sensor:

- sends the PCM a signal indicating the throttle plate angle.
- is the main input to the PCM from the driver.

The IAC valve:

- controls bypass air around the throttle plate at low speeds.
- is controlled by the PCM.

The ECT sensor:

- sends the PCM a signal indicating engine temperature.
- resistance decreases as coolant temperature increases.

The CMP sensor:

- sends the PCM a signal indicating camshaft position used for fuel synchronization.

The CKP sensor:

- sends the PCM a signal indicating crankshaft position.

- is essential for calculating spark timing.

The MAF sensor:

- uses a hot wire sensing element to measure the amount of air entering the engine. Air passing over the hot wire causes it to cool.

The IAT sensor:

- sends the PCM a signal indicating the temperature of the air entering the engine.
- is repaired as an assembly with the MAF.

The front HO2S:

- creates a voltage signal dependent on exhaust oxygen content.
- provides feedback information to the PCM used to calculate fuel delivery.

The rear HO2S:

- monitors oxygen content after it flows through the catalytic converter.
- provides a voltage to the PCM used to calculate catalytic converter integrity.

The KS:

- is used to detect engine detonation.
- sends a voltage signal to the PCM.
- is able to provide a signal which retards the ignition timing, as necessary.

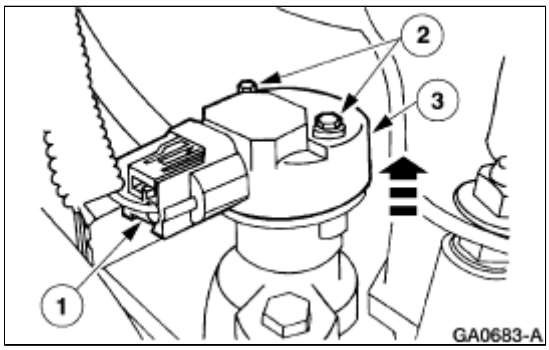
## Electronic Engine Controls

Refer to the Powertrain Control/Emissions Diagnosis (PC/ED) manual.

## Camshaft Position (CMP) Sensor —5.0L, 4.0L (Push Rod)

### Removal and Installation

1. Disconnect the battery ground cable. For additional information, refer to Section 414-01 .
2. For 4.0L (push rod) remove the upper intake manifold. For additional information, refer to Section 303-01A .
3. Remove the camshaft position (CMP) sensor.
    1. Disconnect the CMP electrical connector.
    2. Remove the screws.
    3. Remove the CMP sensor.



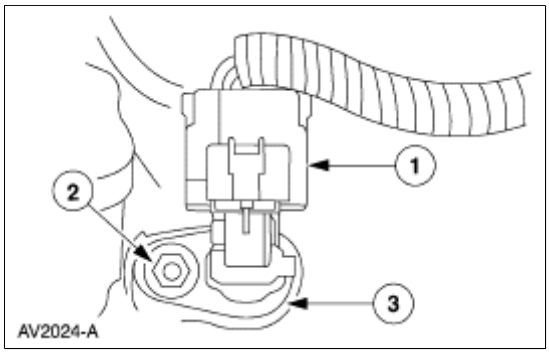

4. To install, reverse the removal procedure.

## Camshaft Position (CMP) Sensor —4.0L SOHC

### Removal

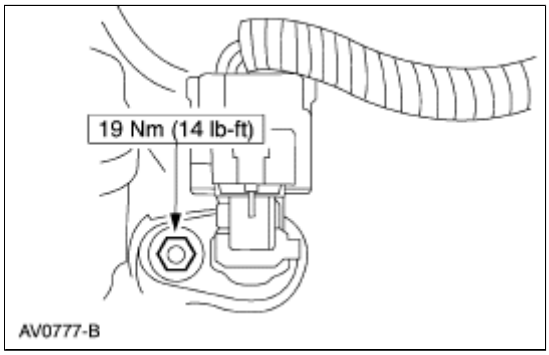
1. Disconnect the battery ground cable (14301). For additional information, refer to Section 414-01 .

2. Remove the camshaft position (CMP) sensor.
    1. Disconnect the CMP sensor electrical connector.
    2. Remove the CMP sensor stud bolt.
    3. Remove the camshaft position sensor.



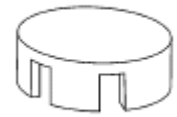

### Installation

1. To install, reverse the removal procedure.



## Synchronizer —4.0L (Push Rod)

**Special Tool(s)**

| | |
|---|---|
|  ST2377-A | Syncro Positioning Tool 303-nt638 |

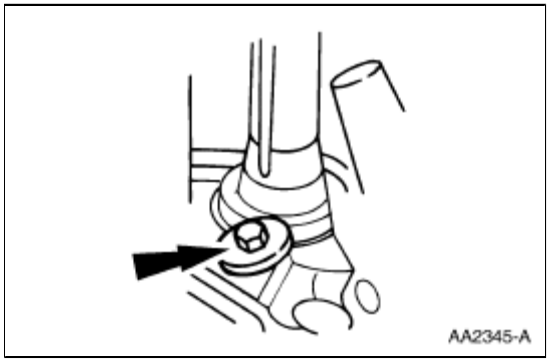
**Removal**

**CAUTION: Do not turn the camshaft during the removal and installation procedure or the fuel system timing will be out of time with the engine and possibly cause engine damage.**

**NOTE:** Prior to the removal of the camshaft position (CMP) sensor, set the No. 1 cylinder to top dead center (TDC) of the compression stroke. Then note the position of the CMP sensor electrical connector. Installation procedures require that the electrical connector be located in the same position.

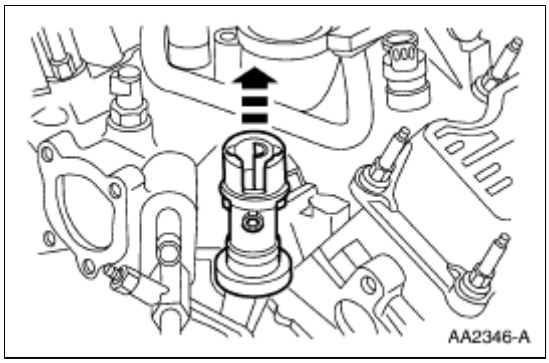
1. Remove the camshaft position (CMP) sensor. For additional information, refer to Camshaft Position (CMP) Sensor—5.0L, 4.0L (Push Rod) in this section.

2. Remove the camshaft synchronizer bolt.




3. **NOTE:** The oil pump driveshaft might come out with the camshaft synchronizer. If so, retrieve the oil pump driveshaft before proceeding.

   Remove the camshaft synchronizer.

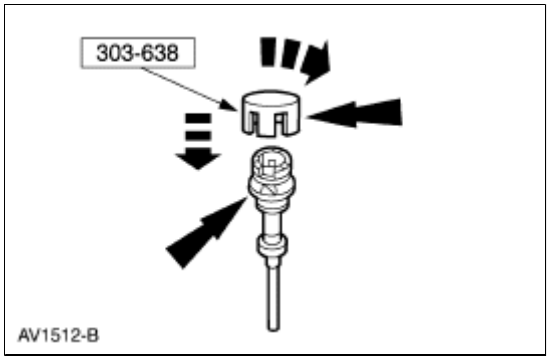



**Installation**

**CAUTION: A special tool must be used during the installation of the replacement synchronizer assembly. Failure to follow this procedure will result in the fuel system being out of time with the engine, possibly causing engine damage.**

**CAUTION: It is very important to coat the gear on the camshaft synchronizer with Super Premium SAE-5W-30 Motor Oil XO-5W30-DSP or equivalent meeting Ford specification WSS-M2C153-G. Failure to do so could result in gear failure.**

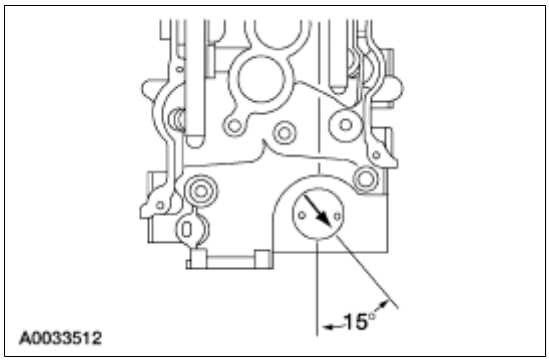
1. Install the special tool by rotating the tool until it engages the notch in the camshaft synchronizer housing and the armature.



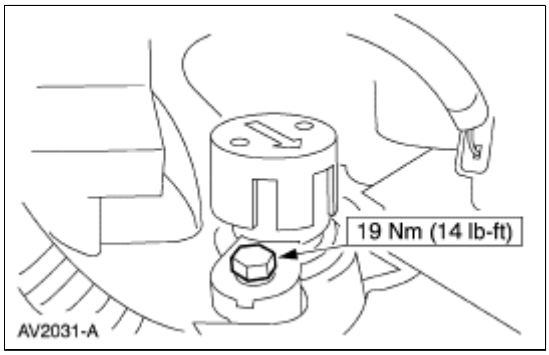

2. **NOTE:** When installing the camshaft synchronizer into the cylinder block, make sure that the arrow on the special tool is pointing to 60 degrees off the engine centerline to the right.

   **NOTE:** The synchronizer will rotate slightly as the synchronizer gear engages the camshaft gear. When the synchronizer is fully installed the arrow on the special tool should point to 15 degrees off the engine centerline to the right.

   Install the camshaft synchronizer.




3. Position the clamp and install the bolt.




4. Remove the special tool.

5. Install the camshaft position (CMP) sensor. For additional information, refer to Camshaft Position (CMP) Sensor—5.0L, 4.0L (Push Rod) in this section.

6. Install the upper intake manifold.

## Synchronizer —5.0L

**Special Tool(s)**

| | |
|---|---|
|  ST2435-A | Syncro Positioning Tool 303-630 |

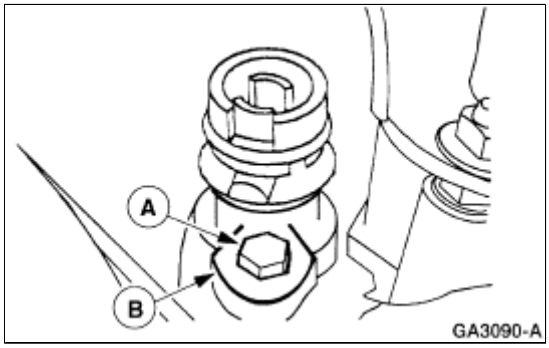
**Removal**

**CAUTION: Once the engine is aligned at TDC, do not move the crankshaft until the entire procedure is complete. Doing so will result in the fuel system being out of time with the engine, causing a possible emissions fault.**

**NOTE:** Prior to the removal of the camshaft position (CMP) sensor, set the No. 1 cylinder to top dead center (TDC) of the compression stroke. Then note the position of the CMP sensor electrical connector. Installation procedures require that the electrical connector be located in the same position.

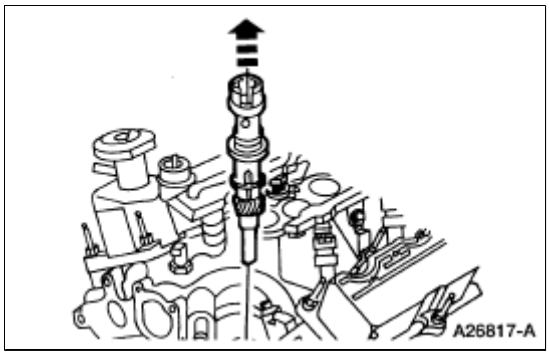
1. Remove the camshaft position (CMP) sensor. For additional information, refer to Camshaft Position (CMP) Sensor—5.0L, 4.0L (Push Rod) in this section.

2. Remove the (A) bolt and (B) clamp.




3. **NOTE:** The oil pump driveshaft might come out with the camshaft synchronizer. If so, retrieve the oil pump driveshaft before proceeding.

   Remove the camshaft synchronizer.

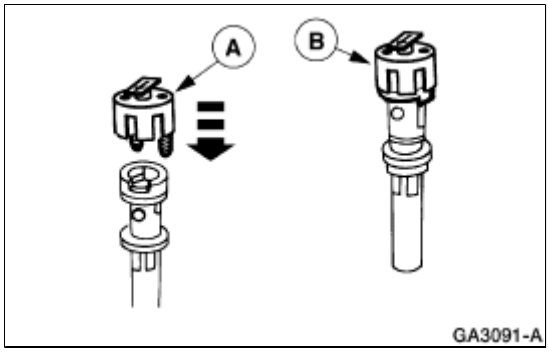



**Installation**

**CAUTION: A special tool must be used during the installation of the replacement synchronizer assembly. Failure to follow this procedure will result in the fuel system being out of time with the engine, possibly causing engine damage.**

**CAUTION: It is very important to coat the gear on the camshaft synchronizer with Super Premium SAE-5W-30 Motor Oil XO-5W30-DSP or equivalent meeting Ford specification WSS-M2C153-G. Failure to do so could result in gear failure.**

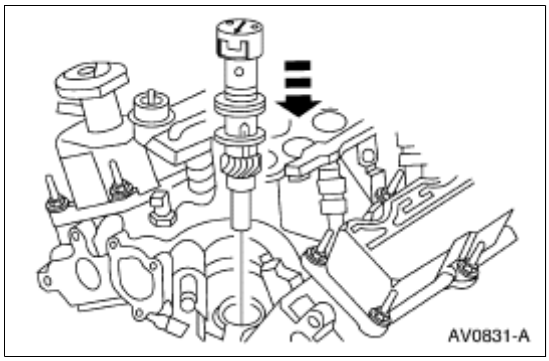
1. Install (A) Synchro Positioning Tool, aligning tabs and notches with those on the (B) camshaft synchronizer.



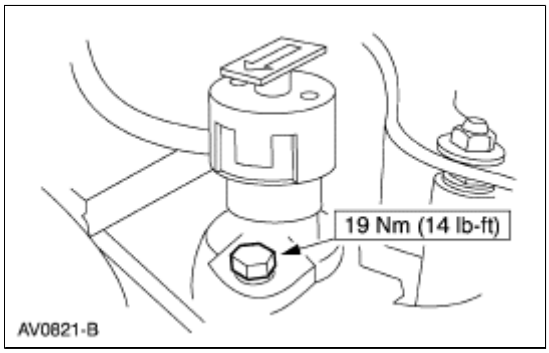

2. **NOTE:** When installing the camshaft synchronizer into the cylinder block, make sure that the arrow on special tool is pointing toward the front of the vehicle, on a line that is parallel to the center line of the crankshaft.

   **NOTE:** The synchronizer will rotate slightly as the synchronizer gear engages the camshaft gear. When the synchronizer is fully installed the arrow on the special tool should point to the position of the electrical connector.

   Install the camshaft synchronizer.




3. Position the clamp and install the bolt.




4. Remove the special tool.

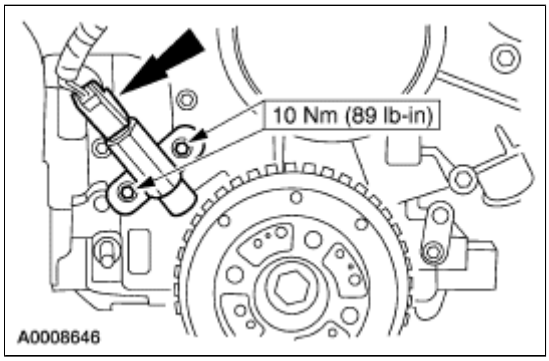
5. Install the CMP sensor. For additional information, refer to Camshaft Position (CMP) Sensor—5.0L, 4.0L (Push Rod) in this section.

## Crankshaft Position (CKP) Sensor

### Removal and Installation

**NOTE:** The 5.0L is shown, the 4.0L SOHC and the 4.0L (push rod) engines are similar.

1. Disconnect the battery ground cable. For additional information, refer to Section 414-01 .
2. Remove the crankshaft position (CKP) sensor.




3. **NOTE:** 4.0L SOHC and 4.0L (push rod) CKP sensors need to be touching the damper. The CKP sensor has wear tabs that will wear off after several engine revolutions.

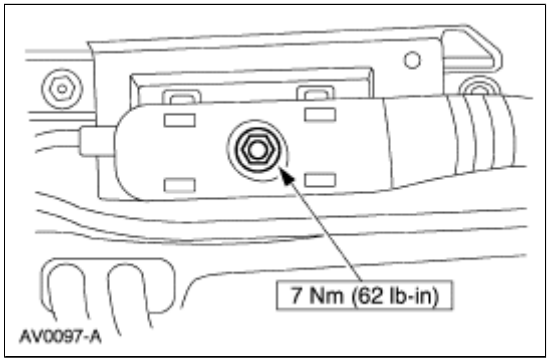
   **NOTE:** Be sure sensor wiring is routed away from the battery cable.

   To install, reverse the removal procedure.

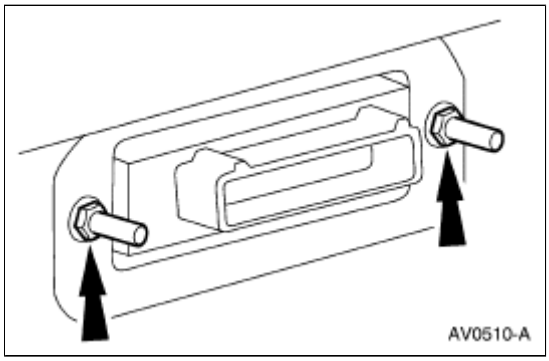
## Powertrain Control Module (PCM)

### Removal and Installation

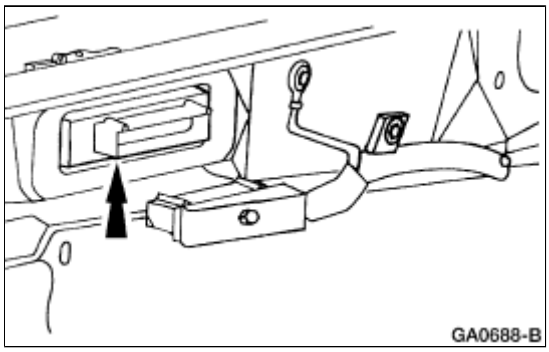
1. Disconnect the battery ground cable. For additional information, refer to Section 414-01 .
2. Disconnect the powertrain control module (PCM) electrical connector.




3. Remove the nuts and the PCM cover.




4. Remove the PCM.



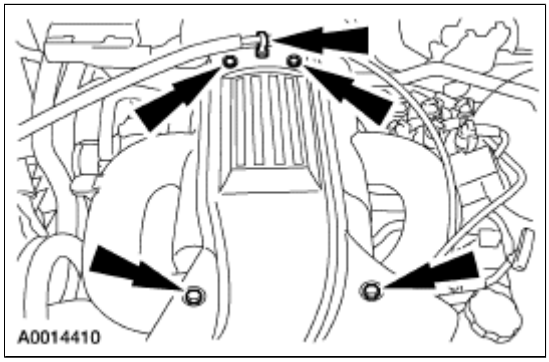

5. To install, reverse the removal procedure.

## Throttle Position (TP) Sensor —4.0L (Push Rod), 4.0L SOHC

### Removal and Installation

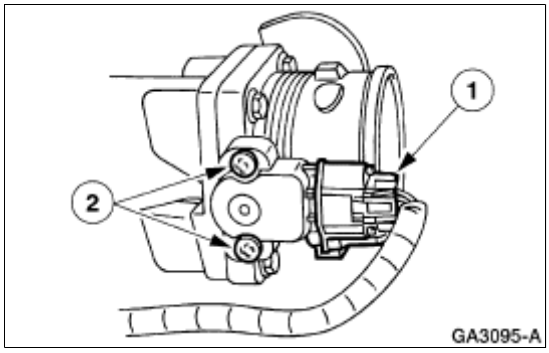
1. Disconnect the battery ground cable. For additional information, refer to Section 414-01 .

2. Remove the accelerator control snow shield.




3. **NOTE:** The 4.0L (SOHC) is shown, the 4.0L push rod is similar.

   Remove the throttle position (TP) sensor.
   1. Disconnect the TP sensor electrical connector.
   2. Remove the sensor.

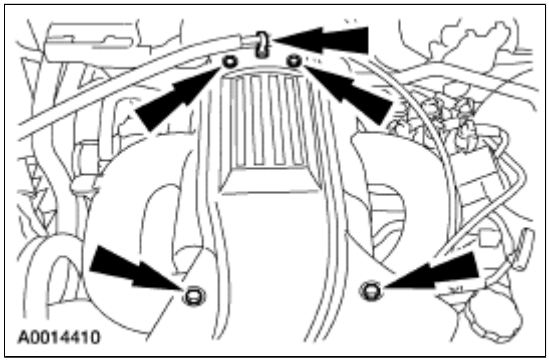



4. To install, reverse the removal procedure.

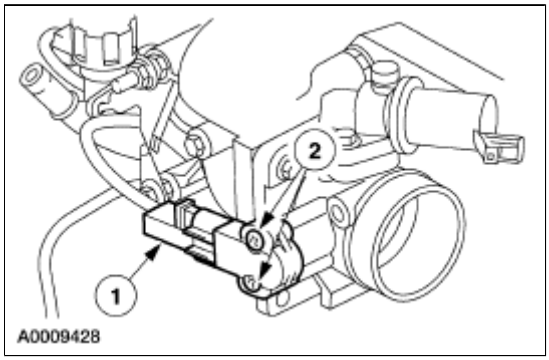
## Throttle Position (TP) Sensor —5.0L

### Removal and Installation

1. Disconnect the battery ground cable. For additional information, refer to Section 414-01 .
2. Remove the accelerator control snow shield.




3. Remove the throttle position (TP) sensor.
    1. Disconnect the elctrical connector.
    2. Remove the sensor.



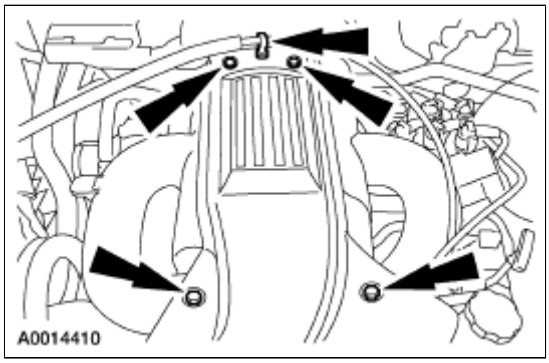

4. To install, reverse the removal procedure.

## Idle Air Control (IAC) Valve

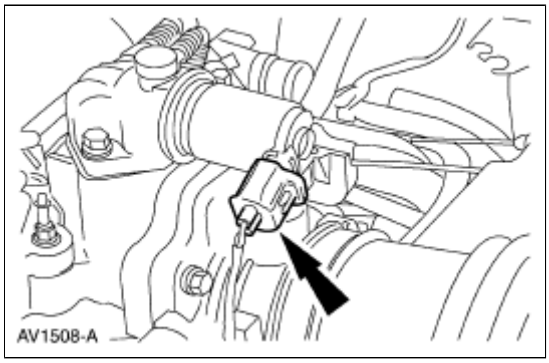
### Removal and Installation

**NOTE:** The 5.0L is shown, the 4.0L SOHC and the 4.0L (push rod) engines are similar.

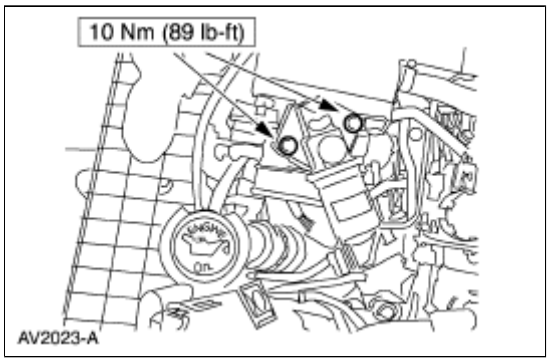
1. Disconnect the battery ground cable. For additional information, refer to Section 414-01 .
2. Remove the accelerator control snow shield.




3. Disconnect the idle air control (IAC) valve electrical connector.




4. Remove the IAC valve and discard the gasket.



5. **NOTE:** Install a new IAC valve gasket.

   To install, reverse the removal procedure.

## Engine Coolant Temperature (ECT) Sensor —4.0L SOHC, 4.0L (Push Rod)

### Removal and Installation

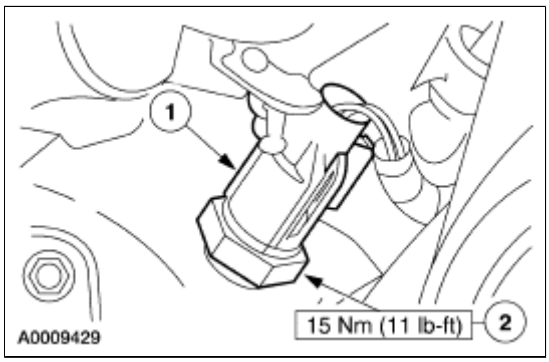
### 4.0L SOHC

1. Remove the thermostat and housing. For additional information, refer to Section 303-03 .

### For All

2. Disconnect the battery ground cable. For additional information, refer to Section 414-01 .

3. Remove the engine coolant temperature (ECT) sensor.
    1. Disconnect the connector.
    2. Remove the sensor.

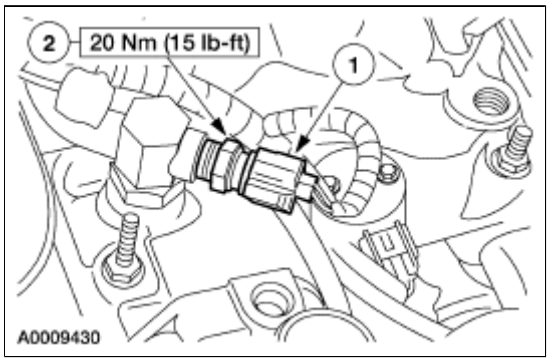



4. To install, reverse the removal procedure.

## Engine Coolant Temperature (ECT) Sensor —5.0L

### Removal and Installation

1. Disconnect the battery ground cable. For additional information, refer to Section 414-01 .
2. Partially drain the cooling system. For additional information, refer to Section 303-03 .
3. Remove the engine coolant temperature (ECT) sensor.
    1. Disconnect the electrical connector.
    2. Remove the sensor.

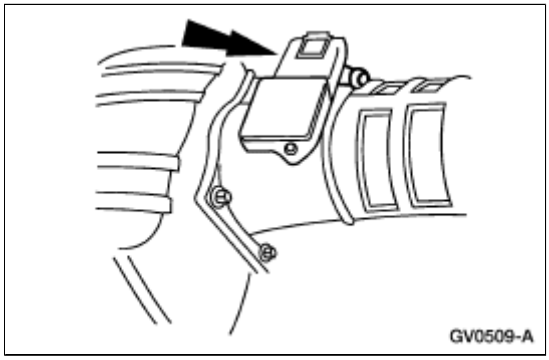



4. To install, reverse the removal procedure.

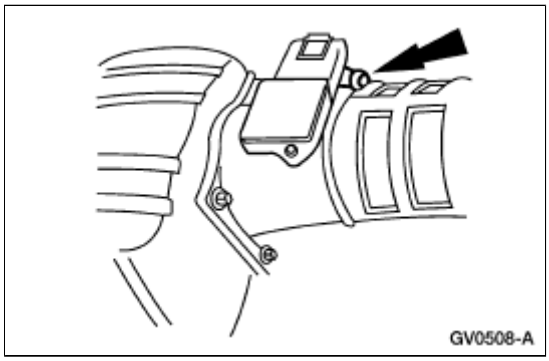
## Mass Air Flow (MAF) Sensor —4.0L, 4.0L SOHC and 5.0L

### Removal and Installation

1. Disconnect the battery ground cable. For additional information, refer to Section 414-01 .
2. Disconnect the mass air flow (MAF) sensor electrical connector.

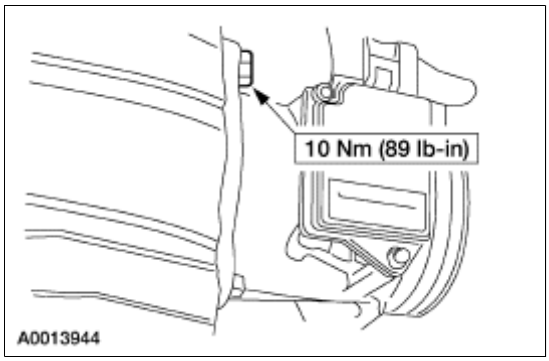



3. Loosen the air cleaner outlet tube clamp and position aside.




4. **CAUTION: The MAF sensor electronics module and body are calibrated as a unit and must be replaced as a unit. Do not tamper with the sensing elements located in the air flow bypass of the MAF body.**

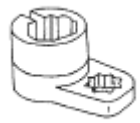
   Remove the four bolts and the MAF sensor.




5. To install, reverse the removal procedure.

## Heated Oxygen Sensor (HO2S)

**Special Tool(s)**

| | |
|---|---|
|  ST1447-A | Socket, Exhaust Gas Oxygen Sensor<br>303-476 (T94P-9472-A) |

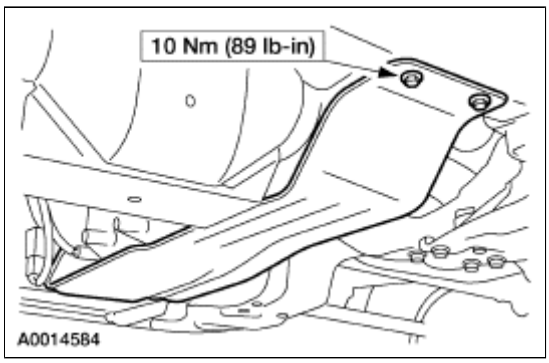
**Material**

| Item | Specification |
|---|---|
| Penetrating and Lock Lubricant<br>E8AZ-19A501-B or equivalent | N/A |
| High Temperature Nickel Anti-Seize Lubricant<br>F6AZ-9L494-AA | ESE-M12A4-A |

**Removal and Installation**

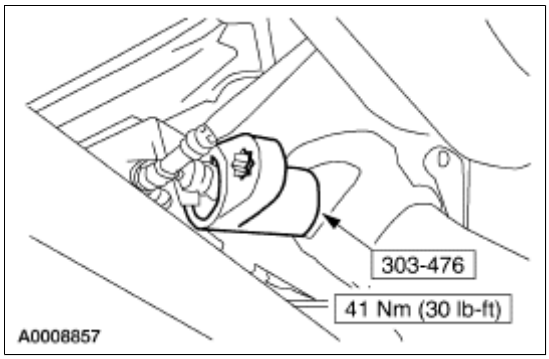
**NOTE:** The 5.0L RH is shown, the 4.0L SOHC and the 4.0L (push rod) engines are similar.

1. Raise and support the vehicle. For additional information, refer to Section 100-02 .
2. Remove the bolts and the skid plate.




3. **NOTE:** If necessary, lubricate the HO2S with lock lubricant to assist in removal.

   Using the special tool, remove the HO2S.




4. **NOTE:** Apply a light coat of anti-seize lubricant to the threads of the HO2S.

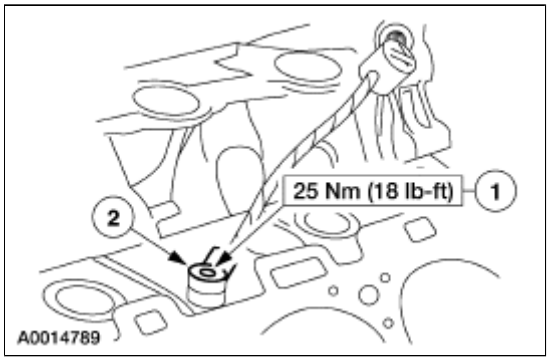
   To install, reverse the removal procedure.

## Knock Sensor (KS) —4.0L SOHC

### Removal and Installation

1. Remove the lower intake manifold. For additional information, refer to Section 303-01B .

2. Remove the knock sensor.
    1. Remove the bolt.
    2. Remove the knock sensor.




3. To install, reverse the removal procedure.