

## Injector Solenoid - Test

### System Operation Description:

Use this procedure to troubleshoot the electrical system if a problem is suspected with the injectors or if any one of the diagnostic codes in Table 1 is active or easily repeated.

Table 1

Diagnostic Codes Table		
Description	Conditions which Generate this Code	System Response
1-5 Cylinder #1 Injector : Current Below Normal	The Electronic Control Module (ECM) detects current below normal.	The code is logged. If equipped, the warning light will illuminate. The ECM will continue to attempt to operate the injector after the code has been logged. The engine may misfire. The engine may experience low power.
1-6 Cylinder #1 Injector : Current Above Normal	The ECM detects current above normal for each of five consecutive attempts to operate. Battery voltage is above 9 volts for 2 seconds.	The code is logged. If equipped, the warning light will illuminate. The ECM will continue to attempt to operate the injector after the code has been logged. The engine may misfire. The engine may experience low power.

2-5 Cylinder #2 Injector : Current Below Normal	The ECM detects current below normal.	The code is logged. If equipped, the warning light will illuminate. The ECM will continue to attempt to operate the injector after the code has been logged. The engine may misfire. The engine may experience low power.
2-6 Cylinder #2 Injector : Current Above Normal	The ECM detects current above normal for each of five consecutive attempts to operate. Battery voltage is above 9 volts for 2 seconds.	The code is logged. If equipped, the warning light will illuminate. The ECM will continue to attempt to operate the injector after the code has been logged. The engine may misfire. The engine may experience low power.
3-5 Cylinder #3 Injector : Current Below Normal	The ECM detects current below normal.	The code is logged. If equipped, the warning light will illuminate. The ECM will continue to attempt to operate the injector after the code has been logged. The engine may misfire. The engine may experience low power.
3-6 Cylinder #3 Injector : Current Above Normal	The ECM detects current above normal for each of five consecutive attempts to operate. Battery voltage is above 9 volts for 2 seconds.	The code is logged. If equipped, the warning light will illuminate. The ECM will continue to attempt to operate the injector after the code has been logged. The engine may misfire. The engine may experience low power.
4-5 Cylinder #4 Injector : Current Below Normal	The ECM detects current below normal.	The code is logged. If equipped, the warning light will illuminate. The ECM will continue to attempt to operate the injector after the code has been logged. The engine may misfire. The engine may experience low power.

4-6 Cylinder #4 Injector : Current Above Normal	The ECM detects current above normal for each of five consecutive attempts to operate. Battery voltage is above 9 volts for 2 seconds.	The code is logged. If equipped, the warning light will illuminate. The ECM will continue to attempt to operate the injector after the code has been logged. The engine may misfire. The engine may experience low power.
5-5 Cylinder #5 Injector : Current Below Normal <b>C6.4 only</b>	The ECM detects current below normal.	The code is logged. If equipped, the warning light will illuminate. The ECM will continue to attempt to operate the injector after the code has been logged. The engine may misfire. The engine may experience low power.
5-6 Cylinder #5 Injector : Current Above Normal <b>C6.4 only</b>	The ECM detects current above normal for each of five consecutive attempts to operate. Battery voltage is above 9 volts for 2 seconds.	The code is logged. If equipped, the warning light will illuminate. The ECM will continue to attempt to operate the injector after the code has been logged. The engine may misfire. The engine may experience low power.
6-5 Cylinder #6 Injector : Current Below Normal <b>C6.4 only</b>	The ECM detects current below normal.	The code is logged. If equipped, the warning light will illuminate. The ECM will continue to attempt to operate the injector after the code has been logged. The engine may misfire. The engine may experience low power.
6-6 Cylinder #6 Injector : Current Above Normal <b>C6.4 only</b>	The ECM detects current above normal for each of five consecutive attempts to operate. Battery voltage is above 9 volts for 2 seconds.	The code is logged. If equipped, the warning light will illuminate. The ECM will continue to attempt to operate the injector after the code has been logged. The engine may misfire. The engine may experience low power.

Perform this procedure under conditions that are identical to the conditions that exist when the fault occurs. Typically, faults with the injector solenoid occur when the engine is warmed up and/or when the engine is under vibration (heavy loads).

These engines have Electronic Unit Injectors (EUI) that are mechanically actuated and electronically controlled. The ECM sends a pulse to each injector solenoid. The pulse is sent at the correct time and at the correct duration for a given engine load and speed. The solenoid is mounted on top of the fuel injector body.

If an open circuit is detected in the solenoid circuit, a diagnostic code is generated. The ECM continues to try to fire the injector. If a short circuit is detected, a diagnostic code is generated. The ECM will disable the solenoid circuit. The ECM will periodically try to fire the injector. If the short circuit remains this sequence of events will be repeated until the fault is corrected.

When an injector is replaced, program the new injector code into the ECM. If the ECM is replaced, all of the injector codes must be programmed into the new ECM. Refer to service Troubleshooting, "Injector Trim File -Install".

**Note:** Discard all fuel injection lines after use. **Fuel injection lines must only be used one time.**

The Caterpillar Electronic Technician (ET) includes the following tests that aid in troubleshooting the injector solenoids:

### **"Cylinder Cutout Test"**

All active diagnostic codes must be repaired before running the "Cylinder Cutout Test". Use the "Cylinder Cutout Test" to diagnose a malfunctioning injector while the engine is running. When a good injector is cut out, the "Fuel Position" should change. The change in the fuel position is caused by the other injectors that are compensating for the cut out injector. If a malfunctioning injector is cut out, the "Fuel Position" will not change. The "Cylinder Cutout Test" is used to isolate the malfunctioning injector in order to avoid replacement of good injectors.

### **"Injector Solenoid Test"**

Use the "Injector Solenoid Test" to aid in diagnosing an open circuit or a short circuit while the engine is not running. The "Injector Solenoid Test" briefly activates each solenoid. A good solenoid will create an audible click when the solenoid is activated. Cat ET will indicate the status of the solenoid as "OK", "Open", or "Short".

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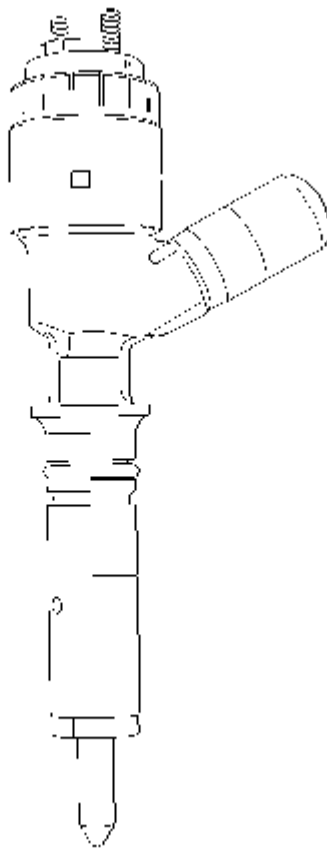


Illustration 1

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Typical example of the fuel injector

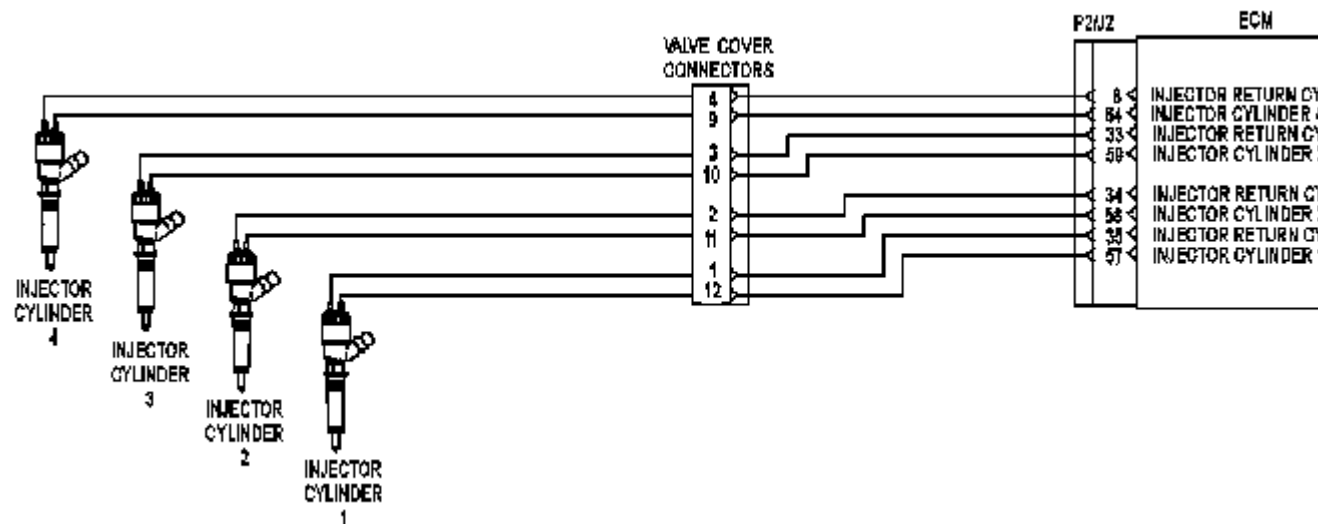


Illustration 2

g01.

Schematic for the C4.2 injector solenoid circuit

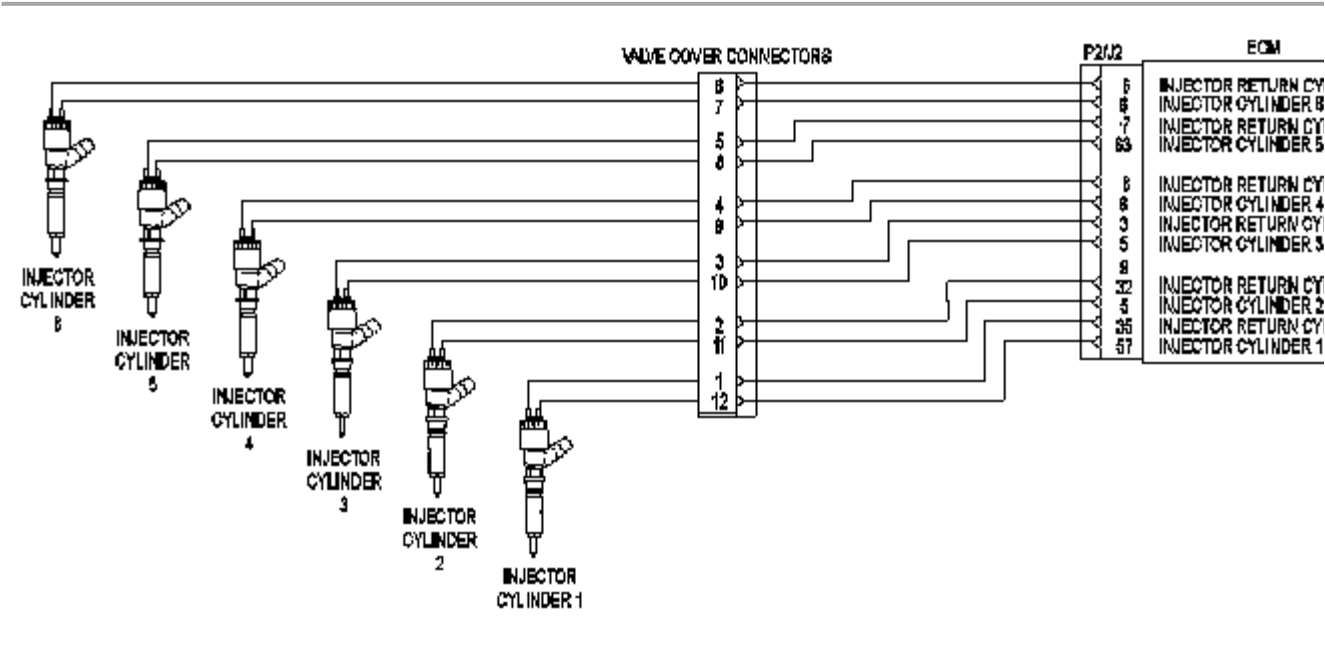


Illustration 3

g01.

Schematic for the C6.4 injector solenoid circuit

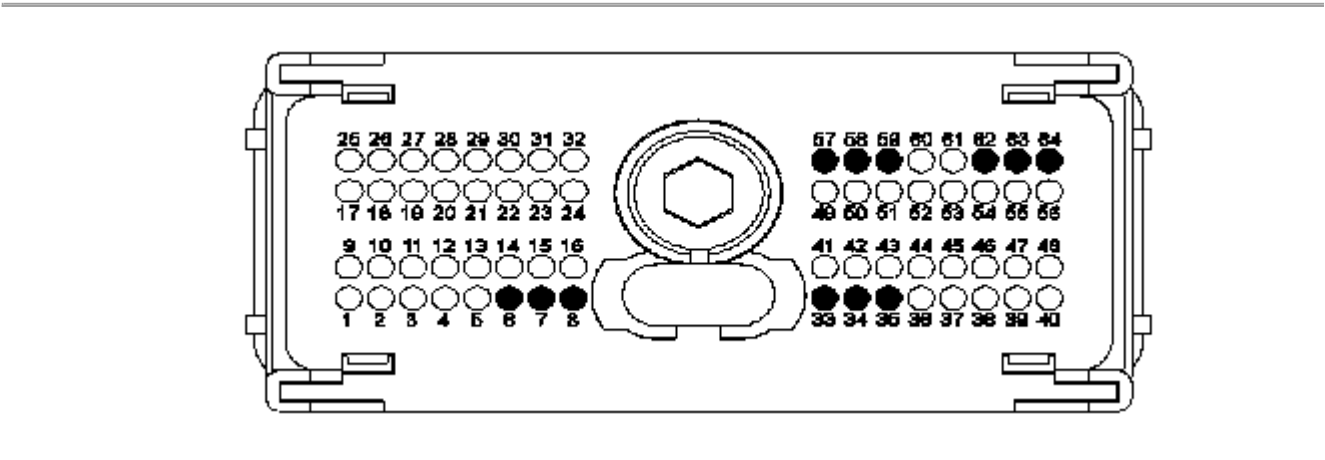


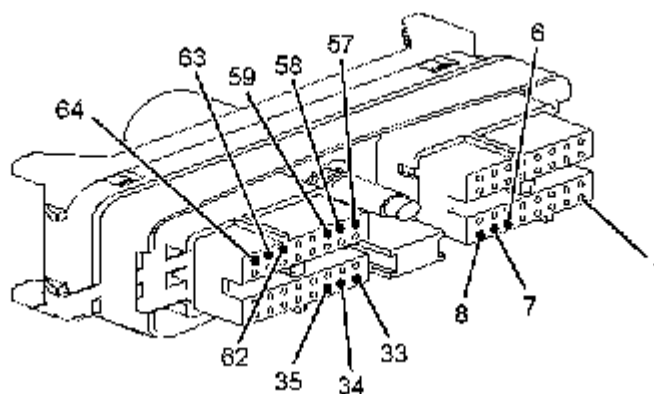
Illustration 4

g01.

A typical view of the P2 connector (harness side) pin locations.

(57) Injector 1 supply

- (35) Injector 1 return
- (58) Injector 2 supply
- (34) Injector 2 return
- (59) Injector 3 supply
- (33) Injector 3 return
- (64) Injector 4 supply
- (8) Injector 4 return
- (63) Injector 5 supply (C6.4 only)
- (7) Injector 5 return (C6.4 only)
- (62) Injector 6 supply (C6.4 only)
- (6) Injector 6 return (C6.4 only)



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Illustration 5

g01.

A typical view of the P2 connector (ECM side) pin locations.

### Test Step 1. Inspect Electrical Connectors and Wiring



**WARNING**

**Electrical shock hazard. The electronic unit injector system uses 67-73 volts.**

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- A. Turn the keyswitch to the OFF position. A strong electrical shock hazard is present if the power is not removed.

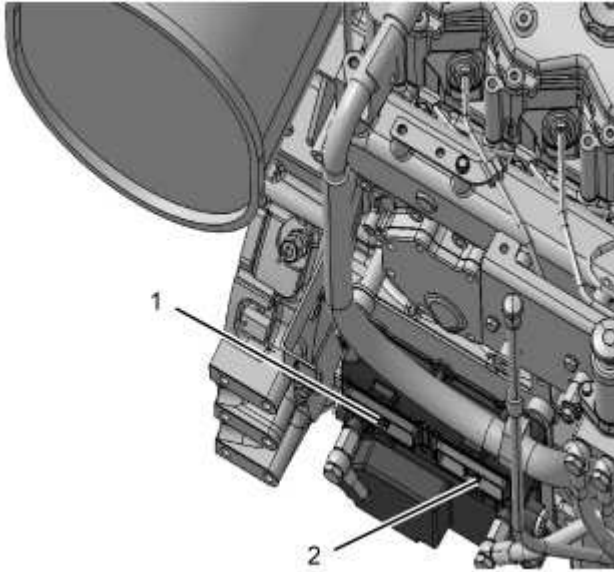


Illustration 6

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Typical engine ECM

(1) J2 ECM connector

(2) J1 ECM connector

- B. Thoroughly inspect connector P2. Thoroughly inspect the connectors at the valve cover base. Refer to service Troubleshooting, "Electrical Connectors - Inspect" for details.
- C. Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector that are associated with injector solenoids.
- D. Check the torque of the allen head screws for the ECM connectors. Refer to service Troubleshooting, "Electrical Connectors - Inspect" for the correct torque values.
- E. Check the harness and wiring for abrasion and for pinch points from the injectors to the ECM.

### **Expected Result:**

All connectors, pins, and sockets are completely coupled and/or inserted and the harness is free of corrosion, of abrasion and of pinch points.

### **Results:**

- **OK** - The harness is OK. Proceed to Test Step 2.



- **Not OK** - There is a problem in the connectors and/or the harness.

**Repair:** Repair the connectors or the harness and/or replace the connectors or the harness. Ensure that all of the seals are correctly in place and ensure that the connectors are completely coupled. Perform a wiggle test with Cat ET in order to identify intermittent connections. Verify that the repair eliminates the problem.

## **STOP**

### **Test Step 2. Check for Logged Diagnostic Codes for the Injector Solenoids**

- A. Connect Cat ET to the service tool connector. Refer to the introduction Troubleshooting, "Electronic Service Tools".
- B. Turn the keyswitch to the ON position.
- C. Check for logged diagnostic codes for the injector solenoids on Cat ET. Wait at least 30 seconds in order for the codes to become active.

#### **Expected Result:**

One or more diagnostic codes for the injector solenoids are logged.

#### **Results:**

- **OK** - One or more diagnostic codes for the injector solenoids are logged. Proceed to Test Step 4.
- **Not OK** - No diagnostic codes for the injector solenoids are logged, but there may be a performance problem. Proceed to Test Step 3.

### **Test Step 3. Perform the "Cylinder Cutout Test"**

- A. Start the engine.
- B. Allow the engine to warm up to normal operating temperature.
- C. Access the "Cylinder Cutout Test" by accessing the following display screens:
  - Diagnostics
  - Diagnostic Tests
  - Cylinder Cutout Test
- D. Shut off all parasitic loads such as air compressors which could affect the results of the test.
- E. Select the start button at the bottom of the screen for the cylinder cutout test on Cat ET.
- F. Follow the instructions that are provided by Cat ET in order to complete the cylinder cutout test. The cylinder cutout test is interactive so the procedure is guided to the finish. The test results are displayed on Cat ET.

The cylinder cutout test may not run unless certain conditions are present. For example, Cat ET will not allow the cylinder cutout test to occur when the temperature of the engine coolant is too low. In this case, warm the engine or perform the test manually.

- G. You may manually cut out a cylinder, if necessary. Highlight a cylinder and select the "Change" button at the bottom of the screen. The injector for that cylinder will be disabled. Check for a difference in the sound, feel, or power of the engine. Also, look for a change to the operating parameters that are displayed on the "Cylinder Cutout Test" screen.

**Expected Result:**

The cylinder cutout test indicates that all of the injectors are operating correctly.

**Results:**

- **OK** - The cylinder cutout test indicates that all of the injectors are operating correctly.

**Repair:** If the engine is misfiring or if the engine has low power, refer to the symptom Troubleshooting, "Engine Misfires, Runs Rough or is Unstable" or Troubleshooting, "Power Is Intermittently Low or Power Cutout Is Intermittent".

**STOP**

- **Not OK** - The cylinder cutout test indicates that at least one of the injectors is not operating correctly. Proceed to Test Step 4.

**Test Step 4. Perform the "Injector Solenoid Test"**

- A. Start the engine.
- B. Allow the engine to warm up to normal operating temperature.
- C. Stop the engine.
- D. Access the "Injector Solenoid Test" by accessing the following display screens:
- Diagnostics
  - Diagnostic Tests
  - Injector Solenoid Test
- E. Activate the "Injector Solenoid Test".
- F. As each solenoid is energized by the ECM, an audible click can be heard at the valve cover.
- G. Allow the "Injector Solenoid Test" to continue until each cylinder is activated at least two times.

**Expected Result:**

All cylinders indicate "OK" on Cat ET.

## Results:

- **OK** - There is not an electronic problem with the injectors at this time.

**Repair:** The problem appears to be resolved. The problem was probably caused by a poor electrical connection in a connector. If the codes continue to be logged, refer to service Troubleshooting, "Electrical Connectors - Inspect". If the engine is misfiring and/or if the engine has low power, refer to the symptom Troubleshooting, "Engine Misfires, Runs Rough or Is Unstable" or refer to the symptom Troubleshooting, "Low Power/Poor or No Response to Throttle".

## STOP

- **Not OK - Open** - Note the cylinder that indicates "Open". Proceed to Test Step 5.
- **Not OK - Short** - Note the cylinder that indicates "Short". Proceed to Test Step 6.

## Test Step 5. Check the Harness between the ECM and the Valve Cover Base for an Open Circuit



**Electrical shock hazard. The electronic unit injector system uses 67-73 volts.**

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- Turn the keyswitch to the OFF position. A strong electrical shock hazard is present if the power is not removed.
- Disconnect the connectors for the valve cover base.
- Turn the keyswitch to the ON position.
- Fabricate a jumper wire 100 mm (4 inch) long with Deutsch pins on both ends of the wire.
- Insert one end of the jumper wire into the terminal for the suspect injector's supply wire. Insert the other end of the jumper wire into the terminal for the suspect injector's return wire.
- Perform the "Injector Solenoid Test" at least two times.
- Repeat this test for each suspect injector. Stop the "Injector Solenoid Test" before handling the jumper wire.

## Expected Result:

Cat ET displays "Open" for the cylinder with the jumper wire.

## Results:

- **OK** - Cat ET displays "Open" for the cylinder with the jumper wire. There is a problem in the wiring between the ECM and the valve cover base. There may be a problem with the ECM. Proceed to Test Step 8.
- **Not OK** - Cat ET displays "Short" for the cylinder with the jumper wire. The harness between the ECM and the valve cover base does not have an open circuit. Proceed to Test Step 7.

#### **Test Step 6. Check the Harness between the ECM and the Valve Cover Base for a Short Circuit**



### **WARNING**

**Electrical shock hazard. The electronic unit injector system uses 67-73 volts.**

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- A. Turn the keyswitch to the OFF position. A strong electrical shock hazard is present if the power is not removed.
- B. Disconnect the connectors from the valve cover base.
- C. Turn the keyswitch to the ON position.
- D. Perform the "Injector Solenoid Test" at least two times.

#### **Expected Result:**

All cylinders indicate "Open" on Cat ET.

#### **Results:**

- **OK** - All cylinders indicate "Open" on Cat ET. Proceed to Test Step 7.
- **Not OK** - One or more cylinders indicate "Short" on Cat ET. Note the cylinders that indicate "Short". Proceed to Test Step 8.

#### **Test Step 7. Check the Injector Harness Under the Valve Cover for an Open Circuit or a Short Circuit**



### **WARNING**

**Electrical shock hazard. The electronic unit injector system uses 67-73 volts.**

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- A. Turn the keyswitch to the OFF position. A strong electrical shock hazard is present if the power is not removed.

- B. Remove the valve cover.
- C. Disconnect the harness connector for each injector solenoid that indicates a "Short" on Cat ET. Ensure that each disconnected connector does not touch other components and create a short circuit.
- D. Turn the keyswitch to the ON position.
- E. Perform the "Injector Solenoid Test" at least two times.

**Expected Result:**

All of the injector solenoids that were disconnected indicate "Open" on Cat ET.

**Results:**

- **OK** - All of the injector solenoids that were disconnected indicate "Open" on Cat ET.

**Repair:** Replace the faulty injector. Perform the "Injector Solenoid Test". Verify that the problem is resolved.

**STOP**

- **Not OK** - At least one of the injector solenoids that were disconnected still indicate "Short" on Cat ET. There is a problem with the wiring harness inside the valve cover. There may be a problem with a connector.

**Repair:** Inspect the connectors for moisture and for corrosion. Repair the wiring and/or the connector, when possible. Replace parts, if necessary. Verify that the problem is resolved.

**STOP**

**Test Step 8. Check the ECM for Proper Operation**



**WARNING**

**Electrical shock hazard. The electronic unit injector system uses 67-73 volts.**

- A. Turn the keyswitch to the OFF position. A strong electrical shock hazard is present if the power is not removed.
- B. Fabricate a jumper that is long enough to create a test circuit from the P2 ECM connector to the engine ground stud. Crimp a connector socket to one end of the jumper wire.
- C. Disconnect the P2 connector.

D. Remove the supply wire from the terminal location for the suspect injector at the ECM connector. Install the socket end of the jumper wire into this terminal location.

E. Connect the J2/P2 ECM connectors.

**F. Verify that the ECM Will Detect an Open Circuit for the Suspect Injector:**

- a. Ensure that the jumper wire is not in contact with a ground source or another circuit. Do not touch the jumper wire during the test. A strong electrical shock hazard is present at the jumper wire while the test is running.
- b. Turn the keyswitch to the ON position.
- c. Perform the "Injector Solenoid Test" at least two times.
- d. Turn the keyswitch to the OFF position.

Cat ET displays "Open" for the suspect injector.

**G. Verify that the ECM Will Detect a Short Circuit for the Suspect Injector:**

- a. Connect the jumper wire to the engine ground stud. Do not touch the jumper wire during the test. A strong electrical shock hazard is present at the jumper wire while the test is running.
- b. Turn the keyswitch to the ON position.
- c. Perform the "Injector Solenoid Test" at least two times.
- d. Turn the keyswitch to the OFF position.

H. Restore the wiring to the original configuration.

**Expected Result:**

Cat ET displays the correct status for each test circuit.

**Results:**

- **OK** - The ECM detects the correct status of the circuit.

**Repair:** The ECM is OK. The problem is in the engine harness or in a connector. Inspect the connectors for moisture and for corrosion. Repair the wiring and/or the connector, when possible. Replace parts, if necessary. Clear all diagnostic codes after you complete this test step. Perform a wiggle test with Cat ET in order to identify intermittent connections. Verify that the repair eliminates the problem.

**STOP**

- **Not OK** - The ECM does not detect the correct status of the circuit.

**Repair:** The ECM does not appear to be operating properly. Perform the following procedure:

1. Temporarily connect a test ECM.

Refer to service Troubleshooting, "ECM - Replace".

2. Recheck the circuit in order to ensure that the original problem has been resolved.

If the problem is resolved with the test ECM, install the suspect ECM. If the problem returns with the suspect ECM, replace the ECM. Verify that the problem is resolved.

If the problem is not resolved with the test ECM, install the original ECM. There is a problem in the wiring.

**STOP**