TECHNICAL BULLETIN APTB-01/09 R1

6.0L Injector Stiction Discussion and Recommendations

REFERENCE: TSB 08-26-3 (pages 4-8)

6.0L Injector Spool Valve Operation (refer to figure 1) – the spool valve is located in a bore in the stator housing; coils and coil housings positioned on both ends of the stator housing serve as end caps to seal the assembly and limit spool valve travel (0.432 mm). An open coil on one side of the stator housing and a close coil on the other are alternately energized during engine operation to move the valve horizontally. The spool valve has two positions — movement of the valve positions the valve over drillings in the stator housing which either (1) allow high pressure oil from the oil rail into the injector high pressure oil pumping chamber, or (2) allow pressure in the high pressure oil chamber to collapse and oil to exhaust from the injector. Open coil energization allows high pressure oil into the high pressure oil pumping chamber; close coil energization allows oil to exhaust from the pumping chamber; when neither coil is energized, the valve will remain where it was last positioned (in figure 1, below, the close coil is shown on the left side, and the spool valve is in the closed position; also note the gap between the spool valve and the open coil on the right side).

Unlike HEUI™ injection pulse width strategy, in which the duration of the solenoid energization determines fuel delivery, 6.0L fuel delivery is determined by the duration between coil open and close commands from the ECM/FICM. **Under normal operating conditions, when energized, each coil has enough time, and creates enough magnetic force, to overcome the static inertia of the spool valve and move the valve the total travel distance.**

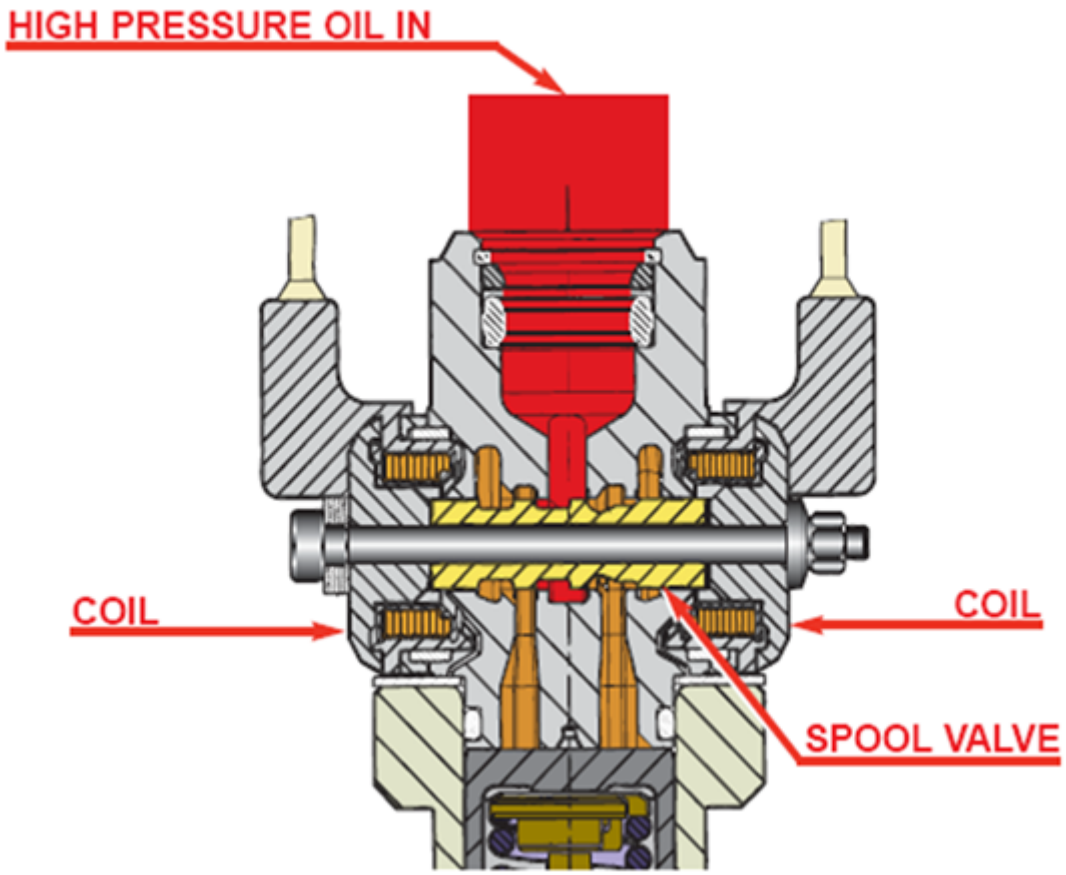

Figure 1

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Stiction – as applied to 6.0L injectors, the term is used to describe the condition when static friction (i.e., stiction), in addition to normal static inertia, is greater than the force of either injector coil, resulting in a delayed spool valve response or a stuck spool valve. Stiction can be either a momentary or permanent condition, but is most often momentary. Because the spool valve is operating in an engine oil environment, stiction is usually temperature related — increased oil viscosity as a result of cold temperature will exacerbate stiction causing conditions, leading to an increase in stiction severity; decreasing oil viscosity as the engine warms up often leads to a decrease or cessation of stiction symptoms.

Stiction Driveability Symptoms – any one, or a combination, of the following symptoms may indicate a stiction issue:

- Hard start or no start
- Runs rough or sluggish performance
- White smoke or exhaust odor
- Multiple cylinder miss
- Stumbles and misses on acceleration
- Excessive white or black smoke on acceleration
- Miss at high engine RPM

Note: When the symptom(s) above occur with a cold engine, and improve, or are eliminated, when the engine warms up, it indicates a stiction problem with virtual certainty.

Common Stiction Causes:

- Extended oil change intervals are the leading cause of 6.0L injector stiction. High soot content or other contaminants in the engine oil will increase friction between the spool valve and the spool valve bore. In addition, oil additives and oil age can increase oil's viscosity.
- Cold weather spool valve latching. Stiction can occur at the site of the close coil and the spool valve, due to hydraulic affinity or latching, especially after a long shutdown, such as overnight (the valve will remain on the close coil side following engine shutdown). Because this condition is worsened by cold weather, Ford has issued a procedure (TSB 08-26-3, attached) to perform a FICM calibration that adds inductive heating of the injector coils to locally heat the oil in the injectors until normal operating conditions are achieved (refer to APTB-02/08R2).
- Using the wrong oil viscosity, especially in cold climates.
- Long idle times increase the amount of soot in the engine oil and also prevent the engine from reaching proper engine operating temperatures.
- Unaided cold starting, including a malfunctioning glow plug system, the operator not waiting for the glow plug light to go out before starting, or not using a block heater in cold weather.

Corrective Procedures to Eliminate Stiction – one thing we don't recommend is automatic replacement of injectors (whether in or out of warranty). Similar to a head and rotor seizure or a failed turbo, if you don't correct the source of the stiction problem, it's bound to reoccur with replacement injectors (furthermore, most stiction afflicted injectors haven't been damaged). Stiction must be eliminated by applying corrective procedures to the source of the stiction cause, which can most often be accomplished with existing injectors.

Notice in the "Common Stiction Causes" section above, that the causes of stiction can generally be considered to be the result of oil issues and/or cold engine driveability. Therefore, when confronted with stiction symptoms, we suggest starting corrective action with the following two procedures:

1. Ensure that engine oil is clean, is the correct viscosity for the temperatures it will be operating in (refer to figure 2, below), and has the recommended API service category rating (we advise using CJ-4 or CI-4 PLUS, although Ford allows CI-4).

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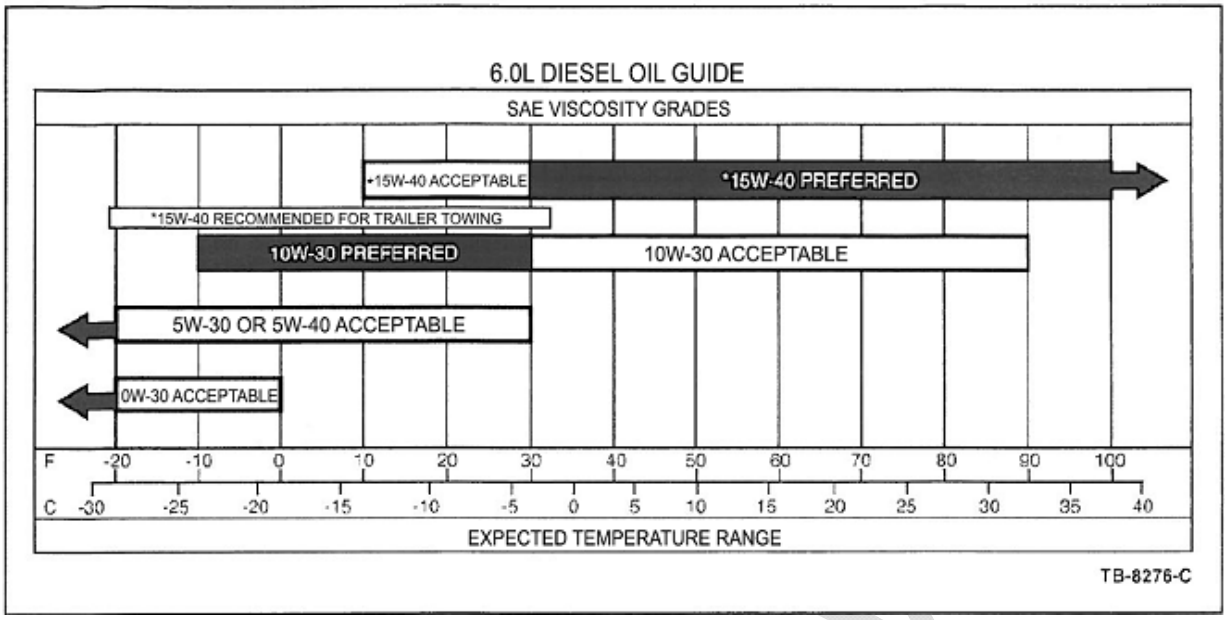

Figure 2

As noted in previous bulletins, you'll do your 6.0L and 7.3L Power Stroke customers a favor to remind them to adhere religiously to Ford's minimum recommended lube oil and filter change intervals (7,500 miles normal duty; 5,000 miles severe duty).

2. Perform the FICM calibration called for in TSB 08-26-3. Ford defines cold engine operating conditions to be whenever engine oil temperature is less than 70˚F, which includes pretty much all of North America, therefore this bulletin applies to virtually all Alliant Power customers.

   It's important to note that inductive heating resulting from the FICM recalibration only works after the engine starts. The click/buzz test doesn't energize the injector coil long enough to overcome cold (engine oil temperature <80˚F) stiction. Therefore, engine tests such as click/buzz or power balance to diagnose stiction will give misleading results and should not be used to identify stiction injectors on a cold engine.

Non-Stiction Related Conditions – the following conditions may be mistakenly attributed to stiction:

- Slow cranking (e.g., low batteries, bad starter, poor connections)
- Low oil pressure during cranking
- Low injection control pressure (ICP)
- Poor fuel quality (e.g., low cetane or contaminated fuel; waxed filters or gelled fuel in cold weather)
- Electrical issues (e.g., no power or ground to ECM or FICM, poor connections to injectors)

Warranty Considerations – when stiction afflicted injectors are submitted to Alliant Power for warranty, we reserve the right to request proof that the engine has clean and fresh oil (e.g., a receipt for an oil change showing a recent date and mileage) and that TSB 08-26-3 calibration has been performed (e.g., a receipt for the procedure). If these procedures cannot be verified, injectors will be flushed and flowed, and returned without labor reimbursement.

Assuming that we can be certain that the engine has clean and fresh engine oil and TSB 08-26-3 calibration has been performed, Alliant Power will continue to provide full warranty coverage for injectors that are diagnosed to have failed due to stiction the first time they're submitted from any vehicle on a policy basis (not due to workmanship or material failure). Alliant Power reserves the right to deny warranty for subsequent stiction related failure claims submitted for injectors from the same vehicle.

R1: Referenced TSB 08-26-3, which supersedes TSB 07-5-4; the new TSB includes procedures to test the FICM, in addition to performing the FICM calibration (program module installation) to incorporate cold injector inductive heat calibration

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6.0L DIESEL—DRIVEABILITY—NO START, HARD START, RUNS ROUGH—FUEL INJECTION CONTROL MODULE DIAGNOSIS

TSB 08-26-3

FORD:
2003-2005 Excursion
2003-2007 F-Super Duty
2004-2009 E-350, E-450, E-550

This article supersedes TSBs **04-18-6 and 07-5-4** to update the repair sequence, FICM_MPWR check, symptoms and additional diagnostic information.

ISSUE

Some 2003-2005 Excursion, 2003-2007 F-Super Duty and 2004-2009 E-Series vehicles equipped with a 6.0L diesel engine may experience no starts, hard starts or rough running when cold and may be accompanied with diagnostic trouble codes (DTCs) P0611, P1378 and / or all 8 injector circuit codes. These symptoms may lessen or disappear when the engine is warm. These conditions may be caused by the Fuel Injection Control Module (FICM) or injector spool valve sticking internally during cold engine operation.

ACTION

Follow the Service Procedure steps to correct the condition.

SERVICE TIPS

A failed FICM module can cause diagnostic trouble codes related to injectors even when the injectors or injector wiring are not at fault. The FICM module should be checked for proper operation before evaluating injector operation or wiring issues.

For information: Symptoms of stiction (These conditions are caused by the injector spool valve sticking internally during cold engine operation engine oil temperature) can be improved by using the lightest possible specified weight oil during winter months. Refer to the Owner Guide Information - Diesel Supplement / Maintenance and Specifications / Engine oil specifications. After confirming that the appropriate weight oil is being used, evaluate the injector operation according to Step 13 of the Service Procedure.

Information On The FICM TEST:

An improperly operating vehicle battery(s) or charging system can cause additional operating loads to the internal components of the FICM module, due to low power supply voltages. Glow plug operation, vehicle accessories (factory and non-factory installed), and hot and cold temperatures can also put additional requirements on the vehicles electrical, battery and charging system. This can result in shortened FICM module component life.

The FICM module contains two major internal components, the main circuit board and a DC-DC converter. The DC-DC converter is the device that amplifies battery voltage to 48 volts (V) to operate the injectors. Two major test entry conditions listed below are critical to accurately test the FICM DC-DC converter:

Engine Oil Temperature (EOT) Less Than 68 °F (20 °C)

The calibration in the FICM uses a pre-cycle mode during Key On Engine Off (KOEO) / glow plug operation. This mode is used to rapidly heat the injector spool valve and prevent sticking during cold operation. During this mode, the electrical demand on the FICM DC-DC converter is near maximum.

L_PWR >= 11.5 V

The target 48 V output of the DC-DC converter is directly affected by the battery supply voltage, or B+. This is measured internally to the FICM with the FICM_VPWR PID. Ensuring both of the above criteria are met before conducting the FICM_MPWR test will prevent incorrect readings, misdiagnosis and replacement of good parts.

SERVICE PROCEDURE

1. Verify the battery and charging system are functioning properly. Refer to Workshop Manual (WSM), Section 414-00 for diagnosis and repair. If the battery cannot maintain a good charge, it will affect the operation and testing of the FICM, as the FICM is an amplifier and has to work much harder to compensate for low battery voltage.
2. Install Integrated Diagnostic System (IDS) and retrieve the FICM calibration information by selecting:
   - Toolbox
   - Powertrain
   - OBD Test Mode
   - Mode 9
3. If the FICM contains one of the following files then it has already had the Inductive Heat calibration installed:
   - ARZ2AH00
   - ARZ2AL00
   - ARZ2AL01

NOTE
RECORD FICM CALIBRATION NUMBER PRIOR TO PERFORMING PROGRAM MODULE INSTALLATION (PMI) AS IT WILL BE REQUIRED LATER IN STEP 11.

4. After checking the FICM calibration info, perform a PMI on the FICM. This should be done even if the FICM already had one of the three (3) calibrations listed above.
5. Disconnect the glow plug control module (GPCM) power wire C1249A, circuit 361 (RD) from the passenger side battery. (Figure 1) This also disconnects the alternator to minimize power draw from the batteries and provide more consistent FICM testing.

NOTE
THIS WILL SET GPCM CODES THAT NEED TO BE CLEARED BEFORE RETURNING THE VEHICLE TO THE CUSTOMER.

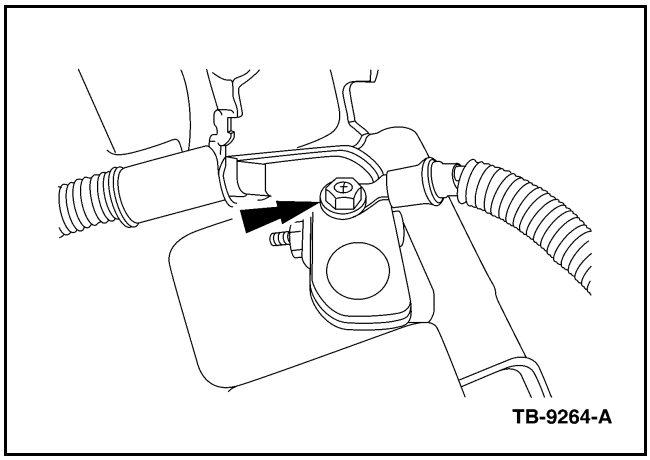


Figure 1 - Article 08-26-3

6. Set up IDS to test FICM power by selecting:
   - EOT
   - B+
   - FICM_LPWR
   - FICM_MPWR
   - FICM_VPWR
7. After the glow plug wait to start light is off, monitor EOT.
   a. If EOT is less than 68 °F (20 °C) go to Step 8.
   b. If EOT is higher than specified use the Instrumentation Gauge Tester 014-R1063 or equivalent to simulate a cold engine by:
      (1) Ignition off.
      (2) Disconnect EOT sensor Connector C104.
      (3) Connect the one lead of the instrument gauge tester to the EOT sensor connector C104-1, circuit 357 (GY/RD), harness side and the other lead of the instrument gauge tester to the EOT sensor connector C104-2, harness side circuit 354 (LG/RD).
      (4) Set the Gauge Tester to 80,000 ohms.

NOTE
IT IS EXTREMELY IMPORTANT TO CONFIRM THE GAUGE TESTER SETTINGS WITH AN OHMMETER TO ENSURE THAT THE GAUGE TESTER IS IN THE CORRECT POSITION. FAILURE TO FOLLOW THIS CHECK MAY RESULT IN INACCURATE TEST RESULTS.

8. Turn key to run KOEO and check the B+ PID.

a. If B+ is not at least 11.5 V, then charge batteries and return to Step 1.

b. If B+ is greater than 11.5 V, go to Step 9.

9. Verify the following voltages and states. Use the FICM ERROR STATE CHECKS chart below.

Table for Step 9 - FICM ERROR STATE CHECK			
FICM_ LPWR	FICM _MPWR	DTC	Check
11.5	MIN 45 V	None	FICM diagnostics - proceed to Step 11b
0	MIN 45 V	P1378	FICM LPWR fuse (15 amp) - proceed to Step 10
0	Less than 45 V	P0611, P1378	FICM relay, 50 amp fuse - proceed to Step 10

10. Disconnect the three (3) FICM connectors and inspect condition of connector, pins, and wiring at the connector, paying close attention for wiring chafes. Repair any issues and reevaluate vehicle, if the condition is corrected go to Step 11. If the condition is still present continue to Step 10a.

NOTE
SOME COMMON CHAFING LOCATIONS ARE: UPPER LEFT VALVE COVER, VALVE COVER BOLT, AND INTAKE BOLTS, UNDER AND NEAR THE FICM.

a. With a voltmeter check the following:

(1) Check for B+ voltage at pin 27 of connector 1388C and ground pins 1, 2, 3, 22 and 26, with the KOEO. (Figure 2 at end of article)

(a) If no, or low voltage is present, repair as necessary.

(b) If B+ is present, proceed Step 10a(2).

(2) Check for B+ voltage between pins 4, 7, 8, 23, 24, 25 and ground. (Figure 2 at end of article)

(a) If no or low voltage is found at any pin, repair as necessary.

(b) If B+ is present at all pins, replace the FICM, reference WSM 303-14B-1, reconnect the GPCM power and EOT connector, clear codes, and return vehicle to customer.

11. With IDS still connected, cycle key to off position and then to on position within 2 seconds to start injector pre-cycle. While the injectors are cycling (glow plug Wait to Start Light is on), record the lowest observed FICM_MPWR.

a. If FICM_MPWR drops below 45 V, replace and reprogram the FICM (WSM 303-14B), reconnect GPCM power, EOT connector if it was removed to perform the test using the Instrument Gauge Tester and return vehicle to the customer.

b. If FICM_MPWR stays above 45 V or greater, the DC-DC converter is good, perform the following:

(1) If the FICM did not have one of the three calibrations listed in Step 3, then it did not have the Inductive Heat feature. Since the PMI performed in Step 4 programmed this calibration into the FICM, it will now address any stiction concerns. If the vehicle functions normally, reconnect GPCM power and EOT connector if it was removed to perform the test using the Instrument Gauge Tester and return vehicle to the customer.

(2) If the FICM already had one of the three calibrations listed in Step 3, then injector stiction is not the concern, proceed to Step 12.

12. Reconnect GPCM power and EOT connector if it was removed to perform the test using the Instrument Gauge Tester.

13. Perform KOEO injector electrical self test as outlined in the Powertrain Controls/Emissions Diagnosis (PC/ED) Section 2.

PART NUMBER	PART NAME
4C3Z-12B599-AARM	FICM Module

WARRANTY STATUS: Eligible Under Provisions Of New Vehicle Limited Warranty Coverage And Emissions Warranty Coverage
IMPORTANT: Warranty coverage limits/policies are not altered by a TSB. Warranty coverage limits are determined by the identified causal part.

OPERATION	DESCRIPTION	TIME
MT082603	Use SLTS Operations If Available; Claim Additional Diagnosis Or Labor Performed As Actual Time	Actual Time

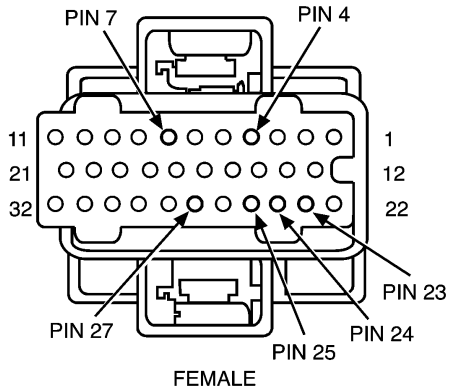
DEALER CODING

BASIC PART NO.	CONDITION CODE
12B599	42

Figure 2 - Article 08-26-3

C1388c (BK)

12B637
Fuel Injector
Control Module
(FICM)



Pin	Circuit	Circuit Function
1	574 (BK/PK)	Ground
2	574 (BK/PK)	Ground
3	574 (BK/PK)	Ground
4	876 (DG/LG)	Fuel Injector Control Module (FICM) power relay, switched power
5	54 (LG/YE)	Fuel delivery command
6	-	Not used
7	1717 (VT/OG)	Voltage supplied in start and run (overload protected)
8	814 (WH/BK)	Fuel Injector Control Module (FICM) power relay, switched power, fused feed
9	878 (PK/YE)	Powertrain Control Systems, Communication
10	56 (DB/OG)	Cylinder identification
11	-	Not used
12	-	Not used
13	-	Not used
14	-	Not used
15	-	Not used
16	-	Not used

Pin	Circuit	Circuit Function
17	-	Not used
18	-	Not used
19	-	Not used
20	-	Not used
21	-	Not used
22	574 (BK/PK)	Ground
23	876 (DG/LG)	Fuel Injector Control Module (FICM) power relay, switched power
24	876 (DG/LG)	Fuel Injector Control Module (FICM) power relay, switched power
25	876 (DG/LG)	Fuel Injector Control Module (FICM) power relay, switched power
26	574 (BK/PK)	Ground
27	3098 (RD/YE)	Fuel Injector Control Module (FICM) power relay, control
28	-	Not used
29	-	Not used
30	69 (RD/LG)	CAN Bus 2H
31	70 (LB/WH)	CAN Bus 2L
32	57 (BK)	Drain wire

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