

3406 B/C PEEC Repair Manual

**3406B – 8TC
3406B – 5YG
3406B – 2EK
3406C – 4CK**

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3406 PEEC Introduction

The 3406 PEEC evolved from the legendary 3406 mechanically governed engine with the addition of an electronic control module (ECM). The ECM controlled major functions of the engine such as engine timing and fuel rate by using actuators. The ECM also monitored the engine through electronic sensors including speed, rack and timing, boost, oil, and coolant temperature

The 3406B PEEC engine was introduced in 1987 and remained in production until 1993. During the six year production cycle, Caterpillar built over 32,000 PEEC engines and many are still in operation today. Serial number prefixes for 3406B/C PEEC engines are:

- 8TC – 3406B - 1987 to 1990
- 5YG – 3406B - 1990 460Hp engines only
- 2EK – 3406B - 1991
- 4CK – 3406C - 1992 - 1993

During this production span, enhancements were made to the engine to not only meet new EPA emission regulations, but to improve engine performance and fuel economy.

The following “reminders” are given to aid in the troubleshooting of PEEC engines. Each item contains a brief description. If further clarification is needed please refer to the appropriate Service documents.

1. ENGINE OIL LEVEL

- It is imperative to maintain the correct engine oil level.
 - The proper oil capacity for PEEC engines is 39 liters (40 quarts)
 - Do Not exceed this level
 - Verify that the dipstick is properly marked for the 39 liters (40 quarts)
 - A suction bell shroud is recommended

2. OVERHAUL or High Mileage

- If the engine is overhauled with a standard or OPT overhaul, the Injection Pump should be inspected and the following parts replaced
 - Fuel Camshaft bearings
 - Rack bar bushings
 - All seals in the timing advance unit

2. DERATE SOFTWARE (Engine Protection and ESC)

- This software was developed in June 1997.
Information about this software release can be found in SEBE6122.
 - This offering also made available a 2 year/Unlimited Mileage ESC.
 - This coverage warranted ALL electronic engine components.
 - The program is ‘STILL AVAILABLE’ if the truck has less than 650,000 miles.

3. “INTERMITTENT FAILURE ANALYSIS MANUAL” (SENR6425)

-Available to aid technicians if Service Manuals do not provide enough details.

4. IMPROVED ELECTRONIC COMPONENTS

-Over the years new components have been developed. Be aware of updated or improved components listed below:

- a. Rack Sensor
- b. PEEC II and PEEC III
- c. Shutoff solenoid

- d. Transducer Module
- e. Speed Sensor
- f. ECM
- g. Timing Advance

REPAIR OPTIONS (After Failure)

Caterpillar factory and dealer personnel as well as TEPS dealer personnel have been challenged with 3406 PEEC failures. The primary objective is to repair the engine with minimal cost to the customer. An experienced PEEC technician should consider all of the component enhancements and consider replacement/upgrade of all affected components. The customer should be made aware of potential problems if these replacements/upgrades are not done.

In the event of major component failure and/or engine failure, the customer should be informed of all options available to put the truck back in operation. The following is a list of brief repair options that could be considered.

Option 1

Repair all known failed iron/electronic components as necessary. Cost unknown until complete.

Option 2

Replace the PEEC engine with a 3406B Mechanical engine (350 and 425hp are only options)

Engine @ Dealer Net	\$10,386.00
New Engine Upcharge	\$542.00
Dealer Profit (20%)	\$2,080.00
Labor	\$1,000.00 Minimum
ESTIMATED TOTAL	\$15,008.00

Option 3

Replace the PEEC engine with a 3406E (any hp)

Engine @ Dealer Net	\$13,485.00
New Engine Upcharge	\$2,500.00
Dealer Profit (20%)	\$2,700.00
Labor	\$2,000.00
ESTIMATED TOTAL	\$21,045.00

There are more repair options than listed above. An important point to remember is that the REMAN Engine has a 2-year warranty. Parts repaired have only 1-year warranty.

PEEC Overview

PEEC Electronics

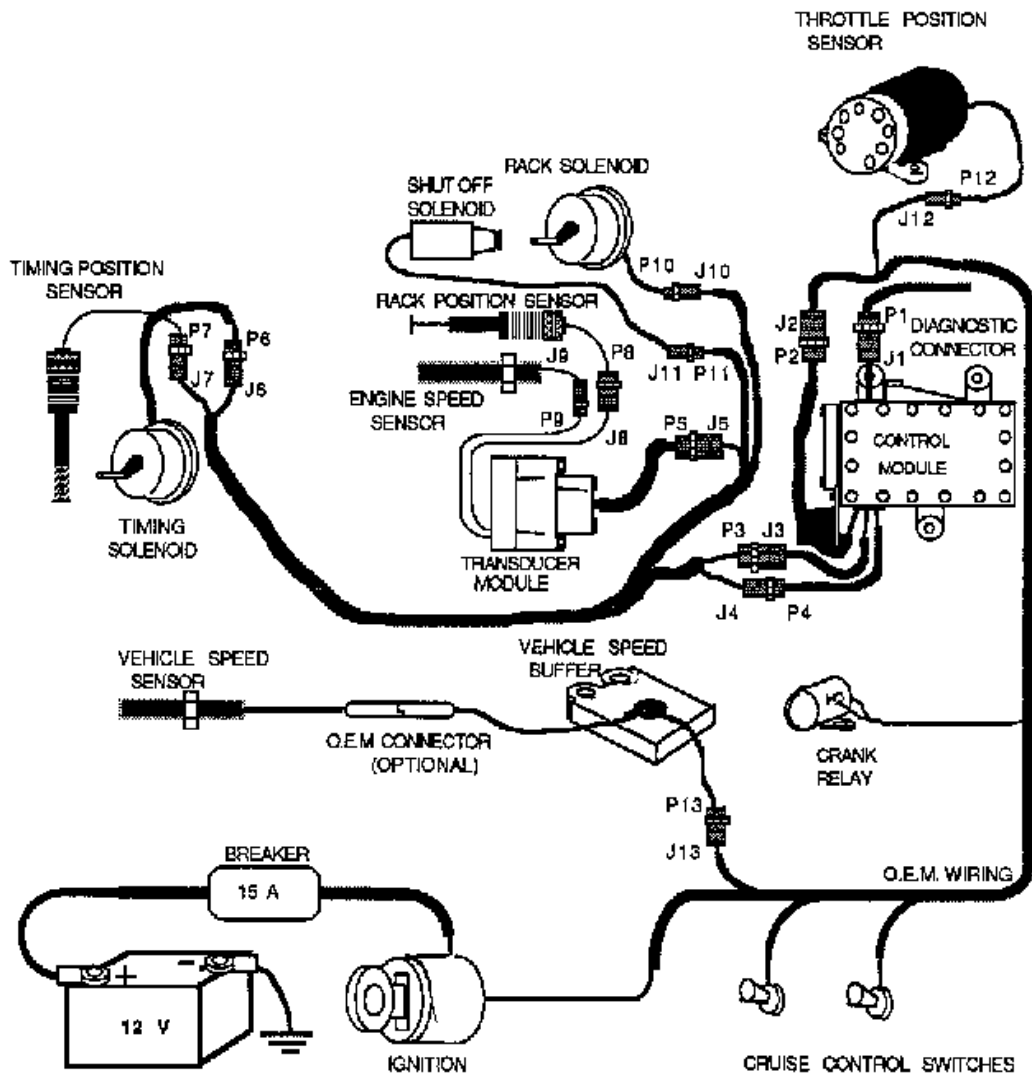


Illustration 1 – PEEC 2 System Diagram

PEEC II vs. PEEC III

-PEEC II

Approximately 15,000 Produced
8TC, 2EK, 5YG Serial Number Prefixes
Bolt-on Personality Module

-PEEC III

Approximately 25,000 Produced
4CK Serial Number Prefix
Plug-in Personality Module
"Fast" Cam
Enhanced Diagnostics
Single 40 Pin ECM Connector
Dedicated Data Link Connector
Coolant Temperature Sensor Added
18 Programmable Parameters

3406B/C vs. 3406E/C-15/C-16

Similarities

- Both engines use Throttle Position, Cruise Control, and Customer Parameters to constantly determine a desired engine speed.
- Both engines use an Electronic Governor (software) to select a desired fuel rate based on the difference between actual and desired engine speed (2 sensors on 3406E/C-15, 1 sensor on PEEC).

Differences

- 3406E/C-15/C-16 - Directly fires each injector.
- 3406E/C-15/C-16 - Determines fuel rate by injector "on time".
- 3406E/C-15/C-16 - Electronically references top dead center to control timing.
- PEEC Controls fuel rate by using the BTM to control a hydraulic servo, which moves the rack bar and changes the scroll settings on the plunger and barrel assemblies.
- PEEC Determines fuel rates by measuring the rack bar travel.
- PEEC Controls timing by hydraulically advancing the camshaft with respect to the crank using a BTM, servo, and position sensor.
- PEEC Rack and timing sensors need to be calibrated when replaced.

Common Failure **Modes**

A. TIMING ADVANCE FAILURES

Timing advance failures have occurred on 2EK and 4CK engines. The January 1995 TEN article (included) summarizes **nine improvements** that should be checked before releasing a truck with a failed timing advance unit.

Recently, the fuel camshaft bearings have been shown to be a contributor to timing advance failures. These bearings should be replaced as part of an OPT or normal overhaul. They should also be checked for wear, on any engine that has high mileage and multiple timing advance failures.

In addition to the nine improvements, there are two Service Letters that should be mentioned. **Service Letter PS8200** (Increase Oil Sump to 40 Quarts) and **Service Letter PI3005** (Install De-rate Software to Limit Contingent Damage After Timing Advance Failure).

These Service Letters are included in this chapter as well as Truck Engine News articles that relate to this subject.

Truck Engine News

Media Number - SEBD6662-00 Publication Date - 1995/01/01

Electronic Timing Advance Improvements

1272, 1253, 1264

3406B (8TC, 2EK),

3406C (4CK) Truck Engines

Numerous improvements have been made to the electronic timing advance components on these truck engines. The Steps that follow provide a way to check the electronic timing advance components to determine if the latest components and improvements are incorporated. Use the chart to determine which Steps apply to your engine.

Engine S/N Range	Applicable Step(s)
8TC1 - Up	1 - 4, 6 - 10
8TC1 - 13234	5, 10
2EK1 - Up	1 - 4, 7 - 10
2EK1 - 01823	6, 10
4CK1 - Up	3, 7, 9, 10
4CK1 - 2537	1, 10
4CK1 - 6001	2, 10
4CK1 - 11473	4, 10
4CK1 - 15840	9, 10

NOTE:

- * Steps 1 through 3 can be performed without removing the cover.
- * Steps 4 through 7 require removing the cover.
- * Step 8 requires the disassembling the timing advance.
- * Step 9 requires removing the governor if the gasket is leaking.

*** Step 10 should NOT be done on the 2EK/4CK Rear Sump configurations or Brakesaver™ equipped engines.**

1. Check solenoid (BTM) arm. See Illustration 1, Item 1.

- * Check arm to shaft joint for damage.
- * Check the solenoid part number. The former 9X-6770 Solenoid has been replaced by the new 105-2939 Solenoid. The new solenoid has a stronger shaft. This change is effective with S/N 4CK2537.

2. Check control group (timing sensor) for a loose tip. See Illustration 1, Item 2.

- * Check for loose tip.
- * Put 9S-3263 Thread Lock of the threads of the 9X-9555 Control Group (timing sensor) before it is installed. This change is effective with S/N 4CK6001.
- * The 118-7204 Sensor Tip Kit is available for repairing or replacing the sensor tip.

3. Check to be sure the bell crank is in the correct position. See Illustrations 1 and 2, Item 3 and Illustration 3, Items 5 and 6.

- * Check the thrust bearing face and the front of the 2W-3635 Sleeve for wear caused by the bell crank being out of position with respect to the thrust bearing.

4. Check bell crank assembly to be sure pin (4) is correctly installed. See Illustrations 1 and 2, Items 3 and 4.

- * Check the faces of the bell crank to be sure that no excessive wear has occurred.
- * Check round area of the bell crank to be sure the spring is not causing galling of the bell crank on the pivot pin.
- * The 2W-3623 Bell crank Assembly pin depth is correct effective with S/N 4CK11473.
- * Bell crank endplay should be .13 to .64 mm (.005 to .025 in).

5. Check spool in fuel pump and governor drive group. See Illustration 3, Item 7.

* Check spool for damage and part number.

* Replace former 4W-2750 or 7E-5564 Spool with new 4P-3384 Spool. The new spool is effective with S/N 8TC13234.

6. Check eight bolts (8) in fuel pump and governor drive group. See Illustration 3, Item 8.

* Check to be sure 6J-2819 Bolts (8) are used.

* Tighten the 6J-2819 Bolts to a torque of 16 N·m (12.0 lb ft). The new longer bolts and higher tightening torque are effective with S/N 2EK1823.

7. Check to be sure the former 3P-3547 Retaining Ring has been replaced by the new 108-4511 Clamp Assembly. See Illustration 3, Item 9.

8. Check to be sure the plug is in position in the carrier assembly. See Illustration 3, Item 10. (New threaded plug used with 101-1944 Carrier Assembly shown.)

* New 101-1944 Carrier Assembly with threaded plug effective with S/N 4CK4699.

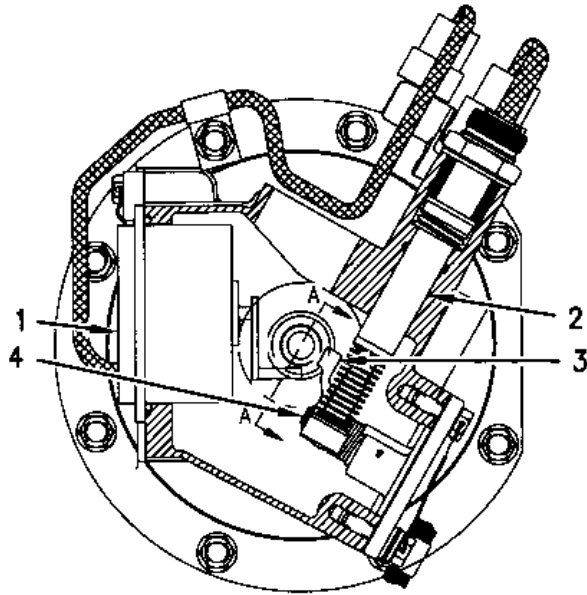
* Do NOT use former 0T0200 Cup Plug.

9. Check for oil leak between governor and fuel injection pump housing. See Illustration 4, Item X.

* Oil leak can be internal or external.

* Oil leaking past 4W-2491 Gasket.

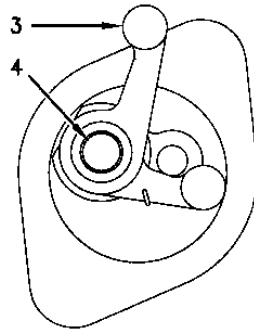
* New tightening specification for 8S-4710 Bolt (11) is 16 ± 4 N·m (12 ± 3 lb ft) and is effective with S/N 4CK15840.



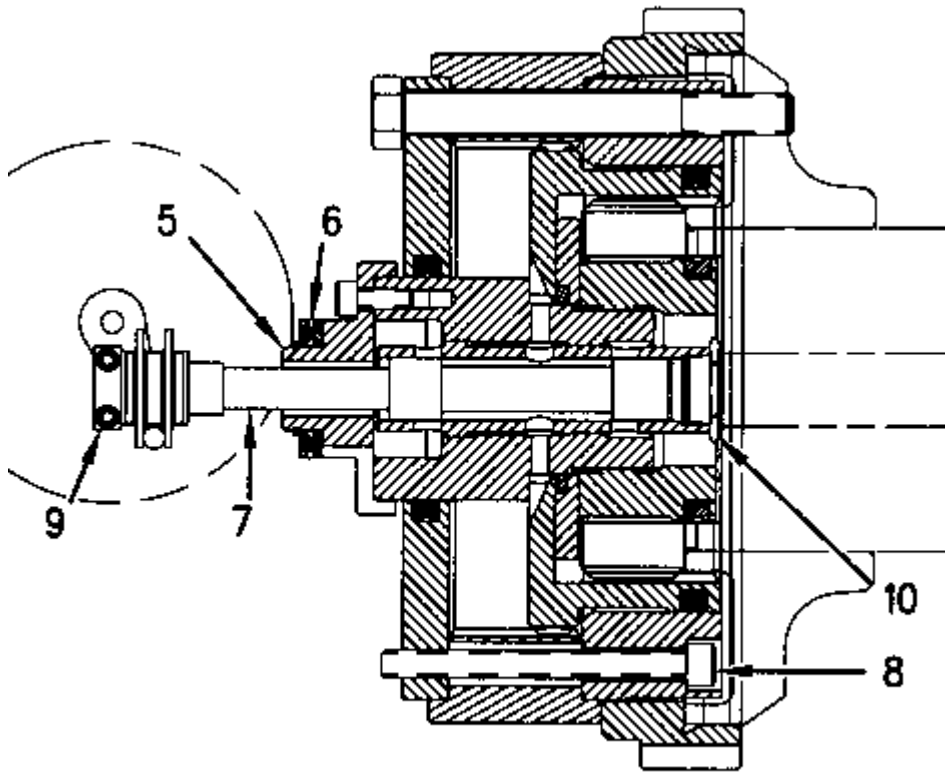
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Illustration 1. Timing Control Group components. Solenoid (1). Control Group (2). Bell crank Assembly (3). Pin (4).

Illustration 2. (View A-A) Timing Control Group components. Bell crank Assembly (3). Pin (4).

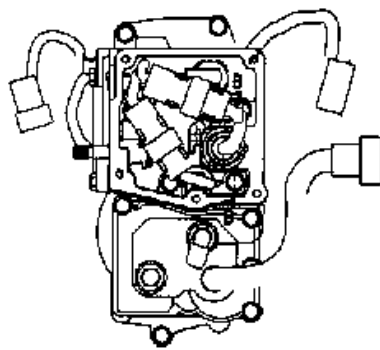
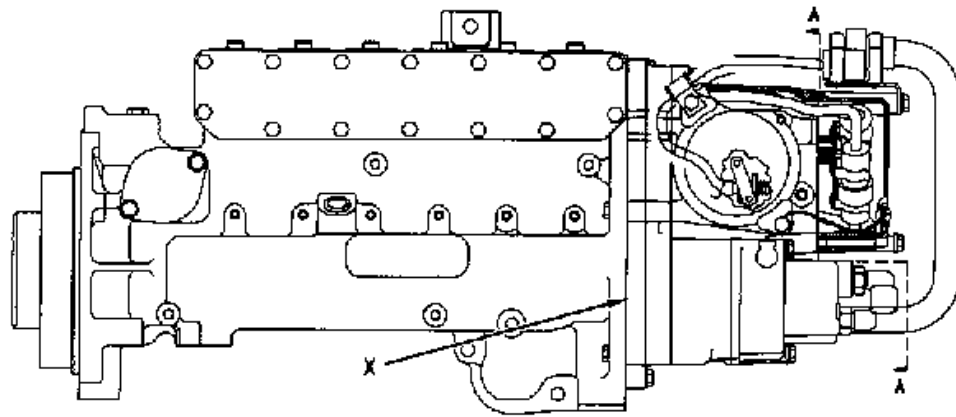


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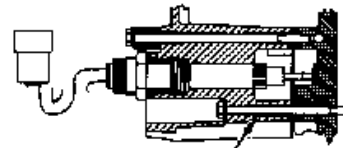


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Illustration 3. Governor And Fuel Pump Drive Group components. 2W-3635 Sleeve Assembly (5). Thrust bearing (6). 4P-3384 Spool (7). 6J-2819 Bolts (8). 108-4511 Clamp Assembly (9). 101-1942 Plug in 101-1944 Carrier Assembly (10).



SECTION A-A



SECTION B-B

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Illustration 4. Governor And Fuel Injection Pump Group. 8S-4710 Bolt (11)

STEP 10

Truck Engine News

Media Number - SEBD6660-00 Publication Date - 1994/11/01

Engine Oil Capacity Change

1326, 7542

3406 (92U),

3406B (7FB, 8TC, 4MG, 5YG, 3ZJ, 5KJ),

3406C (3ZJ, 5KJ, 8PN),

3406E (5EK) Truck Engines Except 3406B (2EK) PEEC And 3406C (4CK)

Electronic Engines Equipped With Front Sump Oil Pan

The approved oil capacity for the above truck engines has been increased to 40 quarts or 10 gallons. Formerly the capacity was 36 quarts or 9 gallons. The new 120-8972 Oil Level Gauge (dipstick) is available to retrofit MOST existing engines to measure the increased capacity. The new dipstick will fit both front and rear sump non-Brake Saver applications. The new dipstick is NOT a full range dipstick. There are NO oil level marks or crosshatch on the new dipstick. Since each application is different, the location of the "FULL" and "ADD" marks will vary. Use the "120-8972 Oil Level Gauge Calibration Procedure" to establish the "FULL" and "ADD" add marks on the new dipstick.

The new calibration procedure is for the 40 quart "FULL" mark with a 34 quart "ADD" mark. The new calibration procedure was created to minimize errors related to drain back time by compensating for oil that is hung up in the cylinder head. The new procedure also takes into account the oil that is not measurable in the deep sump because it is trapped in the shallow sump.

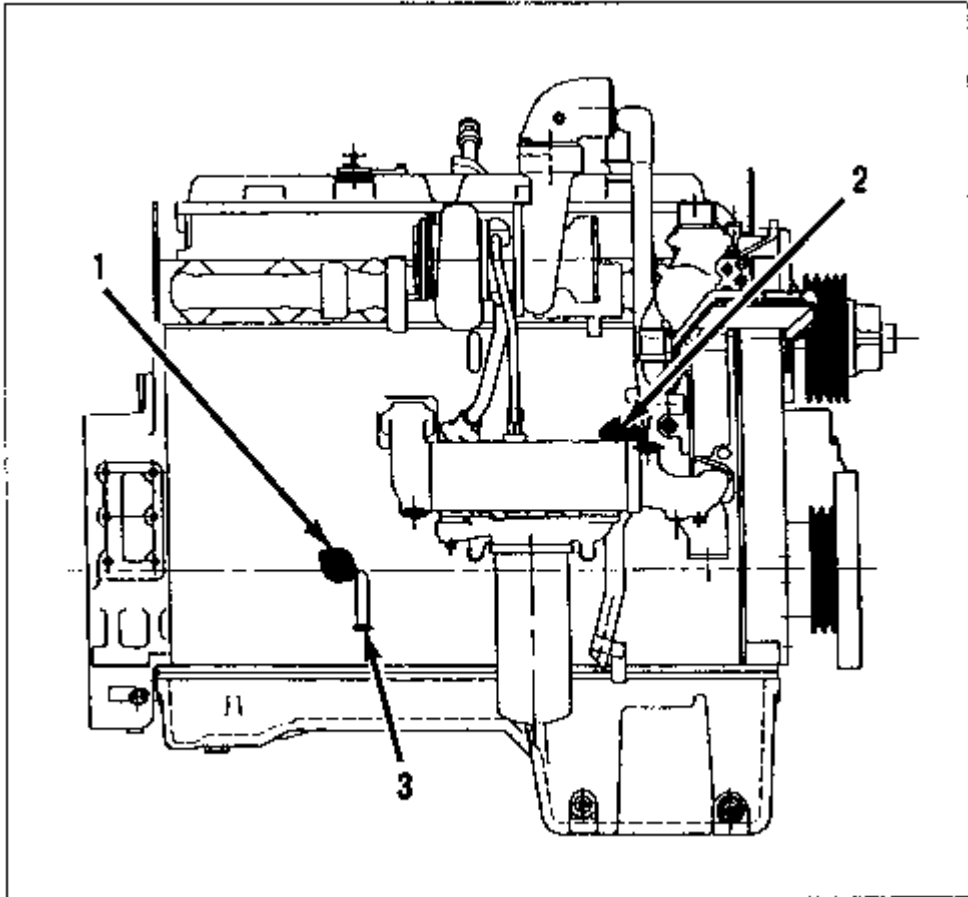
The new oil capacity, dipstick, and dipstick calibration procedure can help alleviate some oil consumption complaints by increasing the effective operating range by two quarts and by improving the dipstick accuracy. The perception of excessive oil consumption can be changed by expanding the size of the operating range. The expanded operating range will help decrease the number of oil additions into an otherwise healthy engine during the oil change period. The chance of overfilling will also be reduced. Some complaints of excessive oil consumption can be directly related to overfilling caused by misinterpreting the full range dipsticks.

120-8972 Oil Level Gauge (Dipstick) Calibration Procedure

This procedure will calibrate the 120-8972 Dipstick to accurately register a 40 quart FULL capacity and a 34 quart ADD capacity on 3406, 3406B, 3406C, and 3406E Truck Engines.

NOTE: This procedure should NOT be used on 3406B PEEC and 3406C Electronic Engines equipped with a front sump oil pan.

- 1.** Drain a hot engine for 20 minutes. Remove BOTH shallow sump and deep sump drain plugs.
- 2.** Remove the oil filter.
- 3.** Install the drain plugs removed in Step 1.
- 4.** Install a new DRY oil filter.
- 5.** Add 28 quarts (7 gallons) of CF4 oil to the engine at locations 1, 2, or 3. **ONLY THESE FILL LOCATIONS SHOULD BE USED WITH THIS PROCEDURE.** (See the illustration.)



Locations to add oil for dipstick calibration. Location 3 is one of three plugs in unused oil level gauge locations.

6. Install the new 120-8972 Dipstick into the guide tube. Then remove the dipstick and **NOTE** the oil level on the dipstick.

7. Mark this level on the new dipstick as "ADD" with an engraving pen or other comparable tool.

8. Add 6 quarts (1.5 gallons) of oil to the engine at locations 1, 2, or 3. **ONLY THESE FILL LOCATIONS SHOULD BE USED WITH THIS PROCEDURE.** (See the illustration.)

9. Install the new dipstick into the guide tube. Then remove the dipstick and **NOTE** the oil level on the dipstick.

10. Mark this level on the new dipstick as "FULL" with an engraving pen or other comparable tool.

11. Add 6 quarts (1.5 gallons) of oil to the engine for a total fill quantity of 40 quarts.

Governor Servo

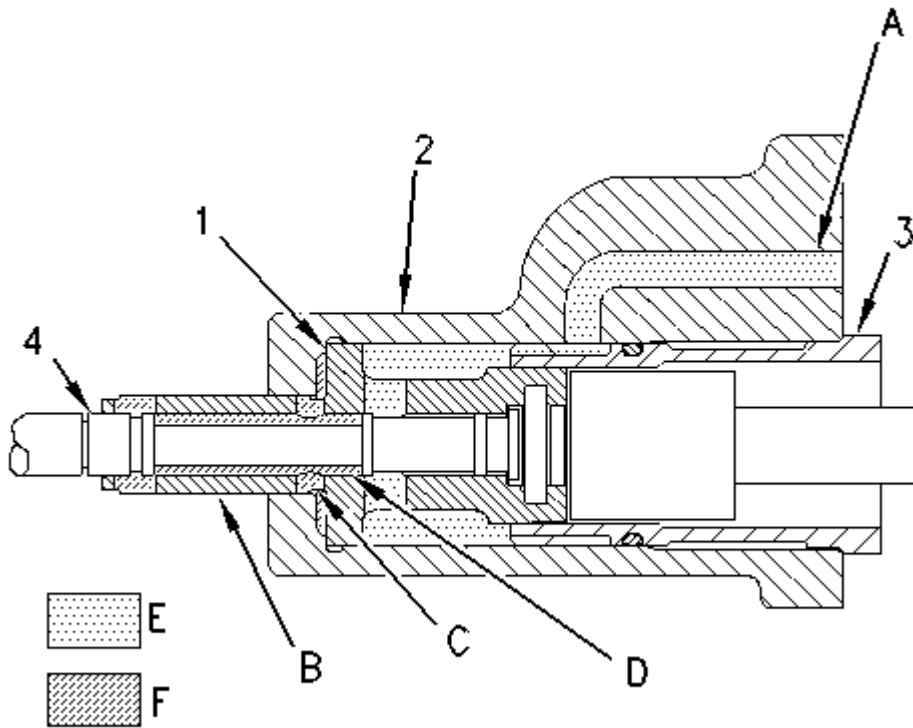


Illustration 14
Rack Movement Toward Full Fuel

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- (A) Oil inlet
- (B) Oil outlet
- (C) Oil passage
- (D) Oil passage
- (E) Pressure oil
- (F) Drain oil
- (1) Piston
- (2) Cylinder
- (3) Sleeve
- (4) Valve

When the rack solenoid (BTM) is energized, the rack solenoid moves valve (4) to the left. The valve opens oil outlet (B) and the valve closes oil passage (D). Pressure oil from oil inlet (A) pushes piston (1) and fuel rack (5) to the left. Oil that is behind the piston goes through oil passage (C) and along valve (4) and out oil outlet (B).

Illustration 15

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No Rack Movement (Constant Engine Speed)

- (A) Oil inlet
- (B) Oil outlet
- (C) Oil passage
- (D) Oil passage
- (E) Pressure oil
- (F) Drain oil
- (G) Blocked oil
- (1) Piston
- (2) Cylinder
- (3) Sleeve
- (4) Valve
- (5) Fuel rack

When the desired engine speed is reached, the Rack Solenoid (BTM) holds valve (4) in a fixed position. Piston (1) moves to the left until both oil outlet (B) and oil passage (D) are blocked by valve (4). Oil is trapped in the chamber behind piston (1). This creates a hydraulic lock which stops the piston and fuel rack movement.

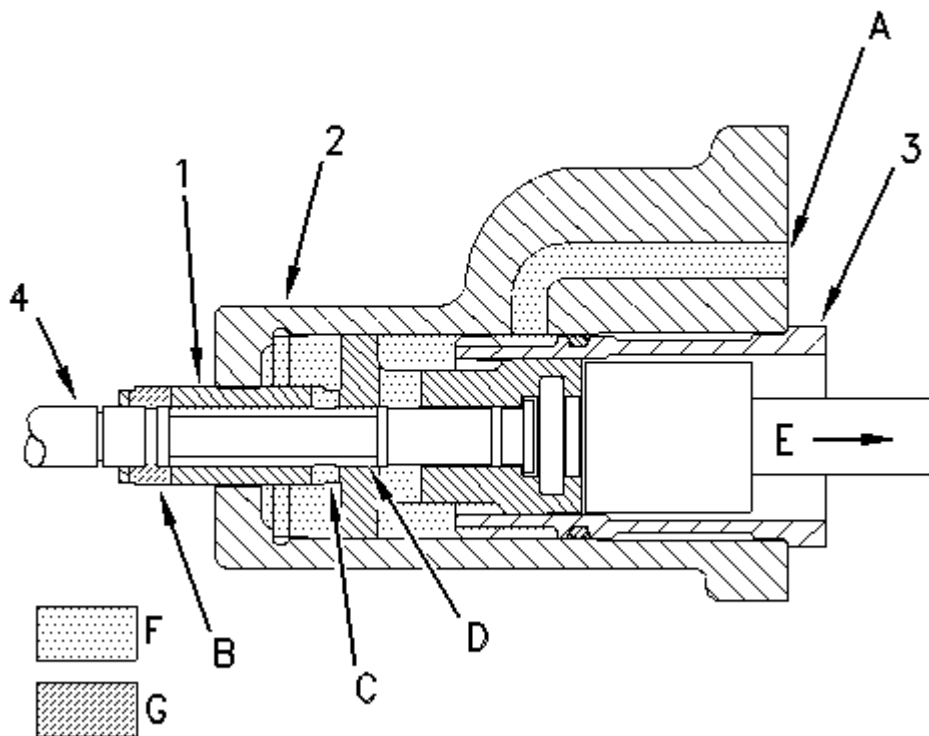


Illustration 16

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Movement Of Rack Toward The Fuel Off Position

- (A) Oil inlet

- (B) Oil outlet
- (C) Oil passage
- (D) Oil passage
- (E) Movement of rack toward the fuel off position
- (F) Pressure oil
- (G) Drain oil
- (1) Piston
- (2) Cylinder
- (3) Sleeve
- (4) Valve
- (5) Fuel rack

When the Rack Solenoid (BTM) is de-energized, spring force in the solenoid moves valve (4) to the right. The valve closes oil outlet (B) and opens oil passage (D). Pressure oil from oil inlet (A) is now on both sides of piston (1). The left side area of the piston is greater than the right side area of the piston. The force of the oil is also greater on the left side of the piston. This moves the piston and fuel rack (5) to the right.

Timing Advance Unit

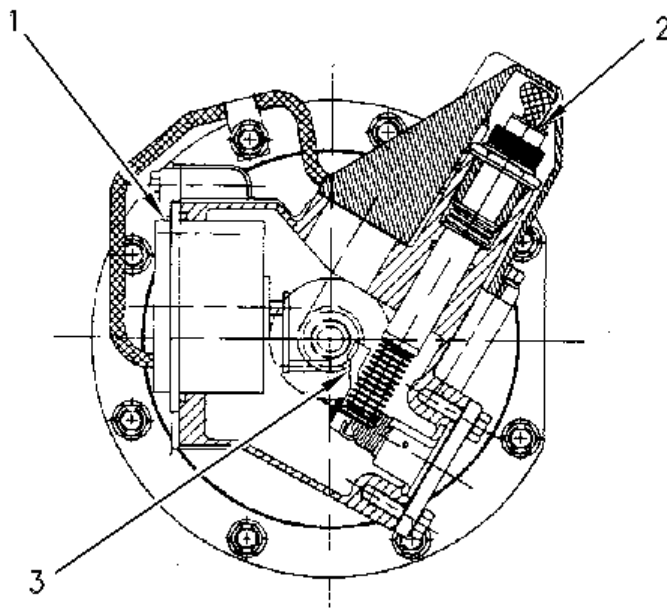


Illustration 17
 Front View of Timing Advance Unit
 (1) Timing solenoid
 (2) Timing position sensor
 (3) Bell crank

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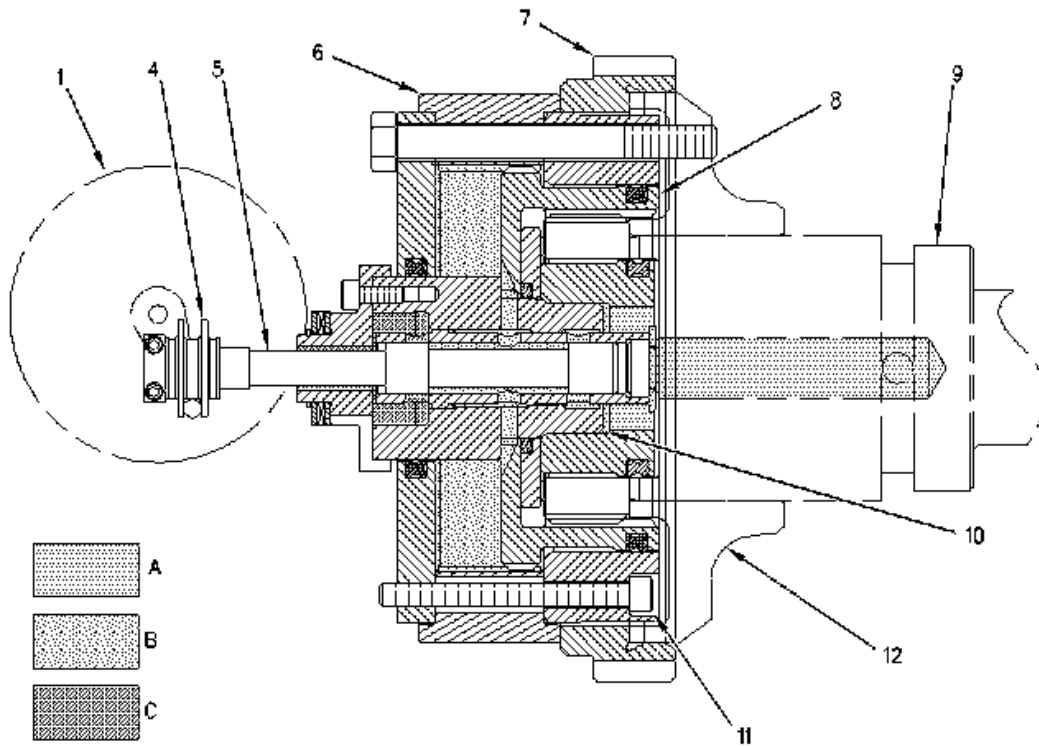


Illustration 18
Timing Advance Unit Before Any The Timing Advance

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- (A) Pressure oil
- (B) Blocked oil
- (C) Drain oil
- (1) Timing solenoid
- (4) Sleeve
- (5) Valve spool
- (6) Ring
- (7) Gear
- (8) Carrier
- (9) Fuel injection pump camshaft
- (10) Body assembly
- (11) Bolt
- (12) Ring

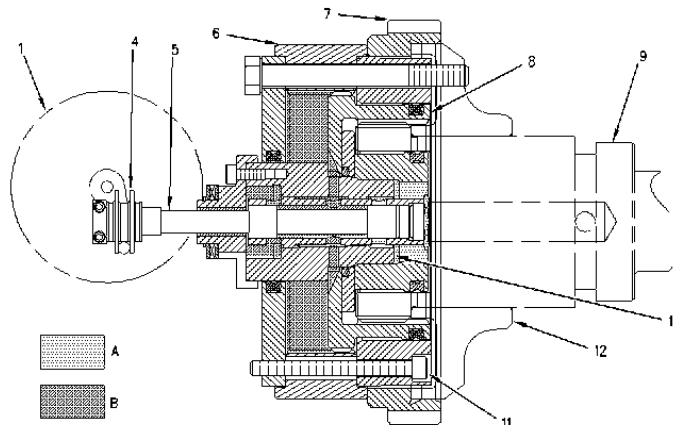
The timing advance unit connects the drive end of the fuel injection pump camshaft with the timing gears in the front of the engine. The unit uses engine oil pressure to change the fuel injection timing. An electronically actuated timing solenoid (BTM) controls a double acting hydraulic servo. The double acting hydraulic servo directs engine oil that is under pressure to either side of the drive carrier. The side determines if the timing will be advanced or if the timing will be retarded. The total timing advance range is 25 crankshaft degrees.

Timing is controlled by the PEEC III system as a function of the following conditions: engine rpm, load demand (rack position), boost pressure, engine acceleration and throttle position. A timing position sensor is used for accurate feedback control of the timing

advance through the ECM and the timing solenoid (BTM). Timing position sensor (2) is located on top of the timing advance actuator housing. Bell crank (3) is used to transfer linear motion of the timing advance unit to the end of Timing Position Sensor (2). Bell crank (3) is in contact with a thrust bearing. The thrust bearing is fastened to the timing advance body assembly (10) and the thrust bearing follows the movement of the timing advance body assembly (10).

The timing solenoid (BTM) (1) is installed toward the inside of the engine into the timing advance actuator housing. The timing solenoid (BTM) is spring loaded toward the retarded position. The timing solenoid (BTM) must receive a positive voltage from the ECM in order to move the servo valve spool that changes the fuel injection timing. The lever of Timing Solenoid (BTM) (1) is connected to servo valve spool (5) through sleeve (4).

The timing advance unit is connected to the fuel injection pump camshaft. Bolts (11) pull rings (6) and (12) together in order to hold gear (7). Carrier (8) has two helical splines. The outer splines are in contact with the helical splines of ring (6) and the inner splines are in contact with the helical splines on fuel injection pump camshaft (9). When the engine is started, gear (7) drives fuel injection pump camshaft (9) through ring (6) and carrier (8).



Advance Timing

Illustration 19
Oil Pressure Locations Toward Maximum Timing Advance

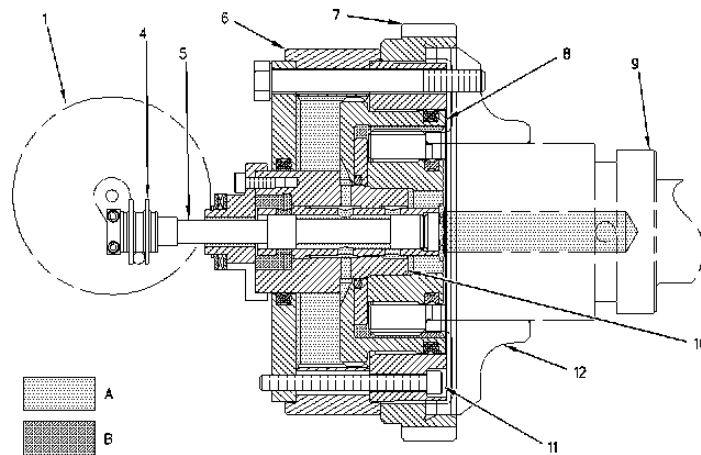
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- (A) Pressure oil
- (B) Drain oil
- (1) Timing solenoid
- (4) Sleeve
- (5) Valve spool
- (6) Ring
- (7) Gear
- (8) Carrier
- (9) Fuel injection pump camshaft

- (10) Body assembly
- (11) Bolt
- (12) Ring

As the engine begins to run, the ECM sends current to the timing solenoid (BTM) which moves valve spool (4) to the left in the above illustration. At this point, the valve spool (4) closes off the oil drain passage in the body assembly (10). Engine lubrication oil flows through the fuel injection pump housing and through a passage in the fuel injection pump camshaft (9) into the body assembly (10) and the oil is stopped by the valve spool (4). Oil pressure pushes the body assembly (10) and the carrier (8) to the left. As carrier (8) is forced to the left by oil pressure, the carrier slides between the helical splines on ring (6) and the helical splines on the fuel injection pump camshaft (9). The helical splines that are on the carrier and the ring cause the camshaft to turn in relation to gear (7). This outward motion of the body assembly (10) causes the fuel injection timing to be advanced.

Retarded Timing



- Illustration 20
Retarded Timing
- (A) Pressure oil
 - (B) Drain oil
 - (1) Timing solenoid
 - (4) Sleeve
 - (5) Valve spool
 - (6) Ring
 - (7) Gear
 - (8) Carrier
 - (9) Fuel injection pump camshaft
 - (10) Body assembly
 - (11) Bolt
 - (12) Ring

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When the ECM senses a need for the engine timing to be retarded, the voltage to the timing solenoid (BTM) is reduced. Spring pressure in the timing solenoid (BTM) moves valve spool (4) to the right in the above illustration. This blocks the engine lubrication oil from the oil drain passage on the outer end of body assembly (10). The oil flows from the fuel injection pump camshaft (9), through the body assembly (10) and around the valve spool (4). The oil pressure builds up and the oil pressure moves the body assembly (10) and the carrier (8) to the right. This action causes fuel injection pump camshaft (9) to turn in relation to gear (7) and fuel injection timing is retarded.

Oil Flow for Fuel Injection Pump, Rack Actuator, and Automatic Timing Advance

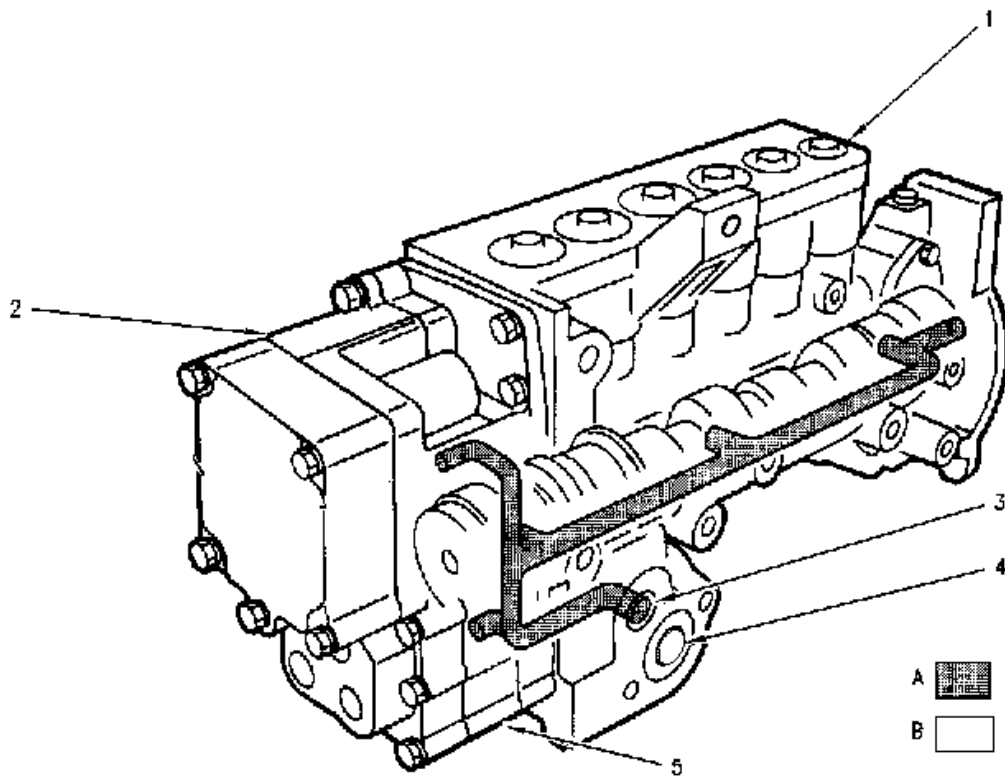


Illustration 21
 Fuel Injection Pump and Rack Actuator Oil Flow
 (A) Pressure Oil
 (B) Drain Oil
 (1) Fuel injection pump housing
 (2) Rack actuator housing
 (3) Oil passage for the cylinder block
 (4) Oil drain passage to the cylinder block
 (5) Transducer module

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Lubrication oil under pressure is supplied to the fuel injection pump housing from the left side of the cylinder block through passage (4). At this point, part of the oil flows into a

main oil passage in fuel injection pump housing (2) in order to lubricate the three fuel injection pump camshaft bearings. At the camshaft bearing that is next to the rack actuator housing, oil flows between the bearing and the camshaft in order to lubricate the thrust bearing for the camshaft retainer. Oil flows at the camshaft bearing on the drive end of fuel injection pump housing (2) into drilled passages in the camshaft. The oil in the camshaft supplies oil to the timing advance unit. Oil drains from the camshaft bearings into the fuel injection pump housing.

An oil drain hole keeps the level of the oil in the housing even with the center of the camshaft. Oil drains from the housing, through drain port (5) and back to the engine block.

From passage (4), part of the oil is directed back to the passages that are formed between the fuel injection pump housing (2) and the rack actuator center housing. Oil flows through these passages to two different locations. Some of the oil flows through a passage that is between the rack actuator housing and fuel injection pump housing (2). The passage goes to the transducer module (6) which sends an electrical signal to the ECM in order to monitor engine oil pressure.

The remainder of the oil flows through a different passage. The passage goes back through the fuel injection pump housing. This passage is connected to fuel rack servo (1). The fuel rack servo moves the fuel rack through a double acting piston.

The internal parts of the rack actuator housing are lubricated by the following methods:

- Oil leakage from the fuel rack servo (1)
- Oil that is slung by the rotation of the camshaft retainer

Oil drains back through an opening between the lower part of the rack actuator housing and the fuel injection pump housing. The fuel injection pump housing has an oil drain passage (5) that is connected to the engine block.

B. Engine Speed Burps/Engine Hesitations

- General Troubleshooting Information
- Explanation of Troubleshooting Manuals
- Erratic Cruise Control
- Relocation of Speed Timing Sensor to Eliminate Engine Surge

Engine Speed hesitations have occurred on all PEEC engines. These surges can be the result of a variety of failure modes:

- OEM Wiring, Battery Wiring
- Parameter Settings
- Gear Train Wear
- Transmission/Clutch Wear
- BTM's
- Rack and Timing Sensors
- Engine Speed Sensors
- Transducer Modules
- Vehicle Speed Sensor Adjustment
- Throttle Sensor
- ECM

For re-creatable surges, use P-111 for the 3406B and P-309 for the 3406C PEEC engines.

These procedures are in the Electronic Troubleshooting guide.

Troubleshooting

3406B (PEEC) PROGRAMMABLE ELECTRONIC ENGINE CONTROLS

Media Number - SENR3479-05

Publication Date - 1991/02/01

Date Updated - 1997/01/06

P-111: Intermittent Engine Speed Or Power Cutouts

NOTE: Use this procedure only if engine DOES NOT completely shut down (that is, it did NOT need to be restarted using the key switch).

Probable root causes:

- * Poor connections
- * Battery power or ground to ECM (vehicle wiring)
- * Vehicle speed signal
- * Fuel supply
- * Throttle position sensor
- * Rack controls
- * Timing advance controls
- * Cruise control switches

* ECM or Personality Module

Perform the following tests in order:

1. Check external PEEC harness and connectors (refer to P-201: Inspecting Electrical Connectors).

* Vehicle connector (J2/P2)

* ECM/Sensors connector (J3/P3)

* ECM/Solenoids connector (J4/P4)

* Transducer connector (J5/P5)

* Rack solenoid connector (J10/P10)

* Shutoff solenoid connector (J11/P11)

2. P-210: Electrical Power Supply To PEEC Test

3. P-213: Vehicle Speed Signal Test

4. Check fuel tanks for foreign objects that may block fuel supply.

5. P-211: Throttle Position Sensor Test

6. P-232: Rack Solenoid (BTM) Test

7. P-231: Rack Position Sensor Test

8. P-242: Timing Solenoid (BTM) Test

9. P-241: Timing Position Sensor Test

10. P-214: Cruise Control and PTO Switches Test

11. P-215: Service Brake and Clutch Switches Test

12. P-220: ECM And Personality Module Test

Troubleshooting

3406C (PEEC III) DIESEL TRUCK ENGINE

Media Number - SENR5503-00

Publication Date - 1992/12/01

Date Updated - 1997/01/06

P-309: Intermittent Engine Speed or Power Cutouts	
Probable Root Causes:	Perform the following tests:
Note: Use this procedure only if engine DOES NOT completely shutdown (that is, it did NOT need to be restarted using the key switch).	
1. Poor electrical connections.....	Check external PEEC III wiring harness and connectors (refer to P-500: Inspecting Electrical Connectors): ECM connector (J4/P4), Vehicle Speed Buffer connector (J14/P14), Transducer connector (J5/P5), Rack solenoid connector (J3/P3), OEM Vehicle Speed Sensor connector, Shutoff solenoid connector (J13/P13).
2. Battery power or ground to ECM (vehicle wiring)...	P-500: Electrical Power Supply
3. After market engine protection devices	Check for correct installation and operation of engine protection devices.
4. Vehicle speed signal.....	P-504: Vehicle Speed Signal
5. Fuel Supply.....	Check fuel tanks and lines for foreign objects that may block fuel supply.
6. Throttle position sensor.....	P-502: Throttle Position Sensor
7. Rack controls.....	P-522: Rack Solenoid (BTM) P-521: Rack Position Sensor
8. Timing advance controls.....	P-532: Timing Solenoid (BTM) P-531: Timing Position Sensor
9. Cruise Control Switches.....	P-505: Cruise Control/PTO Switches
10. Service Brake and Clutch Switches.....	P-506: Service Brake/Clutch Switches
11. ECM or Personality Module.....	P-510: ECM and Personality Module

For further troubleshooting ideas and for intermittent engine surges, **use the 3406C (SENR6425) Intermittent Failure Analysis manual.** This manual is full of troubleshooting short cuts and tricks to help isolate the most troublesome problems. Short cuts covered in SENR6425 are as follows: swap rack and timing BTM's, program parameters out of the way (127mph and 3000rpm), by-pass shutoff solenoid, hotwire OEM battery wiring, temporarily disconnect rack and timing sensors, program engine monitoring package to OFF.....

REHS0478 describes the relocation of the speed sensor. This procedure is sometimes necessary for engines with front gear train wear. In the procedure the speed sensor is relocated to the flywheel housing to get a more stable signal. This publication is included.

Finally, cruise control dropouts and surges around VSL have been caused by worn clutches and transmission yoke nut problems as well as pinched wires behind the BTM and transducer module. Electronic Communicator Newsletters are included to describe this in more detail. A Truck Engine News article discussing the Throttle Adjustment is also included.

Instructions For Correcting Speed Surge In 3406C PEEC III Truck Engines

SMCS Code: 1408

Truck Engine:

3406C (S/N: 4CK1)

Introduction

This instruction addresses the problem of a speed burp (power loss) in the 3406C PEEC III Truck Engines. This speed burp is typically followed by a speed surge (power recovery). This occurs most often during normal driving at varied vehicle speeds. The speed burp with a speed surge is eliminated with the relocation of the engine speed sensor from the fuel injection pump to the flywheel housing.

Speed surge occurs due to wear in the gears in the front gear group. This wear creates excessive clearances between the gears. The fuel pump is driven by the front gear group. There is an engine speed sensor that determines engine speed from the fuel pump camshaft. Because of the excessive clearances in the gears, the engine speed sensor does not sense the most accurate engine speed. Excessive clearances may cause the governor to react erratically. This will cause the governor to undershoot and to overshoot in the actual fuel rack position. The overall effect is a speed burp and a speed surge that is felt by the driver.

The required replacement parts are listed below. These components are designed to work with a speed signal from the flywheel.

This problem is most noticeable with the following horsepower ratings. Any horsepower ratings that are not listed must use one of the available personality modules that is closest to the necessary horsepower rating.

Required Parts

- **165-1594** Harness Assembly
- **165-1595** Harness Assembly
- **115-8109** Wire Splice
- **4P-5820** Pickup Assembly
- **3N-2704** Mounting Plate

Note: The **3N-2704** Mounting Plate can be used to install the speed buffer if a suitable mounting location cannot be found.

Table 1

Engine Serial Number	Horsepower Rating	Personality Module Part Number
4CK3414-UP	350 @ 1800	174-3395
4CK1-3413	350 MT TOP 4	174-3396
4CK1-UP	400 STD W/O BRKSV	174-3397
4CK1-UP	400 STD W/ BRKSV	174-3398
4CK1-UP	425 @ 2000 W/O BRKSV	174-3399
4CK1-9352	425 @ 2000 H/T W/O BRKSV	174-3400
4CK9353-UP	425 @ 2000 H/T W/O BRKSV	174-3401
4CK1-13151	425 @ 1800 H/T W/O BRKSV	174-3402
4CK1-UP	460 @ 1900 W/O BRKSV	174-3403

Installation Procedure

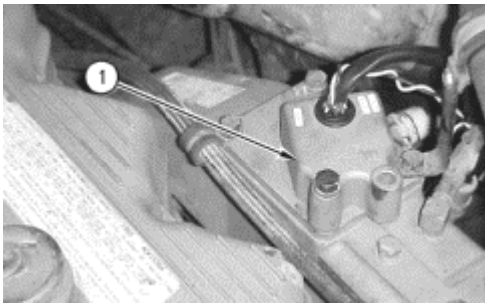


Illustration 1 g00600404

1. Install speed buffer (1) on the **165-1594** Harness Assembly in a convenient location. The speed buffer is used to maintain the signal strength from the **4P-5820** Pickup Assembly in the flywheel housing to the ECM. The **3N-2704** Mounting Plate can be used if a suitable mounting location cannot be found.

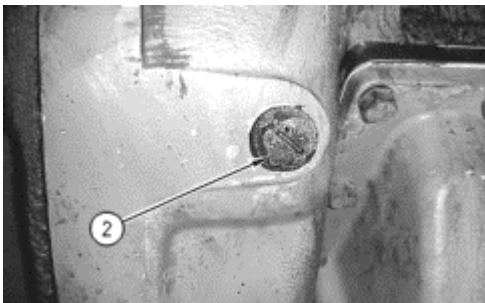


Illustration 2 g00600543

2. Remove plug (2) from the right hand side of the flywheel housing.

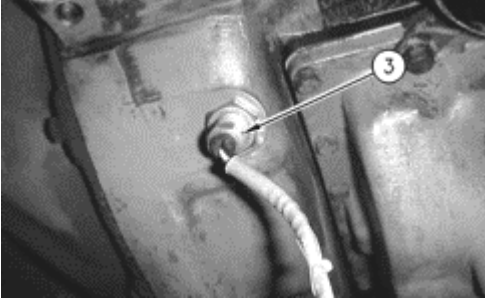


Illustration 3 g00600554

3. Install **4P-5820** Pickup Assembly (3) in the flywheel housing.

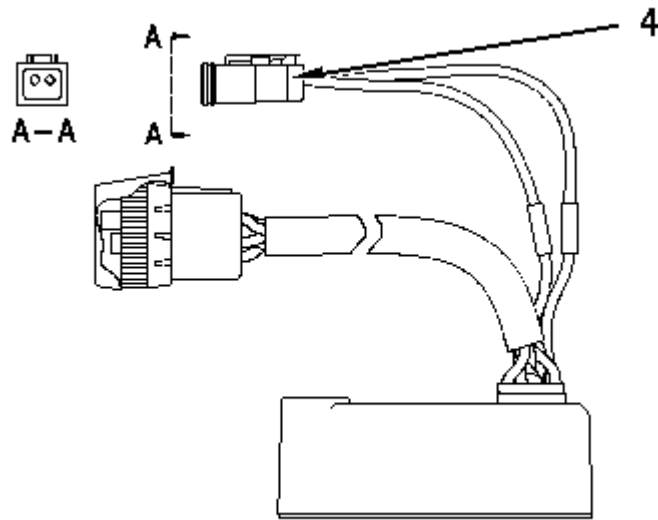


Illustration 4 g00600612

4. Install two pin connector (4) from the **165-1594** Harness Assembly to the **4P-5820** Pickup Assembly (3).
5. Install the wire tie-wraps in order to secure the wiring harnesses.

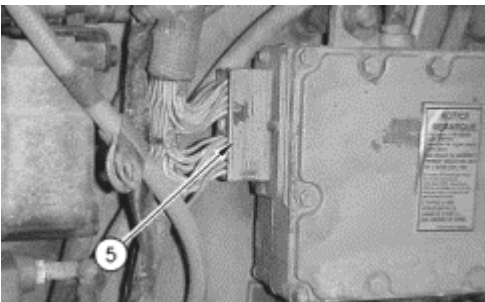


Illustration 5 g00600636

6. Remove the P4 connector (5) from the ECM.

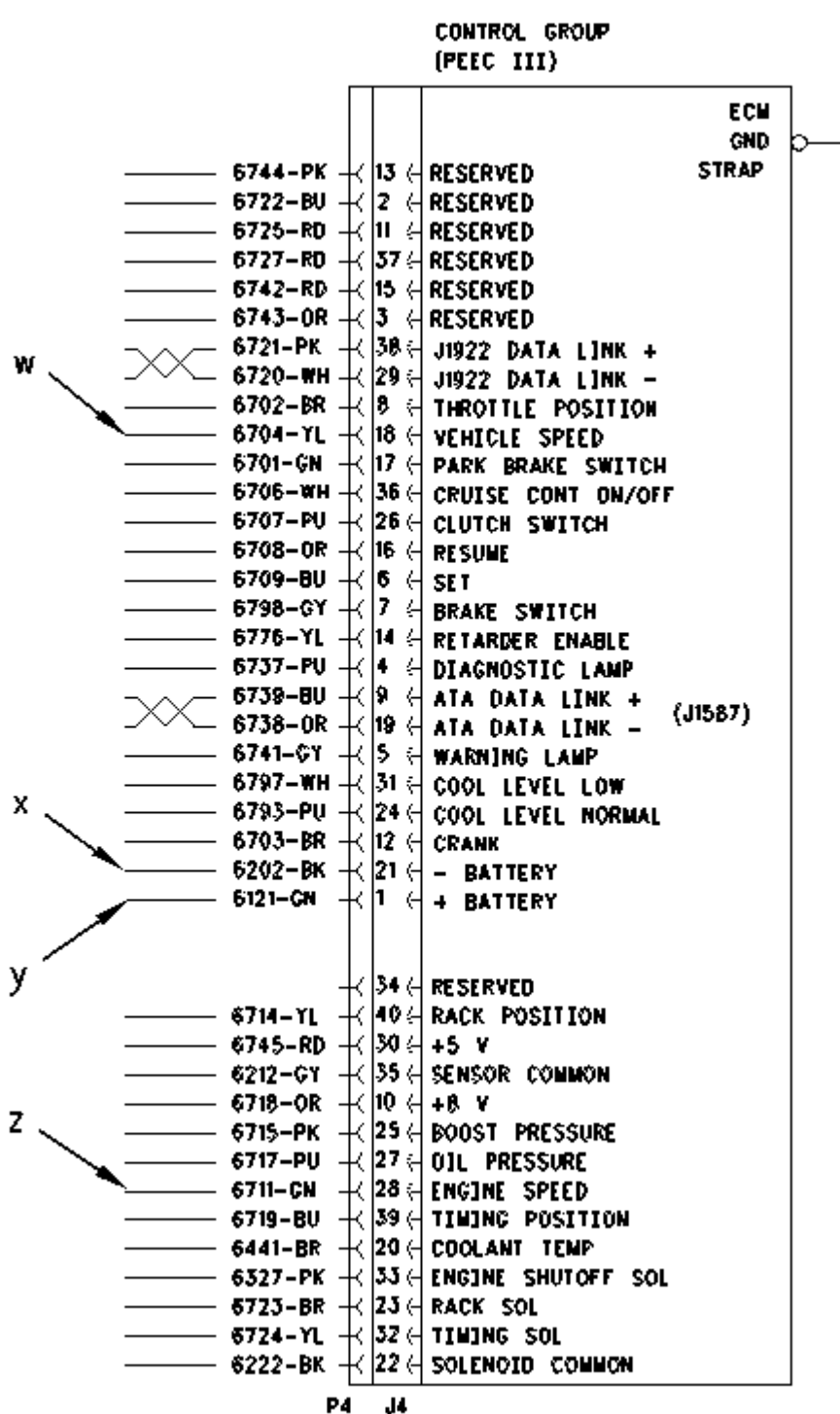


Illustration 6

g00601086

7. Use the following procedure to install the wiring for the electronic control module (ECM):
 - a. Remove the green wire "6711" (Z) from pin "28". Wrap electrical tape around the end of this wire because the wire will not be used.

- b. Remove the yellow wire "6704" (W) from pin "18".

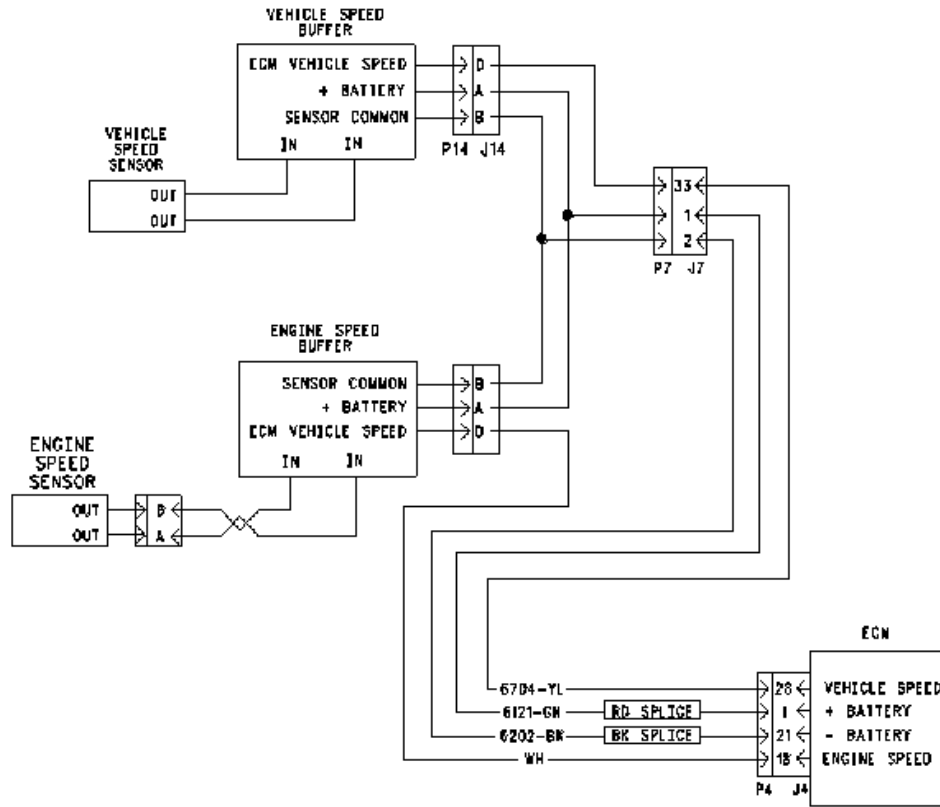


Illustration 7
New Wiring Schematic At The ECM

g00600703

- c. Install the yellow wire "6704" in pin "28". See the new wiring schematic.

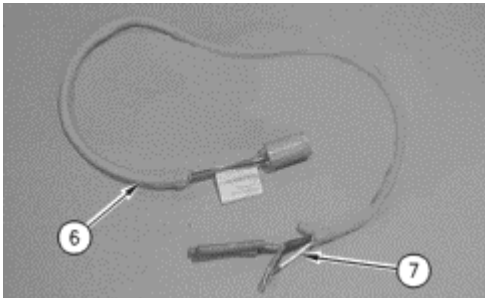


Illustration 8 g00600780

- d. Connect **165-1595** Harness Assembly (6) to the **165-1594** Harness Assembly.
- e. Install white wire (7) from the **165-1595** Harness Assembly in pin "18". See the new wiring schematic.
- f. Remove the green wire "6121" (Y) from pin "1".

- g. Install the red wire from **165-1595** Harness Assembly to pin "1". See the new wiring schematic.
- h. Install the green wire "6121" in the red splice of the **165-1595** Harness Assembly. See the new wiring schematic.
- i. Remove the black wire "6202" (X) from pin "21".
- j. Install the black wire from **165-1595** Harness Assembly to pin "21". See the new wiring schematic.
- k. Install the black wire "6202" in the black splice of the **165-1595** Harness Assembly. See the new wiring schematic.

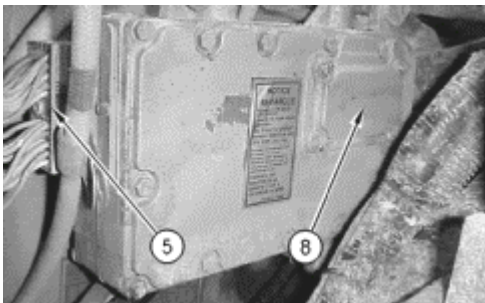


Illustration 9

g00600853

- 8. Install P4 connector (5) to the ECM.
- 9. Remove cover (8) from the ECM.
- 10. Remove the personality module from the ECM.
- 11. Install a new personality module. See Table 1.
- 12. Install cover (8).

ECN 960712

On-Highway Truck Vehicle Speed Tip – Erratic Cruise

There have been several instances where drivers of on-highway trucks would complain of erratic cruise control or loss of power as the truck's vehicle speed approached the programmed vehicle speed limit. The dealership personnel would find that there were no logged vehicle speed faults and the vehicle speed circuitry checked out OK.

One possible solution to these problems is to tighten the nut that secures the yoke to the output shaft of the transmission. When this nut loosens, the chopper wheel can slip causing the ECM to see a slower than actual vehicle speed. The ECM increases the fuel rate to get the vehicle back to the desired vehicle speed. By the time the chopper wheel catches up and sends out the correct vehicle speed, the truck may have exceeded the programmable vehicle speed limit causing the ECM to cut the fuel rate. The same thing happens when cruise control is used. The chopper wheel slips causing the ECM to register a slower than actual vehicle speed. The ECM increases the fuel rate to get the truck back to the set speed. The chopper stops slipping and

sends out the true vehicle speed, which is now higher than the set speed and the ECM cuts the fuel rate back – and the cycle repeats.

If the chopper wheel can be rotated with a screwdriver, it is too loose. (Some chopper wheels have been loose enough to rotate with a finger.) Tighten the nut on the output shaft of the transmission to the torque specified by the manufacturer.

Truck Engine News

Media Number - SEBD6612-00 Publication Date - 1990/09/01

Incorrect Throttle Adjustment Can Cause Engine Surge

3176 And 3406B (PEEC) Truck Engines

Reference: Service Manual Module, 3406B (PEEC) Truck Engine Test Procedures, SENR3479. Service Manual Module, Electronic Troubleshooting 3176 Diesel Truck Engine, SENR3913.

The throttle adjustment procedure is critical to insure proper engine performance. Some engines equipped with 9X9647 or 9X9648 Throttle Position Sensors (TPS) have experienced problems because the throttle linkage was not adjusted correctly. When incorrectly adjusted, the engine may experience low power, or in the worst case, "cutout" when fully loaded. Incorrect adjustment can cause the TPS rotary disk to travel beyond normal operating ranges. If the rotary disk travels too far (over rotates), the engine will "cutout" when fully loaded. If the rotary disk does not travel far enough (under rotates), full throttle will not be reached.

Incorrect adjustment cannot be detected with the Electronic Control Analyzer Programmer (ECAP) status display for throttle position. To verify correct TPS adjustment, connect the ECAP or Digital Diagnostic Tool (DDT) to the output of the TPS with the 8C9801 PWM Signal Adapter Group. Set the service tool to display the screen for duty cycle measurement of the pulse width modulated signal. Adjust the throttle linkage to get a low idle reading of 15 to 20% duty cycle and a high idle reading of 80 to 85% duty cycle. This adjustment may have to be performed several times before both low and high idle adjustment ranges are achieved at the same time.

For more details on the correct throttle adjustment procedure, see the Reference.

C. Engine Shutdowns

Engine shutdowns have occurred on 3406B and C PEEC engines. The following can cause these shutdowns:

- OEM Wiring
- Kysor Shutdown System
- Rack system wear
- Shutoff solenoid'
- Personality module
- ECM
- Rack BTM
- Engine Speed Sensor
- Transducer module
- Rack sensor

For engine shutdowns **use Troubleshooting Procedure P-110 and P-308 for the 3406B and C engines respectively.** These procedures are included in this manual.

For additional tips and short cuts refer to the Intermittent Failure Analysis Manual (SENR6425).

Remember: **Troubleshooting an engine that won't start is easier than troubleshooting and engine with and intermittent problem.**

A Truck Engine News article on the **Kysor Shutdown System** is also included in this manual.

Troubleshooting

3406B (PEEC) PROGRAMMABLE ELECTRONIC ENGINE CONTROLS

Media Number - SENR3479-05

Publication Date - 1991/02/01

Date Updated - 1997/01/06

P-110: Intermittent Engine Shutdowns

NOTE: Use this procedure ONLY if the engine completely shut down and needed to be restarted using the key switch.

Probable root causes:

- * Poor Connection
- * Battery power or ground to ECM (vehicle wiring).
- * After Market shutdown device (PEEC does NOT have engine protection shutdown feature).
- * Fuel supply
- * Shutoff solenoid
- * Shorted 8-volt sensor supply voltage

- * Rack controls
- * Engine speed sensor
- * ECM or Personality Module

Perform the following tests in order:

1. Check external PEEC harness and connectors (refer to P-201: Inspecting Electrical Connectors).

- * Vehicle connector (J2/P2)
- * ECM/Sensors connector (J3/P3)
- * ECM/Solenoids connector (J4/P4)
- * Transducer connector (J5/P5)
- * Rack solenoid connector (J10/P10)
- * Shutoff solenoid connector (J11/P11)

2. P-210: Electrical Power Supply to PEEC Test

3. Check for proper installation and operation of shutdown devices.

4. P-223: Shutoff Solenoid Test

5. Check fuel tanks for foreign objects that may block fuel supply.

6. Bypass OEM wiring and shutdown devices for testing. Refer to P-210: Electrical Power Supply To PEEC Test.

7. Check the following for damaged or abraded 8-volt sensor supply wires:

- * Timing position sensor
- * Rack position sensor
- * Engine speed sensor
- * Transducer module (on wires in governor housing)
- * PEEC engine harness

8. P-232: Rack Solenoid (BTM) Test

9. P-231: Rack Position Sensor Test

10. P-222: Engine Speed Sensor Test

11. P-220: ECM And Personality Module Test.

Troubleshooting

3406C (PEEC III) DIESEL TRUCK ENGINE

Media Number - SENR5503-00

Publication Date - 1992/12/01

Date Updated - 1997/01/06

P-308: Intermittent Engine Shutdowns	
Probable Root Causes:	Perform the following tests:
Note: Use this procedure ONLY if engine shutdown completely and had to be restarted using the key switch.	
1. Poor electrical connections.....	Check external PEEC III wiring harness and connectors (refer to P-500: Inspecting Electrical Connectors): ECM connector (J4/P4), Vehicle connector (J7/P7), Transducer connector (J5/P5), Rack solenoid connector (J3/P3), Shutoff solenoid connector (J13/P13).
2. Battery power or ground to ECM (vehicle wiring)...	P-501: Electrical Power Supply
3. After market engine protection devices	Check for correct installation and operation of engine protection devices.
4. Fuel Supply.....	Check fuel tanks and lines for foreign objects that may block fuel supply.
5. Shutoff Solenoid.....	P-513: Shutoff Solenoid
6. Shorted 8-volt sensor supply voltage.....	By-pass OEM wiring and shutdown devices for testing (refer to P-501: Electrical Power Supply to PEECIII). Check the following for damaged or abraded 8-volt sensor supply wires: Timing position sensor, Rack position sensor, Engine speed sensor, Transducer module (wires in governor housing), PEEC III engine harness.
7. Rack controls.....	P-522: Rack Solenoid (BTM) P-521: Rack Position Sensor
8. Engine Speed sensor.....	P-512: Engine Speed Sensor
9. ECM or Personality Module.....	P-510: ECM & Personality Module

Truck Engine News

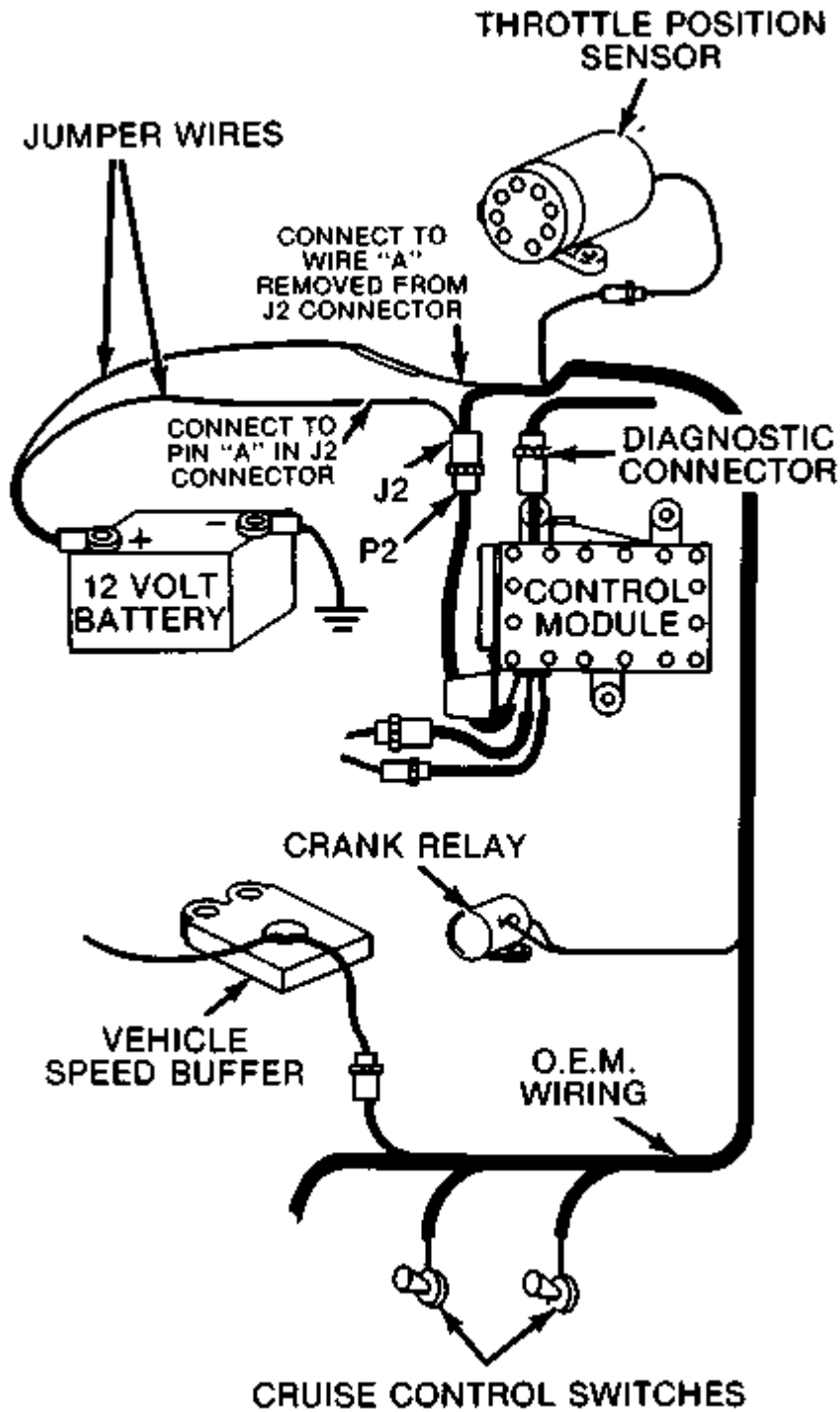
Media Number - SEBD6581-00 Publication Date - 1988/02/01

Servicing And Programming PEEC Truck Engines Equipped With Kysor ® Shutdown System

3406B PEEC Truck Engines Equipped With Shutdown System

Reports indicate a problem servicing and programming a 3406B (PEEC) Truck Engine equipped with a Kysor ® Engine Shutdown System. The Kysor® Engine Shutdown disconnects the Programmable Electronic Engine Control (PEEC) voltage supply when the engine is without oil pressure for a specified amount of time (approximately 30 seconds). This results in an inability to program and service the PEEC system.

Servicing and programming the PEEC can be accomplished by supplying power directly to the PEEC. This can be done as follows.



1. Remove the "A" wire from the J2 connector with a Deutsch pin remover (part to the 1U5803 Deutsch Connector Repair Kit).
2. Attach an 8T8729 Pin to a 16 AWG jumper wire and insert the pin into "A" position of the J2 connector.
3. Connect the other end of the jumper wire to a battery positive (+) source.
4. Connect power to the Throttle Position Sensor and the Vehicle Speed Buffer. In most cases (dependent on OEM wiring) this can be done by connecting a jumper wire from a battery positive (+) source to "A" wire removed in Step 1. An 8T8730 Socket can be used to connect the jumper wire to the 8T8729 Pin on the end of wire "A".

NOTE: Be sure to keep all contacts isolated from any grounded surface.

When power is supplied to all units of the PEEC system, normal servicing and programming capabilities are restored. When servicing and programming are complete, remove the jumpers and install wire "A" in position "A" in the J2 connector. Be sure the 8T8729 Pin is fully installed in the connector. The pin must withstand a pull of 10 pounds and still remain in place in the connector body.

D. Low Power/Restricted RPM

For **low power, reference procedures P-106 thru P-107 (3406B) and P-305 thru P-306 (3406C).**

For engines with serial number prefix of **8TC Cold Mode that can limit engine RPM at start-up and after a loss of battery voltage to the ECM.**

- No coolant temp sensor. ECM asks for timing advance during start-up and based on the response of the timing system the ECM guesses the thickness of the to determines if cold mode should be used.
- This check lasts for about 10 seconds. If the throttle is touched during the check, then cold mode is assumed and low power with 1700 RPM limit is started.
- ECM does this every time the ECM is powered-up (if vehicle speed is less than 30 mph, engine is in low power during cold mode).

A Truck Engine News article on bonnet and barrel cleaning is included as well.

For low power PEEC engines there is also a rack linearity procedure. Rack sensors have occasionally become “non-linear”. In this situation they will typically send the ECM a signal that does not represent actual rack travel. For instance the rack sensor may “tell the ECM” that it is at 15mm of travel when it is actually at 12mm. This error results in low power. This problem does not occur every time the rack is increased.

Verify that the rack sensor has not failed using this procedure: Rack reading on ET should be compared to a dial indicator installed in the fuel pump. One millimeter of dial indicator travel should cause an increase of 1mm on ET. If the increase displayed on ET varies greatly (>0.3mm) from that of the dial indicator, then the rack sensor has become non-linear and may be causing low power. See the attached Truck Engine News article.

Troubleshooting

3406B (PEEC) PROGRAMMABLE ELECTRONIC ENGINE CONTROLS

Media Number - SENR3479-05

Publication Date - 1991/02/01

Date Updated - 1997/01/06

P-106: No Or Poor Response To Throttle

Probable root causes:

- * Active Diagnostic Codes
- * PEEC Self-Checks or Cold Mode (normal operation)
- * Progressive Shift Parameters (normal operation)
- * Acceleration Rate Limit (normal operation)
- * Throttle position signal
- * Rack subsystem
- * Vehicle speed signal

Perform the following tests in order:

1. Troubleshoot any ACTIVE diagnostic codes. Codes 32 and 56 limit engine speed to low idle.
2. Verify that PEEC has completed its start-up self-checks and is out of Cold Mode.
3. Check Progressive Shift Parameters to verify that they are not the cause of the complaint.
4. If complaint is around 1500 to 1600 rpm, the cause may be PEEC's Acceleration Rate Limit (normal operation). Refer to the section Summary Of PEEC Personality Modules Changes to determine if the Personality Module has ARL.
5. P-211: Throttle Position Sensor Test
6. P-231: Rack Position Sensor Test
7. P-232: Rack Solenoid (BTM) Test
9. P-213: Vehicle Speed Signal Test

P-107: Low Power/Engine RPM Restricted/Will Not Reach VSL

Probable root causes:

- * Active Diagnostic Codes
- * Customer Parameters (normal operation)
- * PEEC Self-Checks or Cold Mode (normal operation)
- * Throttle position signal
- * Fuel supply restrictions
- * Inlet air system problems
- * Exhaust system restrictions
- * Boost pressure signal
- * Rack controls
- * Timing advance
- * Vehicle speed signal

Perform the following tests in order:

- 1.** Troubleshoot any ACTIVE diagnostic codes and LOGGED Codes
 - * Codes 24 and 46 limit engine speed to 1350 rpm.
 - * Codes 31 and 36 limit engine speed to "Engine RPM At VSL".
 - * Codes 22, 23, 25, 42, 43, and 44 limit engine power.
 - * Code 48 limits engine speed to 1350 rpm in gear even if it is only LOGGED and not ACTIVE.
- 2.** Verify that complaint is NOT due to parameters.
 - * Check Progressive Shift Parameters, Vehicle Speed Limit, and Top Engine Limit.
 - * Verify that Full Load Setting and Full Torque Setting are programmed to the values stamped on the engine information plate.
- 3.** Verify that PEEC has completed its start-up self checks and is out of Cold Mode.
- 4.** P-211: Throttle Position Sensor Test
- 5.** Check for proper fuel pressure and fuel return flow.
- 6.** Check for air system problems:
 - * plugged air filter
 - * aftercooler restrictions
 - * aftercooler leaks
 - * high intake air temperature
- 7.** Check for exhaust system restrictions.
- 8.** P-224: Boost Pressure Sensor Test
- 9.** P-230: Dynamic Rack Controls Test
- 10.** P-240: Dynamic Injection Timing Test
- 11.** P-213: Vehicle Speed Signal Test
- 12.** Run PAR (Performance Analysis Report) Test.

Troubleshooting

3406C (PEEC III) DIESEL TRUCK ENGINE

Media Number - SENR5503-00

Publication Date - 1992/12/01

Date Updated - 1997/01/06

P-305: No or Poor Throttle Response	
Probable Root Causes:	Perform the following tests:
1. Active Diagnostic Codes.....	Troubleshoot and ACTIVE diagnostic codes
2. PEEC III Self-Checks or Cold Mode (normal operation)...	Verify that PEEC III has completed its start-up self-check and is out of cold mode
3. Progressive Shift Parameters.....	Check Progressive Shift Parameters to verify that they are not the cause of the complaint.
4. Throttle position signal.....	P-502: Throttle Position Sensor
5. Rack sub-system.....	P-521: Rack Position Sensor P-523: Rack Solenoid (BTM)
6. Vehicle Speed Signal.....	P-504: Vehicle Speed Signal

P-306: Low Power/Engine RPM Restricted/Will not reach VSL	
Probable Root Causes:	Perform the following tests:
1. Active Diagnostic Codes.....	Troubleshoot and ACTIVE or LOGGED diagnostic codes. Code 24, 46, and 48 limit engine RPM to 1350. Code 36 limits engine RPM to "Engine RPM at VSL". Codes 22, 23, 25, 43, 44, 61, and 62 limit engine power.
2. Customer Parameters.....	Verify that the complaint is NOT due to parameters. Check Progressive Shift, Vehicle Speed Limit, and Top Engine Limit. Verify that the Full Load Setting and the Full Torque Setting are programmed to the values stamped on the engine information plate.
3. PEEC III Self-Checks or Cold Mode (normal operation)...	Verify that PEEC III has completed its start-up self-check and is out of cold mode
4. Throttle position signal.....	P-502: Throttle Position Sensor
5. Fuel supply restrictions.....	Check for proper fuel pressure/fuel return flow.
6. Inlet air system problems.....	Check for air system problems: Plugged air filter, Aftercooler restrictions, Aftercooler leaks, High intake air temperature.
7. Exhaust system restrictions.....	Check for exhaust system restrictions
8. Boost pressure signals.....	P-514: Boost Pressure Sensor
9. Rack Controls.....	P-520: Dynamic Rack Controls
10. Timing Advance.....	P-533: Dynamic Injection Timing
11. Vehicle Speed Signal.....	P-504: Vehicle Speed Signal

Fuel Injection Pump Barrel Sealing Face Reconditioning

1251

3406 Truck Engines Equipped With New Scroll Fuel System (NSFS)

This article provides information for a new chemical cleaning process for the fuel injection pump bonnet and barrel sealing surfaces. Either chemical cleaning or lapping may be used to recondition the barrel sealing surfaces. Laboratory and field-testing have shown the chemical cleaning process is less subjective and results in better sealing than the hand lapped parts.

Before beginning the Sealing Face Chemical Cleaning Process, do the Precleaning Inspection. Replace 2W-2409 and 6I-1665 Bonnets with new 108-2102 Bonnets.

Precleaning Inspection

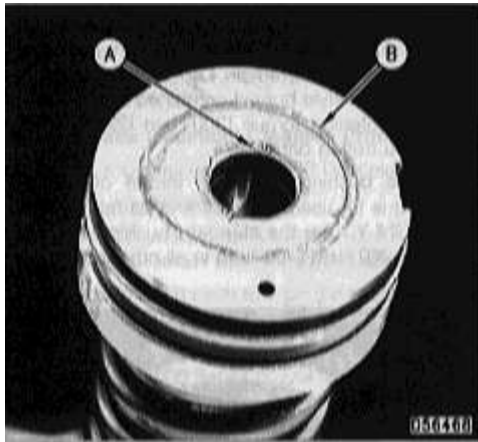


Illustration 1. Top View Of Barrel

A. Do not reuse if the check valve seating surface is nicked.

B. Staining here is acceptable. The new bonnet seal ring is inside this diameter. There is no need to remove light to moderate stains in this area.

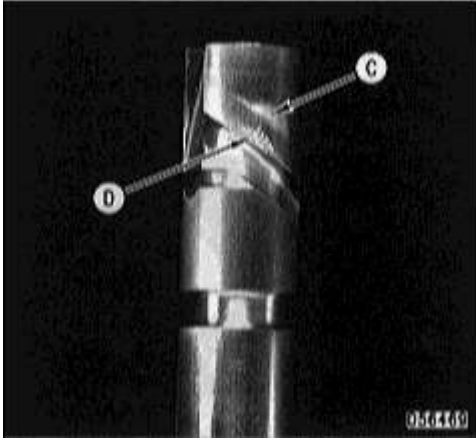


Illustration 2. Plunger

NOTE: Do NOT mix plungers and barrels. The original plungers must remain with the same barrels. If the plunger is not acceptable, a new pump group is required. Do not proceed with this process if the plunger is not acceptable.

- C. Cavitation erosion above the scroll edge is acceptable.
- D. Plungers with worn or nicked scroll edges should not be reused.

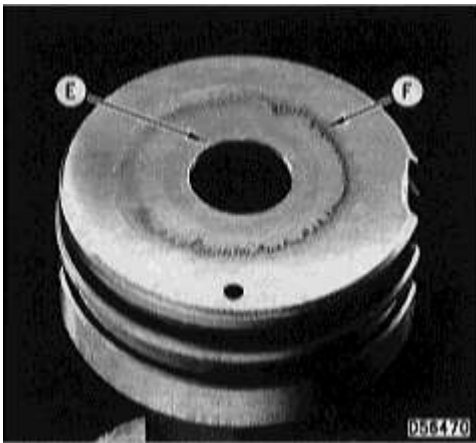


Illustration 3. Top View Of Barrel

- E. A mirror image of the check valve notch is acceptable.
- E. Heavy staining should be removed to prevent debris from getting into the sealing joint during assembly. Visible staining "Not Easily Removed" is acceptable because the new bonnet seal ring is inside this diameter.

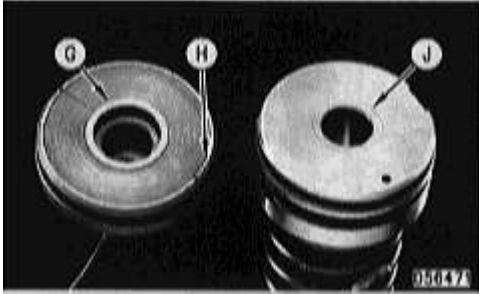


Illustration 4. Bottom View Of Bonnet (Left). Top View Of Barrel (Right)

G. This style bonnet can have staining removed with the same cleaning process and reused.

H. Multiple relief notches are acceptable.

J. Light staining and fretting is not an automatic indication of joint leakage. This should be cleaned before reuse.

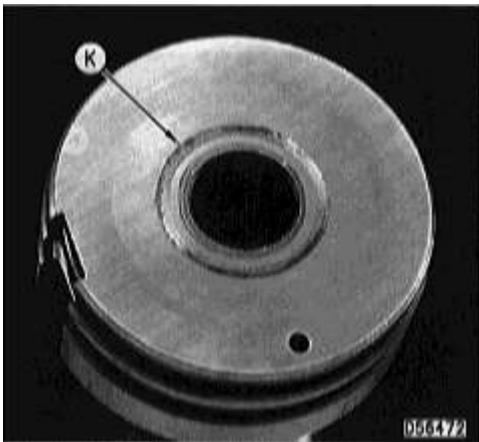


Illustration 5. Top View Of Barrel

K. Staining and/or fretting "Before" cleaning.

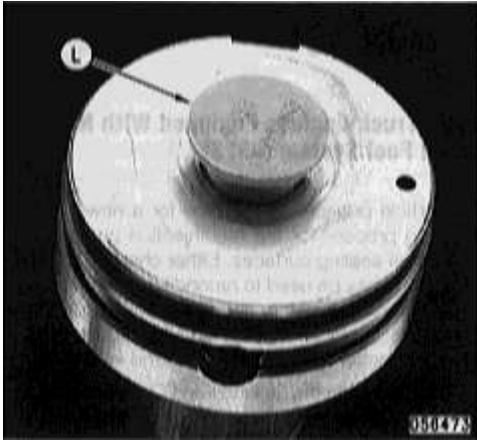


Illustration 6. Top View Of Barrel

L. A 7000 Series nozzle tip cap in the barrel bore will help keep the cleaning fluid on the surface. Remove the cap and flush the barrel with clean diesel fuel after cleaning. The chemical cleaning will remove surface stains, but fretting will remain. Laboratory and field test indicate a new style bonnet combined with increased bushing tightening torque [300 N·m (220 lb ft)] will seal with a fretted barrel.

NOTE: The bushing tightening torque of 300 N·m (220 lb ft) is for used plungers and barrels with face fretting ONLY. Use the standard bushing tightening torque of 260 N·m (190 lb ft) in all other cases.

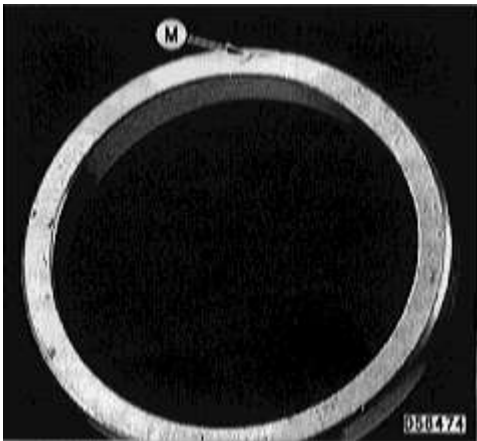


Illustration 7. Timing Spacer

M. Debris dent in a timing spacer. Do not reuse. Manufacturing grind marks are acceptable and lapping is not required.

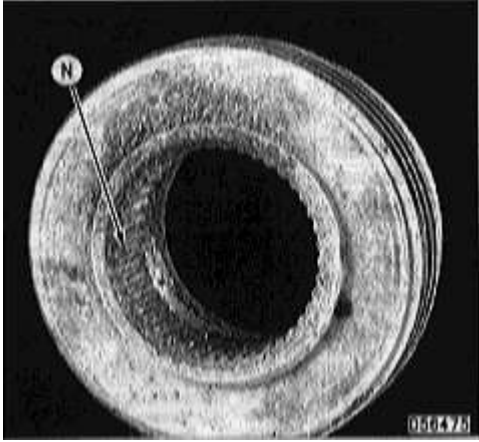


Illustration 8. Bushing

N. Do not reuse bushings with heavy amounts of spline rust. The splines must be in good condition to maintain the tightening torque. The splines must be in good condition to maintain the tightening torque. Number the bushings as they are removed so they can be reinstalled in the same bores.

Sealing Face Chemical Cleaning Process

1. Obtain a container of 1U-9698 Descalant

2. Provide a clean work area.

NOTE: Do NOT mix plungers and barrels. The original plungers must remain with the same barrels.

3. Use a clean soft cloth to wipe the sealing faces of the barrel and bonnet as clean as possible.

4. Plug the barrel and bonnet bores with a non-damaging material. A 7000 Series nozzle tip cap will fit in the bores. See Illustration 6.

5. Use the 1U-9698 Descalant and a cotton swab to scrub the stained sealing surfaces of the bonnet and barrel.

6. Let the descalant remain on the sealing surfaces for between two minutes (minimum) and five minutes (maximum).

7. Use a cotton swab to repeat the scrubbing action. Then flush the sealing surfaces with clean diesel fuel.

8. Assemble the fuel injection pump groups using the original plungers.

9. Visually inspect the timing spacers (Illustration 7) and bushings (Illustration 8).

10. Install the fuel injection pump groups into a clean fuel injection pump housing. Reuse the timing spacers and bushings. Use new seals. Lubricate the new seals with clean diesel fuel.

11. If the new bushings are NOT required, tighten the bushings to a torque of 300 N·m (220 lb ft). If a new bushing is used:

a. Tighten the bushing to a torque of 300 N·m (220 lb ft).

b. Loosen the bushing 1/4 to 1/2 turn.

c. Tighten the bushing to a torque of 300 N·m (220 lb ft).

NOTE: The bushing tightening torque of 300 N·m (220 lb ft) is for used plungers and barrels with face fretting ONLY. Use the standard bushing tightening torque of 260 N·m (190 lb ft) in all other cases.

Check the rack for free movement after each bushing is tightened.

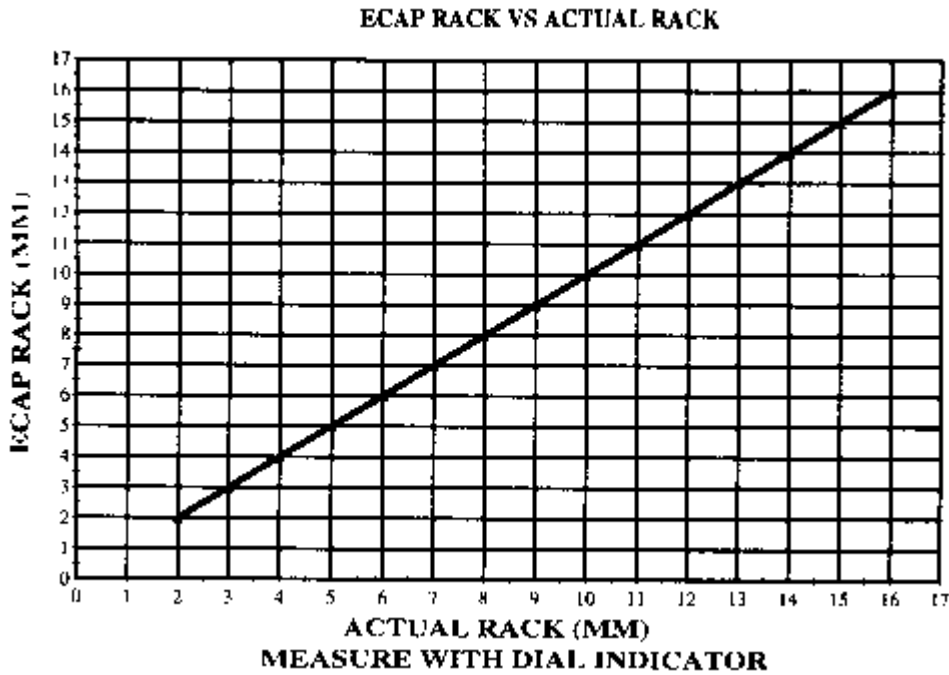
Low Power Complaints Caused By 9X7793 Rack Sensor Non-Linearity On Electronic Engines

3406C (4CK1-Up) Electronic Engines

Low power complaints may result when the output of the 9X7793 Rack Sensor is non-linear at the higher fuel system rack values. This problem cannot be diagnosed using the ECAP (part number 8T8697 with NEXG4522 Dual Truck Service Program Module) alone.

Symptoms of this problem are significant losses in wheel horsepower on a chassis dyno accompanied by equally low readings of fuel rate and boost. This failure mode usually shows up as a 40 to 60 wheel horsepower loss at rated conditions.

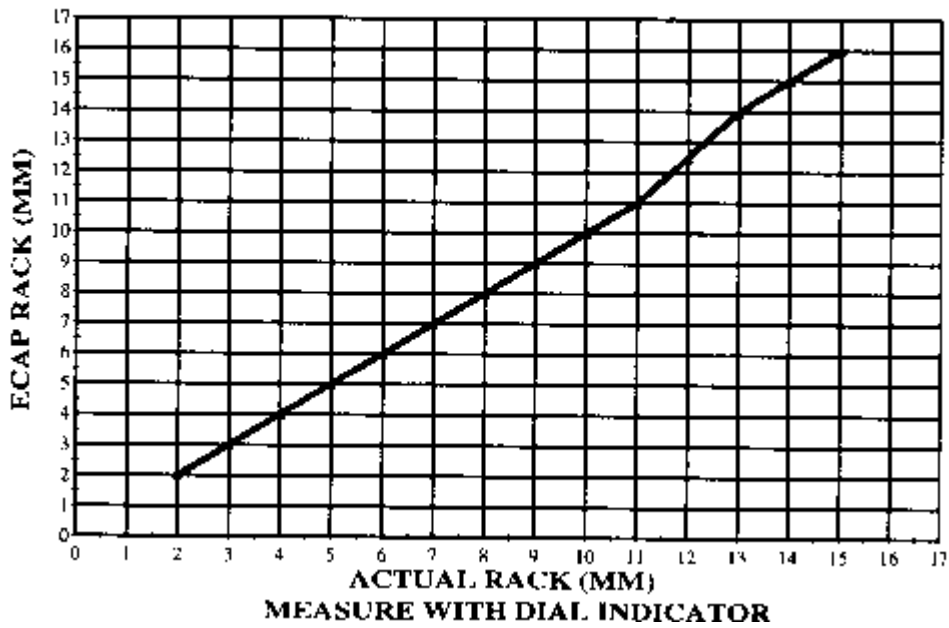
To determine whether a problem exists, use the rack dial indicator group and ECAP together to validate the rack sensor linearity. Install the mechanical dial indicator on the fuel system and then move the rack manually to the point that the rack reads 1.00 mm on the ECAP. Adjust the dial indicator to read 1.00 mm. Then move the rack manually 1.00 mm at a time on the dial indicator and record the ECAP reading. The two numbers should follow within ± 0.25 mm up to 15.00 mm of rack.



Graph 1.

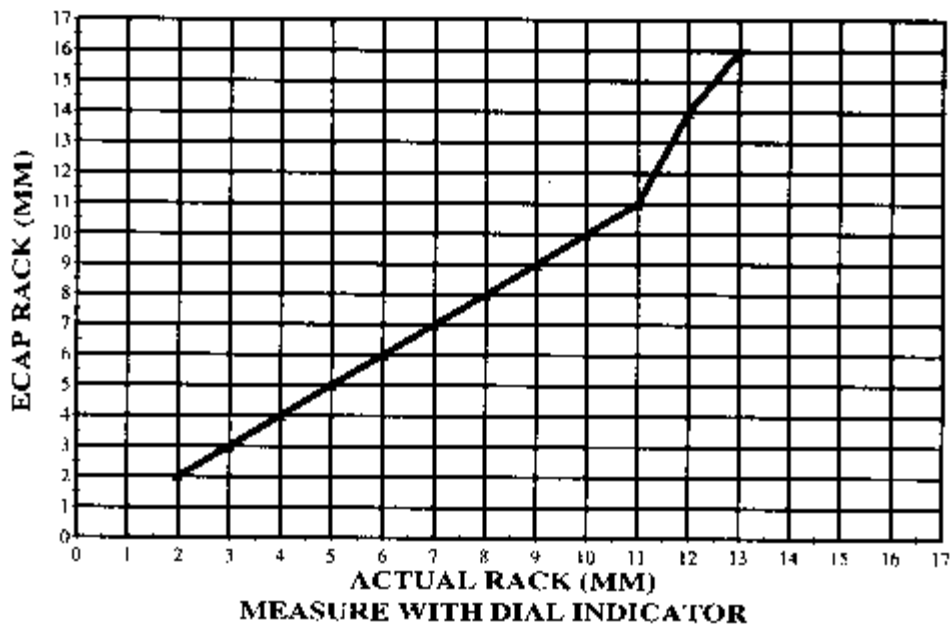
Graph 1 reflects a linear (straight line) output generated by a rack sensor functioning properly. Two types of non-linearity have been identified to date. Graph 2 shows a slight non-linearity at the end of the rack travel, but would probably not cause the engine to have excessively low power. The second example of non-linearity is shown in Graph 3. This type of output would result in the low power, fuel rate and boost levels mentioned previously. Replacement of the rack sensor may be necessary to restore the engine to its normal power levels if the rack values obtained simulate those shown in Graphs 2 and 3.

ECAP RACK VS ACTUAL RACK



Graph 2.

ECAP RACK VS ACTUAL RACK



Graph 3.

PEEC Component **Failures**

A. BTM's

The function of the BTM is to control fuel and injection timing.

Common problems that are associated with the BTM's are as follows:

- Broken Timing BTM arms (4CK Engines)
- Rack BTM arms binding in the servo spool
- Both Rack and Timing BTM having unstable travel

The most common fixes for the above listed problems are as follows:

- Maintain oil levels
- Perform the BTM Sweep Test
- Swap the Rack and Timing BTM's
- Rack bar should move freely if the servo is disconnected

B. Rack/Timing Sensors

The function of the Rack and Timing Position Sensors is to input timing and fuel rate to the ECM.

Some of the more common problems that are associated with the Rack and Timing Sensors are as follows:

- Broken or lost timing sensor tip
- Rack sensors losing accuracy
- Rack sensors losing contact with the rack bar magnet

The most common fixes for the above listed problems are as follows:

- Maintain oil levels
- Loctite sensor tip on shaft
- Ensure the latest Sensor Part numbers are installed
- Perform the rack linearity test
- Verify rack magnet and rack sensor feet are flush

There are also some additional troubleshooting tips for the rack and timing sensors on the 3406C engines.

ECN090194

Tip Kit for 9X9555 Timing Sensor

There is now available a kit to replace the tip of the 9X9555 Timing Sensor used in engines with serial number prefixes of 8TC, 2EK, 5YG, and 4CK. The kit part number is 1187204 and contains the following items: 1-7T8269 Spring, 1-7T8271 Washer, and 1-7T9083 Cap.

Remember to use Loctite when installing the new tip.

ECN 3-4-94

More on Rack and Timing Sensors

1) Tips when troubleshooting the rack and timing sensors:

- For repeatable problems the quickest way to eliminate these sensors as part of the problem is to disconnect them? The engine does not need either one of the sensors to run. However, when these sensors are disconnected the engine will be limited in power. Therefore, this test will work for problems that only appear under load.
- The engine can also start without the rack or timing sensor. The chances of a rack or timing sensor failing in a manner which prevents an engine from starting is very remote.
- Rack and timing sensors RARELY cause engine shutdowns and engine run-aways.
- 24-7 (flash code 43) is a fault that indicates a MECHANICAL problem! To log this fault the rack must be stuck. Check for bad rack bars, bad servos, or sensors hanging up against the governor housing.
- Fault code 22-7 can be logged on certain engines. If the sensor tests good DO NOT replace it. Keep an eye on the oil level for these engines.
- A bad rack sensor does not cause large, rapid changes in desired rack. Desired rack usually changes with engine speed, and/or throttle. Use cruise control to eliminate throttle as a possibility, then check speed sensor adjustment, wires pinched by the BTM, wire abrasions, etc.
- Don't forget the 10 lb. Pull tests. There have been many harnesses that have pins improperly crimped on the harness wires. When the harness is stretched the wire pulls away from the pin and an intermittent problem is created.
- The rack and timing sensors cannot cause BTM open/short circuit faults!
- When the ECM cannot read the rack or timing signal it sets actual rack or timing = desired. On the ECAP it may appear as rack or timing is jumping back and forth between two values. This does not mean the ECM or PM is malfunctioning. It also does not mean the rack or timing sensor is bad either. It is an indication that the sensor signal is not getting to the ECM properly, or the system is binding. Be sure to check connectors, pins, and wiring!
- If a timing sensor has a loose tip, clean the tip, apply primer, and Loctite the tip back on the sensor.
- The most reliable way to troubleshoot low power is on the dyno. Be sure to verify low power before making repairs. If a dyno is not available and no active problem is found, instruct the driver to visit a Cat authorized shop with a dyno.
- **DO NOT PERFORM VOLTAGE CHECKS FOR LOGGED FAULT CODES. IF THERE IS A VOLTAGE OUT OF SPEC, THERE WILL ALSO BE AN ACTIVE FAULT!!! FOR LOGGED CODES CHECK FOR WIRE ABRASION, LOOSE PINS, UNMATED CONNECTORS, ETC.**
- **1 OR 2 LOGGED CODES DOES NOT EXPLAIN WHY AN ENGINE HAS BEEN LOW ON POWER!! DO NOT REPLACE COMPONENTS FOR 1 OR 2 LOGGED CODES, ESPECIALLY IF THEY DO NOT RELATE TO THE COMPLAINT.**

New Features And Enhanced Fault Codes Available In New PEEC Personality Modules

3406B (PEEC) Truck Engines

Reference: "Updated 7X1830 SPM For 8T5282 3406B PEEC DDT Available" in this issue.

The following features are available for all 1987 and 1988 3406B (PEEC) Truck Engines, and are included on all new PEEC Engines, beginning December 1, 1988. To service a truck with these features, the Service Program Module (SPM) for the ECAP must be updated to 8C5919, Version 1.3 and the service program module for the DDT must be updated to 7X1830, Version 2.0. If the Service Program Module has not been updated, Fault Code 56, Check Customer Specified Parameters, will occur, and cannot be cleared without the new SPM.

Programmable Low Idle Rpm

The Programmable Low Idle rpm feature allows the engine's low idle rpm setting to be set anywhere between 600 and 750 rpm. This can be very helpful if a different rpm is needed to suit unique conditions or there is a resonance vibration problem at a specific rpm.

Idle Shutdown Timer

This feature has been developed to eliminate unnecessary idle time, but still allows overnight idling to heat or cool sleeper cabs. The Idle Shutdown Timer will stop the engine after a programmed amount of time if the following conditions are met.

1. The parking brake is applied.
2. Vehicle ground speed is zero.
3. PEEC is in the warm mode.
4. Operator does not override the shutdown timer.

Idle Shutdown Time is a Customer Specified Parameter programmable from three to 60 minutes (in one minute increments). This can be programmed with either of the two electronic service tools (ECAP or DDT) that are equipped with the new Service Program Modules. Without the new SPM, the Idle Shutdown Time cannot be programmed and the resulting Fault Code 56 cannot be cleared. If the Idle Shutdown Time is programmed to zero, the feature is disabled. The feature gives the operator the ability to override the function if the operator waits the programmed amount of time. In situations where it is necessary to keep the engine idling, the clutch pedal or brake pedal must go through a change in position (either by pressing or releasing the pedal) during the final 90 seconds prior to shutdown. During the final 90 seconds prior to shutdown, the Check Engine

Lamp on the dash will flash at a rate of twice a second to warn the operator of the impending shutdown. If there is a change in throttle position during the final 90 seconds prior to shutdown, the timer will be reset, but not be disabled.

NOTE: Vehicle battery power is not turned off after an Idle Timer Shutdown. The ECM and other vehicle electrical loads will result in battery drain after engine shutdown. To equip a PEEC truck with the Idle Shutdown Timer feature, a personality module change, an additional parking brake switch, and the associated wiring supplied by the vehicle's OEM are necessary. This wiring is outlined in the "Correct Wiring of Parking Brake Switch" section of this article.

Intermittent Fault Logging

To aid in troubleshooting intermittent PEEC faults, a new personality module allows diagnostic fault codes to be stored in temporary memory. This feature will retain all diagnostic messages as long as the ignition key remains ON. If the key is turned OFF, the stored diagnostic messages will be erased, and only active faults will be retained. Driver awareness of this "key ON" feature is essential to prevent service calls for the same intermittent faults. An updated ECAP or DDT (with Service Program Modules listed above) is required to display logged fault codes, a description of the fault, the number of occurrences, and the present status (active/not active) of the fault code.

Many intermittent faults are electrical connection problems. When troubleshooting these faults, try to recreate the conditions in which the fault occurred. If the fault can be recreated, follow the troubleshooting procedures. If the fault cannot be recreated, inspect and repair connections and wiring that are associated with the circuit that caused the fault.

Another update planned for release in the second quarter of 1989 will log faults in permanent memory. This feature will retain logged faults even if power has been interrupted to the ECM, or the ignition key has been turned OFF.

Idle Instability Fix

Several PEEC trucks have experienced idle instability problems. The most common method to correct this problem in the past was to change the 6T1789 Rack Brushless Torque Motor (solenoid). The new version of personality module implements a control strategy that is more tolerable to differences in lift-off currents of the BTM and ECM (Electronic Control Module). Previously, if these lift-off currents did not match up closely, idle instability would occur.

Vehicle Speed Diagnostic Improvements

Fault Code 31, Loss of Vehicle Speed Signal, has been added to the list of 3406B PEEC Diagnostic Codes. Engine rpm at Vehicle Speed Limit (VSL) will be allowed with Fault Code 31 present. With Fault Code 36 (Vehicle Speed Signal Overrange) present, engine rpm at VSL will be allowed.

Improved Limp Home

With Fault Code 32 present, Throttle Position Sensor Fault, engine rpm at VSL will be allowed by using the cruise control switches to raise and lower engine rpm. Previously, PTO Engine rpm Limit was allowed with this fault present.

Improved Boost Sensor Diagnostics

A software change has been developed to improve diagnosis of an intermittent Fault Code 25 (Boost Pressure Sensor Fault).

ATA Data Link Update

The ATA Data Link has been updated to maintain compatibility with current data standards of the American Trucking Association (ATA). The data link allows communication of the PEEC system with other electronic devices, such as trip recorders, electronic dashboards, and maintenance systems.

Additional Fault Codes

Four Diagnostic Fault Codes have been added in the new personality module software to aid in troubleshooting PEEC. Complete troubleshooting procedures for these faults are in the PEEC Troubleshooting Manual, SENR3479. A brief description of each is listed.

31 - Loss of Vehicle Speed Signal. This fault can be associated with a harness fault, vehicle speed buffer fault, a control module fault or a speed sensor fault.

47 - Idle Shutdown Timer Fault. If the engine is shut down by the Idle Shutdown Timer Function, Fault Code 47 will occur. If the Idle Shutdown Timer is not functioning correctly, first check the Customer Specified Parameters, and then check for correct operation of the parking brake, service brake, and clutch switches.

48 - Excessive Boost. This fault is generated when the ECM detects excessive boost for that particular engine family. Under normal operating conditions, this fault cannot occur.

57 - Parking Brake Switch Fault. This fault is generated if the PEEC system sees vehicle speed and the parking brake is set. A problem could be in the parking brake switch, the harness, or the control module. If this fault occurs, the Idle Shutdown Timer feature will not function.

Correct Wiring Of The Parking Brake Switch

Operation of the Idle Shutdown Timer feature requires a parking brake switch as well as a 1989 personality module. To correctly wire the parking brake switch, refer to the wiring schematic for the 3406B (PEEC) Truck Engine, SENR3486, and follow these steps.

1. Attach an 8T8730 Socket to a 16 AWG wire, and insert the wire into the D position of connector P1, the Parking Brake Switch line for the ECM.
2. Connect the other end of the wire to one of the terminals on the 9G8011 Parking Brake Switch or an equivalent pressure switch.

NOTE: The parking brake switch must be connected into the parking brake control line.

3. The other terminal of the parking brake switch should be wired to chassis ground. The switch should be normally closed in the applied position.

Part Numbers Of Personality Modules

The chart lists the new and former serviced parts and their comparable Remanufactured parts.

Personality Modules				
Engine Serial No.	hp Rating	New Part No. ¹		Former Part No. ¹
BTC976-	310 EPA	OR6019	-	OR5935 7X1023
BTC1412	350 EPA	OR6020	-	OR5936 7X1026
BTC1413-Up	310 EPA	OR6014	9X3107	OR5943 7X1354
	310 CARB	OR6013	9X3110	OR5942 7X1352
	350 EPA	OR6010	9X3119	OR5944 7X1356
	400 EPA	OR6012	9X3114	OR5940 7X1207
	400 CARB	OR6011	9X3117	OR5941 7X1209
	425 EPA	OR6016	9X3103	OR5997 9X0385
	425 EPA	-	-	OR5938 7X1203
	425 CARB	OR6015	9X3104	OR5998 9X0386
425 CARB	-	-	OR5939 7X1205	

¹ "OR" prefixes are Remanufactured parts. "7X" and "9X" prefixes are serviced parts.

C. Shutoff Solenoid

The function of the Shutoff Solenoid is to force the rack back to the OFF position.

Some of the more common problems that are associated with the Rack and Timing Sensors are as follows:

- Damaged due to keyswitch wiring problems
- Intermittently fails resulting in shutdown

The most common fixes for the above listed problems are as follows:

- Make sure the ECM crank wire is attached to the “crank” position and not the “run” position on the keyswitch

D. Transducer Module

The function of the Transducer Module is to house the boost and oil pressure sensors as well as passing power/signal wires through to the rack and speed sensor.

Some of the more common problems that are associated with the Transducer Module are as follows:

- Failed oil pressure sensor.
- Failed boost pressure sensor.
- Internal wire abrasion causing faulty rack or speed signal (engine surge).

The most common fixes for the above listed problems are as follows:

- Install a remote oil pressure sensor. (See Special Instruction)
- Install the newest transducer part number.

ECN 12/17/93

Troubleshooting LOW OIL PRESSURE Faults

1. The majority of transducer modules are replaced due to oil pressure faults.
 - a. Check engine oil level; verify that the dipstick is accurate. Low oil level will cause low oil pressure faults as well as other problems.
 - b. If the fault is active, follow the procedure in the troubleshooting manual.
 - c. If the fault is logged numerous times and no problem can be found, update the Personality Module to a December 1993 version. Numerous software improvements have been made to the oil pressure diagnostics. These improvements should eliminate many of these false fault codes, as well as derates and shutdowns.
 - d. DO NOT replace a transducer module because oil pressure reads 1-2 with the engine off and the key in the ON position. The same is true for boost pressure readings in this situation.
 - e. DO NOT use the resistance test in the troubleshooting guide for 4CK1360 and above. (250K Ohms to transducer casting)
2. Oil Pressure Short Circuit Faults
 - a. For active faults with oil sensor voltages (key ON/engine off) between 1.3 and 1.55 volts, update the personality module to December 1993 version. The fault should be eliminated.
 - b. Follow the above procedure for logged oil pressure short circuit faults as well.

New Electronic Transducer Module Installation Instructions For 3406B and 3406C Truck Engines

1900, 1904, 1917, 1924

3406B (8TC, 5YG, 2EK);

3406C (4CK Truck Engines)

Introduction:

A new electronic transducer module is being installed in the above truck engines. The new electronic transducer module contains only a boost sensor. The former electronic transducer module contained a boost sensor and an oil pressure sensor. After installation, the new electronic transducer module will no longer provide an oil pressure signal to the Electronic Control Module (ECM).

The new configuration requires a remote mount oil sensor (and wiring kit) be installed. The remote mount oil kit may or may not already be installed on the engine.

Adaptability:

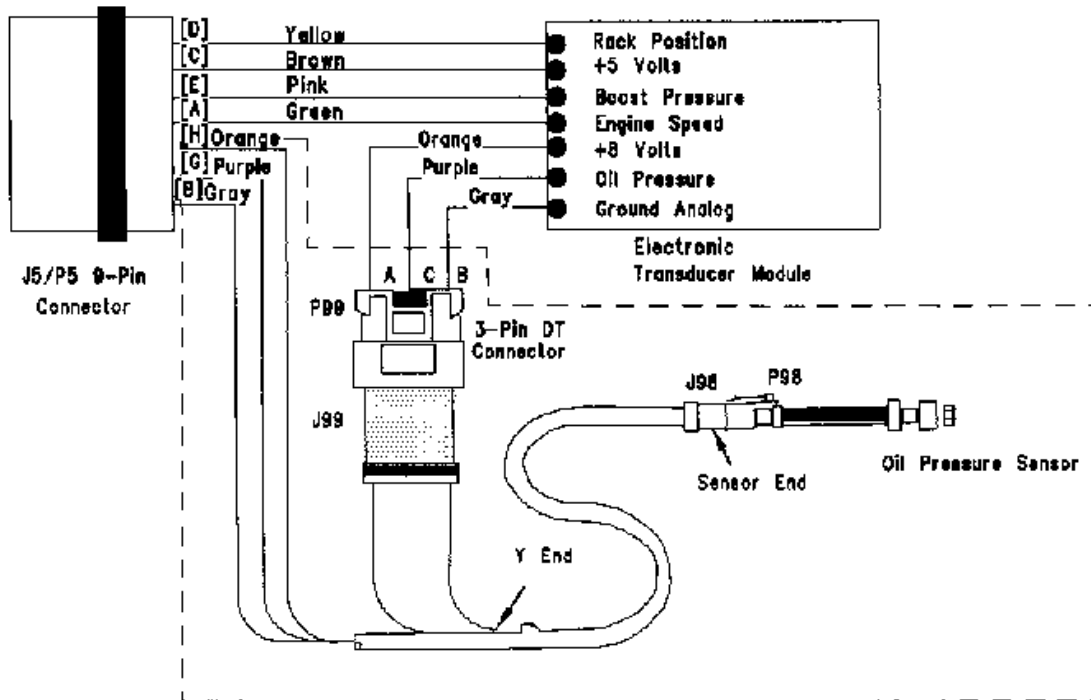
The new 132-4363 Electronic Transducer Module (with an oil pressure sensor kit) is a direct replacement for the former 3E-8540 Electronic Transducer Module and the remanufactured OR-6471 Electronic Transducer Module. Both of the former electronic transducer modules have been canceled.

The new 132-4363 Electronic Transducer Module is adaptable to the above truck engines.

Reason For Change:

When installed, the new 132-4363 Electronic Transducer Module will no longer contain the oil pressure sensor. This will make the system more reliable.

If a Remote Mount Oil Sensor Is Already Installed



D6723

Illustration 1, 3406B Wiring Diagram. View of 132-4363 Electronic Transducer Module and 122-1649 Oil Sensor Kit schematic.

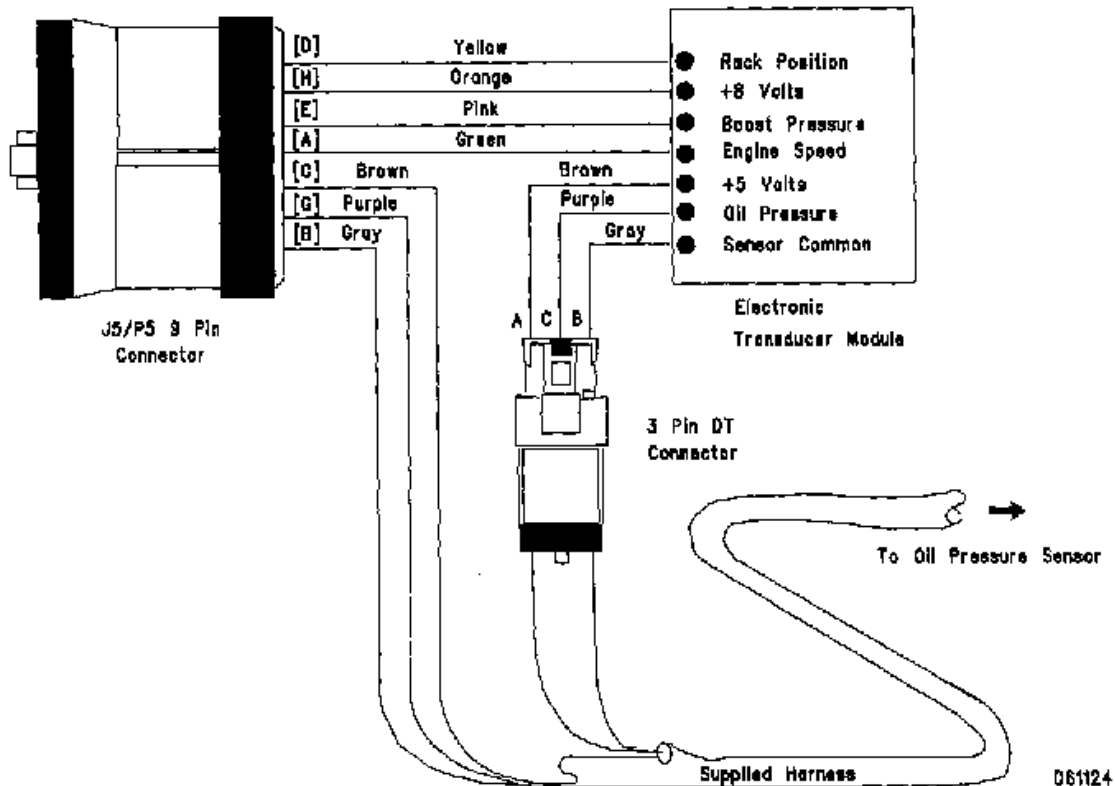


Illustration 2, 3406C Wiring Diagram. View of 132-4363 Electronic Transducer Module and 118-6256 Oil Sensor Kit Schematic.

A. When replacing the electronic transducer module with the new 132-4363 Electronic Transducer Module, determine if the engine has a remote mount oil pressure sensor. If it is already installed:

- * Note and record which wires were pulled from the connector P5 and the position they were installed on the remote mount oil sensor harness.
- * Note which wires from the remote mount oil sensor harness were installed in the connector P5. Again, note the pin locations.
- * Replace the electronic transducer module with the new 132-4363 Electronic Transducer Module.
- * See Illustration 1 for the 3406B and Illustration 2 for the 3406C Remote Oil Sensor Wiring Diagram.

If A Remote Mount Oil Pressure Sensor Is Not Installed

Adaptability Of Oil Pressure Sensor Kits		
Model	Engine Serial Number	Part Number
3406B	8TC, 5YG, 2EK	122-1649
3406C	4CK	118-6256

* Install a 118-6256 or 122-1649 Oil Pressure Sensor Kit in order to use the new 132-4363 Electronic Transducer Module. See the chart to determine which oil pressure sensor kit to use.

NOTE: Installation instructions are provided in each oil pressure sensor kit.

ECN 9/6/94

118-6256 Oil Pressure Sensor Kit

The 118-6256 will only work on the 4CK 3406C engines. If you have an 8TC, 2EK, or 5YG you will have to continue using the 0R-6471 Transducer Module.

When troubleshooting a 4CK engine with a 118-6256 Oil Pressure Sensor Kit installed, the sensor voltage will change when the signal line (pin C) is disconnected from the ECM.

For example, the signal line will have roughly 1.8 volts with no pressure applied and the ECM is reading the signal(C wire plugged in). If Pin C is pulled out, the voltage of the sensor will drop to around 1.0 volt DC. The 4CK Troubleshooting Guide SENR5503 will tell you to replace the sensor under these conditions. DO NOT follow this step.

Special Instruction

Media Number - SEHS9794-00

Publication Date - 1994/08/05

Date Updated - 1997/01/06

Installing the 118-6256 Sensor Kit

1300

3406B and 3406C Electronic Engines

Introduction

This Special Instruction describes the procedures for the installation of the 118-6256 Sensor Kit on 3406B and 3406C electronic engines.

The 118-6256 Sensor Kit is now available to install the oil pressure sensor in an alternate location.

In the event of an oil pressure sensor failure/fault, the 118-6256 Sensor Kit alleviates the need to replace the transducer module by providing an alternate location for the oil pressure sensor.

The disabled oil pressure sensor, located within the transducer module, is left in place and a new oil pressure sensor is installed in the engine cylinder block's oil gallery.

The 118-6256 Sensor Kit simplifies the replacement of a failed oil pressure sensor and minimizes customer downtime/expense.

The 118-6256 Sensor Kit contains all necessary parts for the installation including a special tool (8T-5318 Connector) for the removal of Deutsch electrical connectors.

118-6256 Sensor Kit

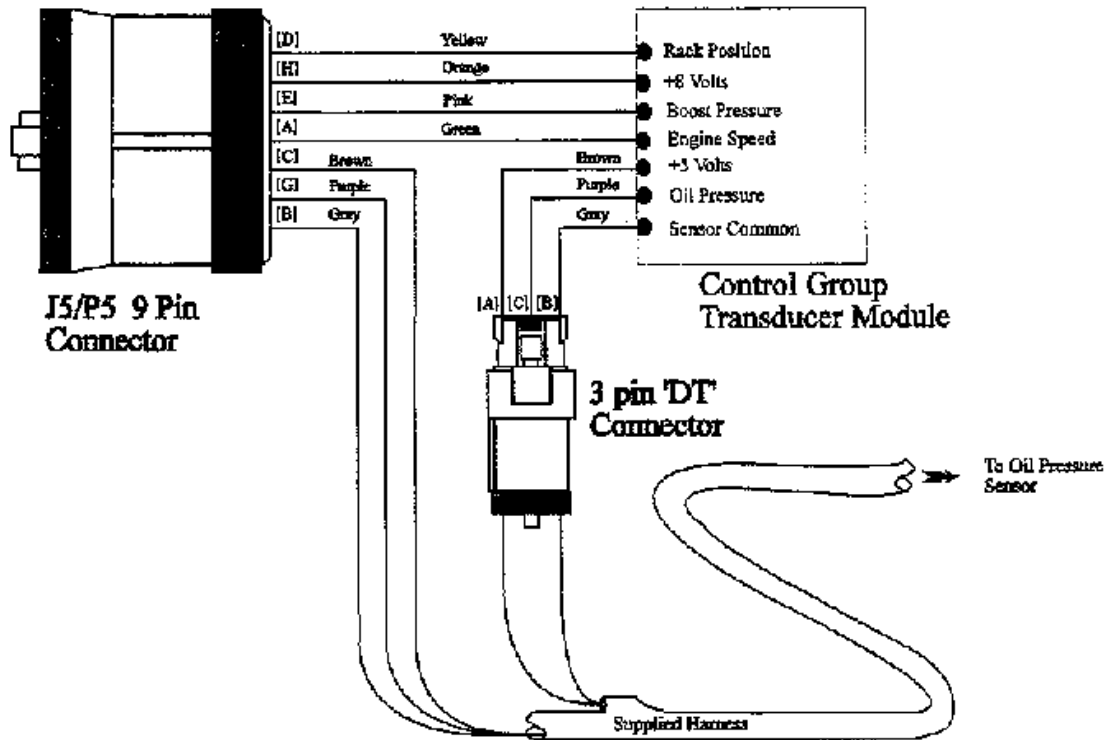
118-6256 Sensor Kit Parts Consist		
Part No.	Description	Quan.
3E-3368	Wedge .. Plug Lock	1
3E-7448	Connector	1
3J-7354	Seal .. O-ring	1
3S-2093	Strap .. Cable	15
4P-7581	Clip	1
5M-3062	Bolt	10
8T-4896	Washer .. Hard	16
8T-5318	Connector .. Removal tool for Deutsch connectors	1
104-2921	Plug Assembly .. Connector	1
117-8145	Harness Assembly	1
118-6315	Sensor Group	1

Installation

1. Locate the oil pressure gallery on the right side of the engine (as viewed from the flywheel end).

Inspect the area to verify that there is at least one oil pressure port available on this gallery BEFORE attempting to install the kit.

2. Locate the Transducer Module on the left side of the engine (as viewed from the flywheel end).



Pull back the black plastic sheathing on the Control Group Transducer Module wiring (pigtail) from the 9 Pin Connector (J5/P5).

Remove Pin B (Grey [Sensor Common]), Pin C (Brown [+5 Volts]) and Pin G (Purple [Oil Pressure]) from connector P5 using the 8T-5318 Deutsch Connector Pin Removal Tool (for 16 and 18 AWG wire).

3. Insert three wires into 104-2921 3 Pin DT Connector Plug Assembly on the Y end of 117-8145 Wiring Harness.

- * Insert the Brown (+5 Volts) wire (removed from Pin C) into Pin A.
- * Insert the Grey (Sensor Common) wire (removed from Pin B) into Pin B.
- * Insert the Purple (Oil Pressure) wire (removed from Pin G) into Pin C.

After inserting the Brown (+5 Volts), Grey (Sensor Common) and Purple (Oil Pressure Signal) wires into the 104-2921 3 Pin DT Connector Plug Assembly, install the Orange 3E-3368 Wedge (Plug Lock) into the Connector Plug and mate the connector.

NOTE: The 3 Pin DT Connector Plug Assembly **MUST** be properly **LOCKED** together to ensure that the two halves can **NOT** be pulled apart. You will hear an audible **CLICK** as the connectors seat.

NOTE: The wire colors should match on both sides of the 104-2921 3 Pin DT Connector Plug Assembly, except for the Purple (Oil Pressure) wire, there is no wire on the receptacle side (Pin C) of the connector.

4. Locate the three wires on the opposite branch of the Y end of the 117-8145 Harness. The wires can be identified by the Deutsch female pins on the wire ends and are to replace the three wires pulled from the 9 Pin Control Group Transducer Module Connector (J5/P5) in Step 2.

* Insert the Brown (+5 Volts) wire into Pin C (P5).

* Insert the Grey (Sensor Common) wire into Pin B (P5).

* Insert the Purple (Oil Pressure) wire into Pin G (P5).

5. Secure the two branches of the 117-8145 Harness Y to the Control Group Transducer Module by installing two 3S-2093 Straps around the 3 Pin DT Connector Plug Assembly, braided engine wiring harness and the Control Group Transducer Module 3 Pin DT Connector Plug Assembly pigtail.

6. Route the harness to the new 118-6315 Oil Pressure Sensor location by following the existing braided engine wiring harness underneath the engine fuel pump. Secure the existing engine harness and the new Transducer Module-to-Oil Pressure Sensor harness together by installing 3S-S2093 Straps spaced approximately 0.305 m (1.0 ft) apart.

7. Route the harness behind the timing advance and up to the coolant sensor area, around the front of the engine and then behind the alternator.

NOTE: The new 118-6315 Oil Pressure Sensor Group, when connected to the harness, should reach three or four of the ports on the gallery.

8. Remove one of the plugs from the oil gallery.

Install the 3E-7448 Connector Adapter (3/8 -18 NPTF end) into oil gallery port.

Install the 3J-7354 Seal onto the 3E-7448 Connector (7/16 -20 UNF THD end).

Install the 118-6315 Sensor Group onto the 3E-7448 Connector (Adapter) and tighten the 118-6315 Sensor Group to a torque of 40 ± 2 N·m (29 ± 1.5 lb ft).

NOTICE

To avoid damaging the sensor and/or internal and external threads:

* **DO NOT exceed a torque of 40 ± 2 N·m (29 ± 1.5 lb ft).**

9. Connect the harness to the 118-6315 Sensor Group.

Determine the best area to install the 4P-7581 Clip onto the lower part of the engine block using 8T-4896 Washer and 5M-3062 Bolt.

NOTE: The 4P-7581 Clip is used to secure/support any slack in the harness.

The harness and/or sensor connector may have to be looped/coiled to remove any slack and can be secured to the 4P-7581 Clip.

10. Connect an electronic service tool (ECAP, ET, ProLink) to the engine to verify that there are no active fault codes.

Start the engine:

- * Verify that there are no active fault codes.
- * Verify that the 118-6315 Oil Pressure Sensor Group is operating correctly.
- * Inspect for oil leaks at the 3E-7448 Connector (Adapter), 3J-7354 Seal and 118-6315 Oil Pressure Sensor.

E. Engine Speed Sensor

The function of the Engine Speed Sensor is to provide the ECM with the engine speed data.

Some of the more common problems that are associated with the Engine Speed Sensor are as follows:

- Sensor filling with oil and pushing out into cam gear.
- Pinched wires in transducer module
- Too large of a sensor gap or cam end play.

The most common fixes for the above listed problems are as follows:

- Installing the current Engine Speed Sensor.
- Ensure the sensor is adjusted $\frac{1}{2}$ out after making contact with the cam gear. Maximum cam endplay should be 0.28".

F. ECM/Personality Module

The function of the ECM and Personality Module is to control all engine functions, store engine software and ratings, store logged diagnostic codes, and store customer settings.

Some of the more common problems that are associated with the ECM/Personality Module are as follows:

- Moisture entry.
- No communication.
- 17-05, 20-05, and 23-05 fault codes (4CK).

The most common fixes for the above listed problems are as follows:

- Personality module seal or module cover seal.
- Use test ECM to ensure the original ECM is bad.
- If only codes are present and there is NO engine problems...repair is NOT necessary.

Truck Engine News

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Effective Dates, Serial Numbers And Features Of PEEC Personality Modules

3406B (PEEC) Truck Engines

This article supersedes the article with the same title on Page 1 of the November 1989 Truck Engine News.

Each production change listed in this article is added to the previous change(s).

April 1987

Original PEEC personality module, 1987 model year engine serial numbers 8TC1-1412.

October 1987

Beginning of 1988 model year, effective with 8TC1413. Update: Programming Low Idle rpm.

November 1987

Update: Improve customer specified parameter fault detection. Parameter that is programmed incorrectly can be displayed with ECAP (electronic control analyzer programmer).

April 1988

Update: Improvements to torque map for 425 hp rating.

September 1988

Effective with 8TC6047.

Updates:

1. Elimination of intermittent Diagnostic Code 25, Boost Pressure Sensor Fault, through correction of boost diagnostic change.
2. Fix low idle instability problems with rack brushless torque motor (BTM).

October 1988

Beginning of 1989 model year (emissions same as in 1988), effective with 8TC6561.

Updates:

1. Addition of idle shutdown timer feature.
2. Addition of intermittent (temporary, key ON) fault logging.
3. Improved tampering detection.
4. Improved vehicle speed sensor diagnostics.
5. Improved limp home for throttle position sensor fault.
6. Allow acceleration to high idle when vehicle is out of gear.

April 1989

Personality module serial numbers 10000-Up, effective with 8TC7985.

Update: Fix to correct intermittent shutdowns, communication problems, and inconsistent diagnostic codes.

May 1989

Personality module serial numbers 20000-Up, effective with 8TC8565.

Updates:

1. Enhanced detection of tampering. Engine performance is monitored to detect and permanently log tampering. When tampering has been detected, Diagnostic Code 48 will be logged and engine performance will be inhibited (limited to 1350 rpm in gear) until the diagnostic code is cleared.
2. Addition of permanent fault logging. Diagnostic codes will be logged into permanent memory if they occur after the engine has been running in warm mode at least one minute.
3. Diagnostic lamp actuation with cruise control switches. Momentary push button will no longer operate lamp to flash out diagnostic codes. To read code, switch the cruise control ON/OFF switch to the OFF position. Then hold the SET/RESUME switch in the RESUME position until the code sequence is flashed out. All current faults, and all faults that have been logged since the key was turned ON, will then be flashed out.
4. Autocal software for use with a pedal-mounted throttle position sensor.

5. Rack and timing sensor calibration no longer automatically calibrate boost sensor. Boost sensor must now be calibrated separately.
6. Addition of Diagnostic Code 41, Vehicle Overspeed Warning. Diagnostic Code 41 is logged any time the vehicle speed exceeds the programmed vehicle speed limit by 5 mph for 5 seconds.
7. PEEC will no longer disable cruise control or power take-off operation if a fault code is activated. The only fault codes that will disable cruise control are the vehicle speed fault codes.
8. Diagnostic Code 46, Low Oil Pressure Warning, will not be generated until the engine has been running for at least 10 seconds. Only Diagnostic Code 34, Loss Of Engine Speed Signal, will be "active" with the key turned ON and engine not running.
9. Improved diagnostics for Diagnostic Code 43, Rack Actuator or Sensor Fault.
10. Cold Mode Operation displayed with ECAP service tool.
11. 310 hp Multi-Torque (310 MT CARB) Rating.
12. 350 hp CARB Rating.

July 1989

Personality module serial numbers 30000-Up, effective with 8TC9090.

Update: Addition of chip to personality module circuit board to aid in permanent fault logging strategies.

May 1990

Effective with 8TC13244 and 5YG00392.

1. Acceleration rate limiting above 1500 rpm is eliminated.
2. Engine speed Diagnostic Codes 33, 34, and 35 are now permanently logged.
3. Diagnostic Code 01 (legal override of idle shutdown timer) added. This tattletale increments each time there is an operator override of the idle shutdown timer.
4. Override for Diagnostic Code 31 (loss of Vehicle Speed Fault) added. PEEC will never initiate Diagnostic Code 31 if rpm at vehicle speed limit is set to 3000.
5. Idle shutdown timer improved to reduce the possibility of engine shutdown during light load PTO usage.
6. Improved tampering detection.
7. Fault logging available 10 seconds into warm mode and is less susceptible to electrical voltage spikes from solenoids and relays.
8. 350 hp Multi-Torque (350 MT EPA) rating available.
9. 460 hp NAR rating available.

10. The 350 hp LCV NAR rating has an enhanced performance strategy.

11. Diagnostic Code 34 (loss of engine RPM signal) is no longer active with key on but engine off.

Parts List

The chart lists the new and former serviced parts and their comparable Remanufactured (OR) parts. The engineering change number is also shown after each part number. Current personality modules (shown in the far right column) are adaptable to all previous engines.

When ordering replacement modules, ALWAYS order the remanufactured module ("OR" part number). Ordering the production module will result in unnecessary delays.

Abbreviations used:

CARB-California Air Resources Board.

DDT-Digital Diagnostic Tool.

ECAP-Electronic Control Analyzer Programmer.

EPA-Environmental Protective Agency.

LCV-Low Crevice Volume (piston).

MT-Multi-Torque.

NAR-North American Rating.

PDCC-Power Demand Cruise Control.

SPM-Service Program Module.

Not So Common **Symptoms**

A. Cold Starting Tips

ECN 1/18/94

Cold Starting Tips for 3406C Engines

1. The ECM must see above 100 RPM cranking speed or it will not try to start the engine.

The ECAP must be powered from a separate battery source or it will not function because the batteries of the truck will be too low from cranking.
2. The ECM needs about 6 volts to function, if the batteries are below 6 volts when cranking the ECM will not be able to start the engine.
3. Since the rack servo is an oil driven device, the engine usually will not start until oil pressure begins to build.
4. An oil pan heater is usually a better cold starting aid than a block heater.
5. Switching to 10W30 oil will improve starting considerably in extreme cold.
6. There is a new personality module available that improves cold starting. This module eliminates repeated restarts occasionally required to get a 3406C engine running.
7. This module does NOT reduce white smoke, nor will it help an engine that is not firing. If an engine is not producing any smoke the mechanic should determine whether the rack is advancing.

If the rack is advancing but the engine does not start the fuel may begin gelling.

If the rack is not advancing, the oil pressure may not be building, or the ECM voltage may be too low.

Truck Engine News

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Cold Start Procedures For 3406 (PEEC) Truck Engines

While cold start procedures for PEEC engines are similar to those for mechanical engines, two major differences exist.

First, PEEC often requires a couple more seconds of cranking in order to bring oil pressure high enough to move the rack from the shutoff position. Using an oil with incorrect viscosity can result in longer cranking time.

Second, when a PEEC engine is first started, PEEC goes through a cold start sequence to provide the correct warm-up time. If during this sequence PEEC determines the engine is cold, PEEC will increase low idle to 900 to 1000 rpm (to decrease warm-up time), limit engine speed to around 1700 rpm, inhibit timing advance, and limit power significantly

(to less than 200 hp). This "cold mode" operation will continue until either; the engine is warm, 15 minutes expires, or vehicle speed exceeds 30 mph.

Note that PEEC goes through this sequence whenever the engine is started, regardless of outdoor temperature. In warm weather, the cold start sequence will take only about ten seconds. If a driver steps on the throttle before the sequence is complete, PEEC cautiously assumes "cold mode", and continues to limit power. Full power will not be restored until the driver's foot remains off the throttle for at least three seconds.

Knowledge of this cold start sequence can help in troubleshooting intermittent electrical power problems. If electrical power to PEEC is momentarily interrupted, PEEC again assumes "cold mode" until it can complete the cold start sequence. Both power and rpm will then be limited until the driver again leaves his foot off the throttle for at least three seconds, and PEEC completes its cold mode check (about another 7 seconds). If vehicle speed is above 30 mph, however, PEEC assumes that the engine is warm and that electrical power was just momentarily interrupted, so operation continues as normal.

B. Can't Program Parameters or Boost Sensor/Fault Code 48

ECN 2/10/95

Can't Program PEEC II Systems and Pin Functions

One of the more frequent phone calls received at the factory is about programming the 8TC with ECAP. Factory passwords won't work or the boost won't calibrate.

We have found this happens most commonly with the 8TC, 2EK, and 5YG engines. These engines all use the PEEC II ECM. The PEEC II ECM was the only ECM to have a "Program" pin. Pin F on J1/P1 (Where the Service Tool is teed in).

If you are experiencing these symptoms here are some things to check:

1. Try using another service tool cable. (8T5275 for older ECAP with the plastic connector, or 7X1412 for newer ECAP with the metal connector) Since the only ECM's to use this line the cable are the older engines you may not have noticed if the wires were broken.
2. Check the J1/P1 connection. Pin F may have backed out of the connector housing.
3. Remove Pin F from the J1 side (nearest to the ECM). Then ground the removed pin. This should be the same ground as Pin B of J2/P2. While Pin F is grounded, try programming the ECM again. When finished re-install Pin F into J1.

Additional troubleshooting:

- Communication Adapter II (CA2) does not support Pin F of J1 on PEEC II engines.
- Pin F needs to be tied to ground when programming parameters or calibrating boost
- ECAP and CA1 automatically take care of this
- When using CA2, you will need to ground this pin manually.
- There have been cases when CA1 and ET also need Pin F manually grounded.

Fault Code 48

- Signifies driver tampering
- 12 Volts to rack BTM motor causes full rack travel
- Once logged engine speed is limited to 1350 RPM (except when 12 volts is applied)
- Fault requires passwords to clear (1350 RPM active until fault cleared)

C. Repeated Shutoff Solenoid & ECM Failures

Repeated shutoff solenoid failures have been reported after a new key switch is installed.

The ECM requires a “crank” line input, which is tied to battery during cranking. This line is applied directly to the shutoff solenoid during cranking (briefly) to insure the solenoid moves out of the way to allow the rack to move and the engine to start.

After the key is released, the “crank” line to the ECM should go open circuit and the ECM uses a driver to continue to hold the solenoid out of the way.

If the “crank” line is tied to the “run” position of the keyswitch, the shutoff solenoid will see battery voltage all the time (not just during cranking). This will result in the shutoff solenoid melting down and failing. In some cases the ECM fails as well.

Ensure that the “crank” line input is NOT tied to the “run” position of the keyswitch.

Extended Service **Coverage**

Caterpillar Announces Protection Plan

Covers 3406C Truck Engines equipped with Programmable Electronic Engine Controls

Electronically controlled Cat 3406C Truck Engines with serial number prefix of 4CK are eligible for and Extended Service Coverage Program which guarantees timing advance units and certain electronic components for 2 years/200,000 miles. This protection plan is available for engines having less than 650,000 miles. The program is available at a cost of \$500. Customers are required to take their Cat powered vehicle to an authorized full-service outlet to participate in this plan.

For complete details on this program, users should contact the nearest Caterpillar authorized full-service dealer location.

Latest PEEC Part **Numbers**

3406C (4CK) Current Parts

- ECM = 9X8085/0R6486
- Transducer Module = 1324363
- Speed Sensor = 1006619
- Rack Sensor = 9X7793
- Timing Sensor = 1294501
- BTM = 1052939
- Coolant Temperature Sensor = 1022240
- Pedal Mounted Throttle Position Sensor = 1108190
- Remote Mounted Oil Pressure Sensor Kit = 1186256
- Vehicle Speed Buffer = 3E0020 (also for PEEC II)

3406 PEEC II.V (8TC and 2EK) Current Parts – FORD Only

- ECM = 9X4840/0R6081
- Transducer Module = 1324363
- Speed Sensor = 1006619
- Rack Sensor = 9X7793
- Timing Sensor = 1294501
- BTM = 1052939
- Throttle Position Sensor
 - Remote Mounted “Beer Can” Sensor = 9X9648
 - Pedal Mounted Throttle Position Sensor = 1108190
- Remote Mounted Oil Pressure Sensor Kit = 1221649
- If the engine (2EK and 5YG) has had the white smoke product support program performed, the following parts will be installed:
 - Wiring Harness = 6I2382
 - Temperature Sensor = 9X5370

3406 PEEC II (8TC, 5YG, and 2EK) Current Parts

- ECM = 8T8770/0R5607
- Transducer Module = 1324363
- Speed Sensor = 1006620
- Rack Sensor = 9X7793
- Timing Sensor = 1294501
- BTM = 1052939
- Throttle Position Sensor
 - Remote Mounted "Beer Can" Sensor = 9X9647
 - Pedal Mounted Throttle Position Sensor = 1108190
- Remote Mounted Oil Pressure Sensor Kit = 1221649
- If the engine (2EK and 5YG) has had the white smoke product support program performed, the following parts will be installed:
 - Wiring Harness = 6I2382
 - Temperature Sensor = 9X5370