





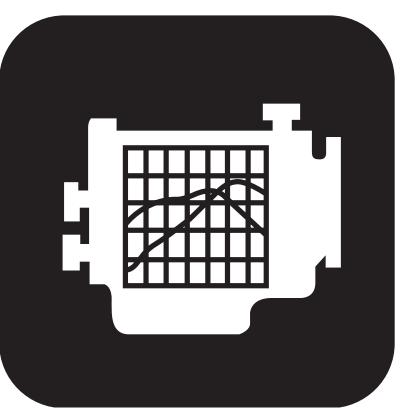








Diesel Engine Performance Diagnosis



51 - Diesel Engine Performance

Student Guide



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June, 2006

Service Technician Specialty Training



Ford Customer Service Division Technical Training

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IMPORTANT SAFETY NOTICE

Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all motor vehicles, as well as the personal safety of the individual doing the work. This manual provides general directions for accomplishing service and repair work with tested, effective techniques. Following them will help assure reliability.

There are numerous variations in procedures, techniques, tools and parts for servicing vehicles, as well as in the skill of the individual doing the work. This manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Accordingly, anyone who departs from instructions provided in this manual must first establish that he compromises neither his personal safety nor the vehicle integrity by his choice of methods, tools or parts.

As you read through the procedures, you will come across NOTES, CAUTIONS, and WARNINGS. Each one is there for a specific purpose. NOTES give you added information that will help you to complete a particular procedure. CAUTIONS are given to prevent you from making an error that could damage the vehicle. WARNINGS remind you to be especially careful in those areas where carelessness can cause personal injury. The following list contains some general WARNINGS that you should follow when you work on a vehicle.

- Always wear safety glasses for eye protection.
- △ Use safety stands whenever a procedure requires you to be under the vehicle.
- A Be sure that the ignition switch is always in the OFF position, unless otherwise required by the procedure.
- ▲ Set the parking brake when working on the vehicle. If you have an automatic transmission, set it in PARK unless instructed otherwise for a specific service operation. If you have a manual transmission it should be in REVERSE (engine OFF) or NEUTRAL (engine ON) unless instructed otherwise for a specific service operation.
- △ Operate the engine only in a well-ventilated area to avoid the danger of carbon monoxide.
- A Keep yourself and your clothing away from moving parts when the engine is running, especially the fan and belts.

- To help prevent serious burns, avoid contact with hot metal parts such as the radiator, exhaust manifold, tail pipe, catalytic converter and muffler.
- \triangle Do not smoke while working on the vehicle.
- ⚠ To help avoid injury, always remove rings, watches, loose hanging jewelry, and loose clothing before beginning to work on a vehicle. Tie long hair securely behind your head.
- ☆ Keep hands and other objects clear of the radiator fan blades. Electric cooling fans can start to operate at any time by an increase in underhood temperatures, even though the ignition is in the OFF position. Therefore, care should be taken to ensure that the electric cooling fan is completely disconnected when working under the hood.

The recommendations and suggestions contained in this manual are made to assist the dealer in improving his dealership parts and/or service department operations. These recommendations and suggestions do not supersede or override the provisions of the Warranty and Policy Manual, and in any cases where there may be a conflict, the provisions of the Warranty and Policy Manual shall govern.

The descriptions, testing procedures, and specifications in this handbook were in effect at the time the handbook was approved for printing. Ford Motor Company reserves the right to discontinue models at any time, or change specifications, design, or testing procedures without notice and without incurring obligation. Any reference to brand names in this manual is intended merely as an example of the types of tools, lubricants, materials, etc. recommended for use. Equivalents, if available, may be used. The right is reserved to make changes at any time without notice.

DANGER: Exposure to potentially hazardous components may occur if dusts are created during repair of friction components, such as brake pads and clutch discs. Exposure to excessive amounts of dust may be a potential cancer and lung disease hazard. Exposure may also cause irritation to skin, eyes, and respiratory tract, may cause allergic reactions, and/or may lead to other chronic health effects.

Do not breathe dust. Do not use compressed air to blow dust from storage containers or friction components. A high-efficiency (HEPA) vacuum cleaner should be used carefully to remove dust. Adherent dust should be removed with a damp rag.

If inhaled, remove to fresh air. If irritation persists, seek medical attention or advice.

If dust gets in eyes, irrigate under eyelids with water for 15 minutes and seek medical attention.

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Customer Expectations: Service

- **1.** Make it convenient to have my vehicle serviced at your dealership.
- **2.** The Service Advisor should demonstrate a genuine concern for my service needs.
- **3.** Fix it right the first time, on time.
- **4.** Complete servicing my vehicle in a timely and professional manner.

- **5.** Provide me with a clear and thorough explanation of the service performed.
- **6.** Call me within a reasonable amount of time after my service visit to ensure that I'm completely satisfied.
- **7.** Be responsive to questions or concerns that I bring to your attention.

Expectation #3

"Fix It Right the First Time, on Time."

Both service advisors and technicians are important players when it comes to Expectation #3.

Why

Customers tell us "Fixing It Right the First Time, on Time" is one of the reasons they would decide to return to a dealer to buy a vehicle and get their vehicles serviced.

Technician Training

It is our goal to help the technician acquire all of the skills and knowledge necessary to "Fix it Right the First Time, on Time." We refer to this as "competency."

Technician's Role

Acquire the skills and knowledge for competency in your specialty via:

<u>STST</u>

New Model

- Web-Based — Instructor Led —
 - Web-Based
 - _ea
- Instructor Led

The Benefits

The successful implementation of expectations means:

- Satisfied customers
- Repeat vehicle sales
- Repeat service sales
- Recognition that Ford and Lincoln/Mercury technicians are "the Best in the Business"

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INTRODUCTION

FORD DIESEL ENGINE PERFORMANCE DIAGNOSIS

Course Description



6.0L PowerStroke® Diesel Engine

This is the only instructor-led course in the Diesel Engine Performance curriculum. It is a four-day course facilitated by an instructor. This course is designed to provide hands-on opportunities for technicians to learn and improve their skills using tools and equipment, and to apply knowledge learned in previous curriculum courses. Each day, you will have multiple opportunities to practice selected skills. The results of your work are recorded on worksheets.

Worksheets

All classroom and hands-on activities are guided by worksheets. When you are assigned to one of four workstations, you will be given 30 to 45 minutes to complete the tasks and questions required by the worksheet for that workstation. Every 30 to 45 minutes, you will move to another workstation and complete another worksheet until all four worksheets are complete.

Course Requirements

Each technician attending this course will be required to pass a combination of hands-on and written evaluations. These will be administered after Lesson 4.

- The hands-on evaluation is a pass/fail type. It will be conducted with exercises in diesel engine performance diagnosis, and will cover:
 - diesel performance system diagnosis
 - service publication navigation
 - selected special tool usage

In order to pass the course, you must demonstrate mastery of the skills covered at the evaluated hands-on exercise AND you must answer at least 80% of the written post-test questions correctly.

Course Objectives

Upon successful completion of this course, you will be able to:

- Diagnose selected coded, non-coded and intermittent 6.0L PowerStroke[®] diesel engine performance concerns.
- Set up a PID list, record PIDs and review/analyze PID data related to 6.0L PowerStroke[®] diesel engine performance concerns.
- Perform tests to verify and pinpoint air leaks, pre-turbo exhaust leaks, fuel leaks, high-pressure oil leaks and combustion leaks into the fuel system on a 6.0L PowerStroke[®] diesel engine.
- Service the high-pressure oil system and fuel injectors by disassembly and assembly of the top-end of a 6.0L PowerStroke[®] diesel engine.
- Perform visual inspections and selected tests on various components to verify failures.

Course Agenda

LESSON ONE:

Introductions, Prerequisite Review, Lesson 1 Workstations (Service Publications Navigation, On-Vehicle, PID Data Analysis and Engine Stand)

LESSON TWO:

Lesson 1 Workstation Reviews, Lesson 2 Workstations (PID Data Analysis, On-Vehicle, CMT and Engine Stand)

LESSON THREE:

Lesson 2 Workstation Reviews, Lesson 3 Workstations (PID Data Analysis [2], On-Vehicle and Engine Stand)

LESSON FOUR:

Lesson 3 Workstation Reviews, Lesson 4 Workstations (PID Data Analysis, On-Vehicle, CMT and Engine Stand), Final Review, Post-Test

NOTES:

PREREQUISITE REVIEW

DIRECTIONS: Answer the following diesel engine performance questions. These will be reviewed in class.

1. What three basic elements are required for a diesel engine to start?

2. What are some characteristics essential to diesel fuel?

- 3. What is the function of glow plugs?
 - A. To heat the air in the intake tube.
 - B. To heat the engine coolant.
 - C. To ignite the air/fuel mixture.
 - D. To heat the air in the combustion chambers.

4. What causes the sound that is characteristic of diesel engines?

- 5. Why does a diesel engine produce more torque than a gasoline engine?
 - A. Diesel fuel burns hotter than gasoline.
 - B. Diesel fuel burns throughout most of the power stroke.
 - C. The piston travels farther in a diesel engine.
 - D. Diesel engines have a larger cubic inch displacement.
- 6. Where is the fuel heater located (if equipped)? Why is a fuel heater used on some diesel applications?

7.	Where is the fuel	pressure regulator	r located on a 6.0	L PowerStroke®	diesel engine?
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8. What causes excessive white smoke from the exhaust?

9. What causes excessive black smoke from the exhaust?

10. How can engine maintenance affect engine performance?

11. What type of sensor is the crankshaft position (CKP) sensor and how is its signal used?

12. What two modules work together to control fuel delivery on a 6.0L PowerStroke[®] diesel engine? How do these two modules work together on this engine?

13. What is the function of the Charge Air Cooler (CAC)?

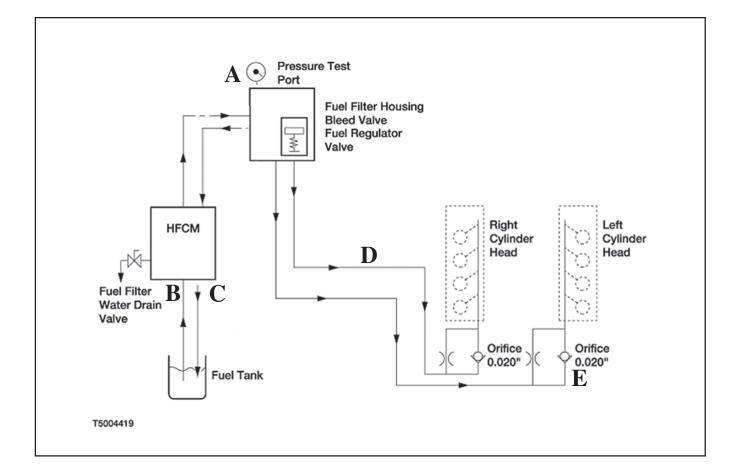
- A. To lower the temperature of incoming air charge before it enters the cylinders.
- B. To lower the temperature of the exhaust before it enters the catalytic converter.
- C. To lower the temperature of the exhaust before it enters the turbocharger.
- D. None of the above.

14. How is the high pressure oil system controlled?

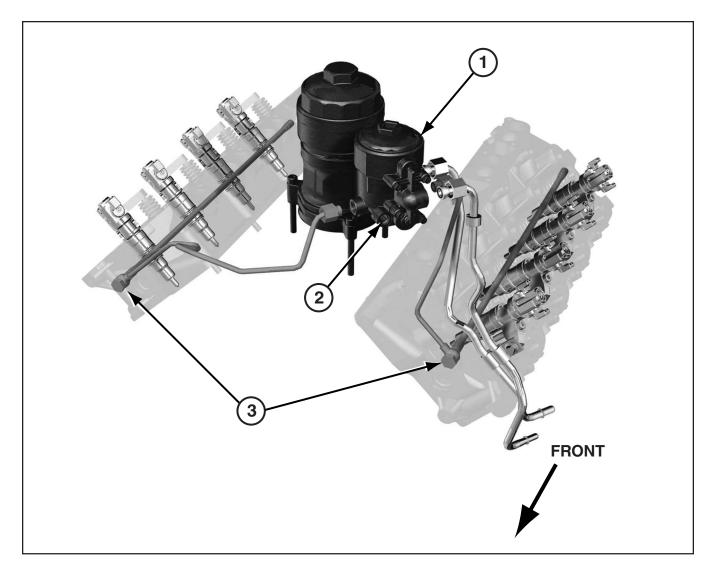
15. What are some unique features and benefits of the Variable Geometry Turbocharger (VGT) used on 6.0L PowerStroke[®] diesel engines?

16. How is exhaust backpressure controlled on a 6.0L PowerStroke® diesel engine?

17. What are the components of the Exhaust Gas Recirculation (EGR) system?



- 18. Where would fuel pressure be tested in the diagram above?
- 19. When would you check for a fuel inlet restriction?
- 20. At what point in the above diagram would you check for a fuel inlet restriction?

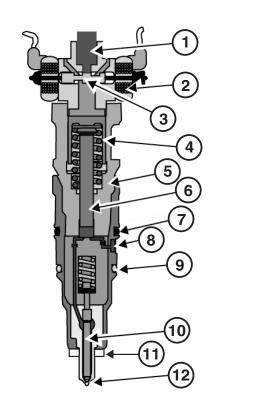


ltem	Description	ltem	Description	ltem	Description
1	Secondary Fuel Filter	2	Fuel Pressure Test Port	3	Banjo Bolts

21. What important components are located in the banjo bolts at the fuel rails?

FUEL INJECTION

Fuel Injectors



Hydraulic Electronic Unit Injector (HEUI)

ltem	Description	ltem	Description	ltem	Description
1	Oil from Rail	5	Barrel	9	External O-Ring
2	Coils	6	Plunger	10	Needle Valve
3	Spool Valve	7	External O-Ring	11	Copper Washer
4	Intensifier Piston	8	Fuel Inlet	12	Nozzle

- Hydraulic Electronic Unit Injectors (HEUI) are actuated by high-pressure engine oil that enters each injector from the top.
- The injector uses two Fuel Injector Control Module (FICM) controlled 48-volt, 20-amp coils to control a spool valve that directs oil flow in and out of the injector.
- Low fuel pressure destroys injectors.
 - Proper fuel pressure provides lubricity and a cushioning effect (along with spring).
 - Low fuel pressure also causes PCM to increase Injection Pressure Regulator (IPR) duty cycle, which increases Injection Control Pressure (ICP) and forces injector plunger farther down than normal.

Injector Coils

• There is an OPEN coil and a CLOSE coil that move the spool valve from side to side using magnetic force.

Spool Valve

- The spool valve has two positions.
- When the valve is in the open position, oil is allowed to flow from the high pressure oil rail to the injector.
- When the valve is in the closed position, oil is allowed to drain from the injector back to the crankcase.
- Total movement of the valve is only 0.017 inch.

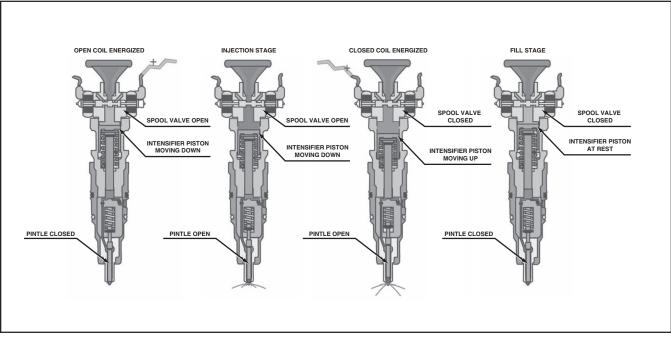
Intensifier Piston

- When the spool value is in the OPEN position, high pressure oil enters the injector and pushes down the intensifier piston and plunger.
- Since the intensifier piston is seven times greater in surface area than the plunger, the injection force is seven times greater at the plunger than the ICP.

O-Rings

- Two replaceable o-rings on the outside of the body.
- One non-replaceable internal D-ring in the top of the injector.
- One replaceable copper combustion gasket on the tip of the injector.
- Replace both O-rings and copper gasket any time an injector is removed and reinstalled. Torque the injector hold-down bolt as follows:
 - 2005 and earlier models (T-40 Torx bolt): 33 N•m (24 lb-ft).
 - 2006 models (T-45 Torx bolt): 35 N•m (26 lb-ft).

Hydraulic Electronic Unit Injector (HEUI) Operation



HEUI Injector Operation

Plunger and Barrel

- The bottom of the plunger and barrel is where the fuel injection pressure is built.
- When the plunger is pushed downward by the intensifier piston, the fuel pressure in the barrel is increased to seven times the ICP.
- Prior to 2004.25, the plunger was coated with a tungsten carbide coating to reduce the possibility of scuffing and poor performance.
- From 2004.25 on, the plunger has been coated with a Diamond Like Carbon (DLC) coating.
- This coating further protects the injector against poor fuel quality/water intrusion and the risk of internal scuffing.
- **Note:** The DLC coated injector has different operating characteristics and CANNOT be interchanged with non-DLC injectors. Installing the incorrect injector may cause erratic or rough engine operation.

Injection Nozzle

- The injection nozzle needle is an inwardly opening type. It lifts off its seat when fuel pressure overcomes the Valve Opening Pressure (VOP) of approximately 21,374 kPa (3100 psi) for 2003 models or 18,616 kPa (2700 psi) for 2004.25 and later models.
- Fuel is atomized at high pressure through the nozzle tip.

Three Stages of Injection

- Fill Cycle
- Main Injection (2 steps)
- End of Main Injection (2 steps)

Fill Cycle

- During the fill stage, the spool valve is in the closed position.
- High pressure oil from the oil rail is dead headed at the spool valve.
- Low pressure fuel fills the port below the plunger.
- The needle control spring holds the needle on its seat so fuel cannot enter the combustion chamber.

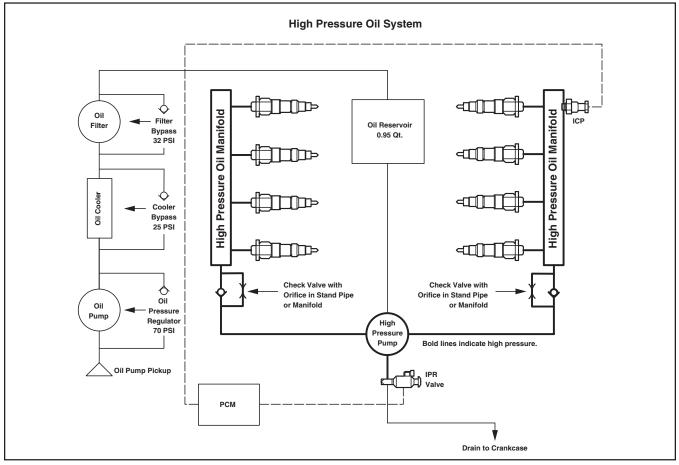
Main Injection

- Pulse-width controlled current energizes the OPEN coil and magnetic force moves the spool valve to the open position.
- High pressure oil flows past the spool valve into the intensifier piston chamber.
- Oil pressure overcomes the intensifier piston spring force and the intensifier starts to move.
- The fuel inlet check ball seats due to an increase of fuel pressure under the plunger.
- Fuel pressure starts to build.
- Force on the nozzle needle begins to build.
- When fuel pressure rises above the VOP, the nozzle needle lifts off its seat and injection begins.

End of Main Injection

- When the FICM determines that the correct injector ON time has been reached (the correct amount of fuel has been delivered), it sends a pulse-width controlled current to the CLOSE coil of the injector.
- The current energizes the CLOSE coil and magnetic force pulls the spool valve to the closed position.
- High pressure oil is dead headed against the spool valve.
- Oil above the intensifier piston flows past the spool valve through the drain ports.
- As pressure is released, the intensifier piston and plunger begin to return to their initial position.
- Fuel pressure decreases until the nozzle needle control spring forces the needle back onto its seat.

HIGH PRESSURE OIL SYSTEM

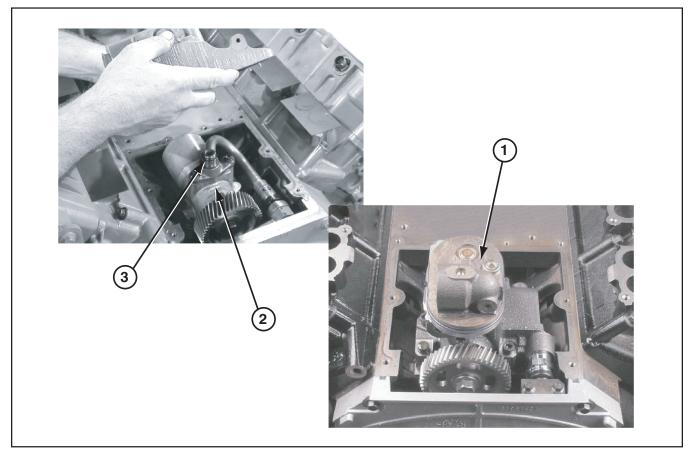


High-Pressure Oil Flow

The high-pressure oil flow is detailed below.

- 1. Crankcase oil is pumped by the lube oil pump through the oil cooler.
- 2. Engine oil then flows through the oil filter.
- 3. Oil fills the high-pressure pump reservoir.
- 4. The oil flows through the screen at the bottom of the reservoir to the high-pressure pump.
- 5. The high-pressure pump pushes oil through the lines.
- 6. Excessive pressure is drained back to the crankcase by the IPR valve. The IPR valve also contains the relief valve for the high-pressure oil system.
- 7. Oil passes the check valves and into the high-pressure oil manifolds.
- 8. The high-pressure oil is used by the injectors to deliver fuel. The oil used by the fuel injectors returns to the crankcase.
- 9. The PCM uses the ICP sensor input to determine injection control pressure. (Location is model specific.)

High Pressure Pump



High-Pressure Oil Pumps

lte	m Description	ltem	Description	ltem	Description
1	Sheppard High Pressure Pump (2005)	2	Rexroth High Pressure Pump (2003.25)	3	O-Ring Seal for IPR

All 6.0L PowerStroke® diesel engine models use a high pressure pump to provide the high pressure oil that actuates fuel injectors.

- Pump location is similar on all models. Cover and tubing changes have been made.
- The early style high-pressure pump is a seven-piston, swash plate-style pump that is driven off the rear gear train.
- The later style high pressure pump is a four-piston design. The pistons are moved by a cam inside the pump.
- The O-ring on top of the high pressure pump should be replaced whenever the cover is removed.

Injector Pressure Regulator (IPR) Valve

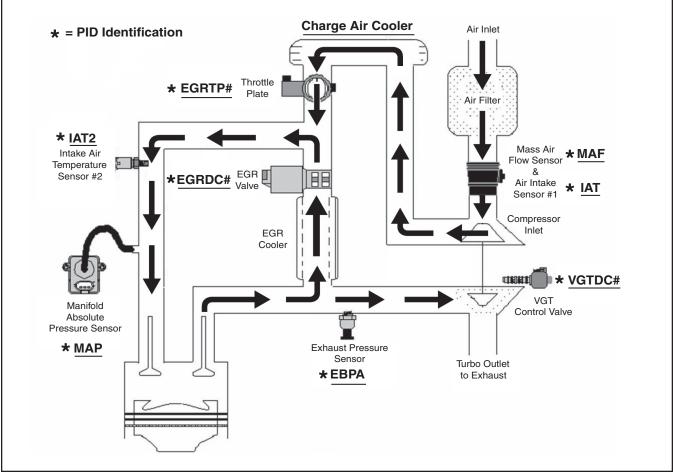


Injection Pressure Regulator (IPR) Valve (2005 Shown)

The IPR valve is a duty-cycle controlled valve used by the PCM to control high-pressure oil.

- The IPR is supplied with battery voltage and a duty cycle-controlled ground from the PCM.
 - The IPR valve blocks the path to drain for oil coming out from the high-pressure pump.
 - As the duty cycle signal increases at the IPR the restriction to drain also increases, raising the ICP.
 - As the duty cycle signal decreases, the injection control pressure decreases.
 - When the valve is disconnected, it is open or in its drain state. In this position, the engine will not start and ICP will be approximately 250 psi.
- The 2005 IPR includes an improved screen and can be easily identified by the "peace sign" plastic holding the screen to the end of the IPR.
 - The improved screen removes particulates larger than 150 microns.
 - The 2003 through 2004.25 screen removed particulates larger than 200 microns.

AIR MANAGEMENT SYSTEM



Air Management System Flow

The air management system is made up of the air filter, Variable Geometry Turbocharger (VGT), charge air cooler (CAC), intake manifold, catalytic converter and the Exhaust Gas Recirculation (EGR) system.

Air Management System Flow

- Air enters the system through the air filter where particles are removed from the air. The air filter has a filter minder on it to warn the operator of a restricted air filter.
- After the air is filtered, the amount of air and temperature is measured by the Mass Air Flow (MAF) sensor.

Note: The MAF sensor is not used on all model year vehicles.

- The filtered air is then directed past the crankcase ventilation system where crankcase vapors and fresh air are mixed.
- After mixing with crankcase vapors, the fresh air mixture is drawn into the turbocharger compressor where it is compressed and sent to the CAC.
- The CAC condenses the air by cooling it, then the air returns to the engine through the intake manifold.
- There is an active throttle body and plate on the intake manifold for 2004.25 model year ONLY.
- The intake manifold directs the air to the intake ports of the cylinder heads.
- The burned air fuel mixture is pushed out of the cylinder into the exhaust manifold which collects the exhaust gases and routes them to the turbocharger turbine wheel.

- The exhaust up pipe, connected to the right side exhaust manifold, has a passage that connects it to the EGR cooler.
- The exhaust gasses, cooled by the EGR cooler, are sent to the EGR valve in the intake manifold.
- The EGR valve controls the flow of exhaust gasses into the intake system where the gasses are mixed with intake air to reduce Nitrogen Oxide (NOx) emissions and noise.
- The hot and expanding exhaust gases that are routed to the turbocharger turbine spin the turbine wheel through flow and expansion. The spinning turbine wheel in turn spins the compressor wheel via a common shaft.
- Exhaust gasses are routed through the catalytic converter, muffler and out the tail pipe.

Air Filter/Filter Minder

- The air filter is located on the left side of the engine compartment between the battery and the radiator.
- A filter minder (device used to measure filter restriction) in located on the back of the air filter housing.

AIR MANAGEMENT INPUTS

Exhaust Pressure (EP) Sensor

• The PCM uses the EP sensor to monitor exhaust backpressure, which is used to control the VGT solenoid.

Note: The PID for the EP sensor in WDS/IDS is "EBP."

Mass Air Flow (MAF) Sensor (Not Used on 2005 Federal Emissions Vehicles)

• The MAF sensor internal circuitry produces an analog voltage signal that is proportional to air mass. The PCM receives this signal and uses it primarily to control EGR valve operation.

Intake Air Temperature (IAT) Sensor

• The PCM uses the input from the primary IAT sensor to monitor ambient air temperature and determine when to close the VGT vanes to increase exhaust pressure. On vehicles equipped with a MAF sensor, the IAT sensor is integrated into the MAF sensor assembly.

Intake Air Temperature 2 (IAT2) Sensor

- The IAT2 on the 6.0L PowerStroke[®] diesel engine monitors air temperature at the intake manifold.
- The PCM uses the IAT2 signal to measure manifold air temperature to help determine the proper fuel delivery.

Manifold Absolute Pressure (MAP) Sensor

- The PCM monitors the map signal to determine the intake manifold pressure (boost). This information is used to control the fuel rate and injection timing.
- The MAP sensor is located on the right side of the engine compartment, above the A/C evaporator housing.

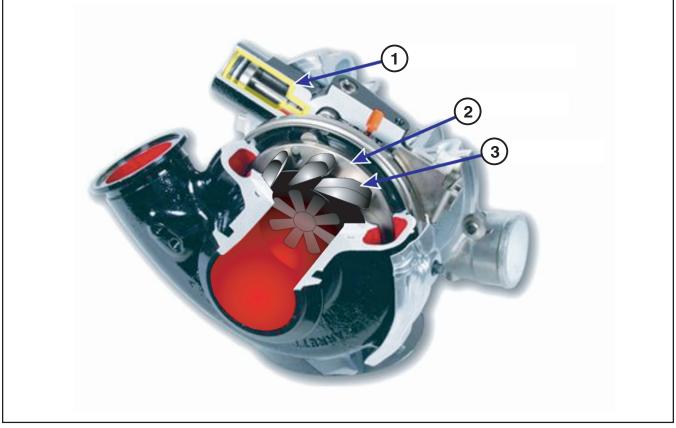
Barometric Pressure (BP) Sensor

• The primary function of the BP sensor is to provide altitude data so the PCM can adjust timing, fuel quantity, glow plug on time, and VGT control.

Note: The PID for the BP sensor in WDS/IDS is "BARO."

AIR MANAGEMENT OUTPUTS

Turbocharger System



Variable Geometry Turbocharger (VGT)

ltem	Description	Item	Description	ltem	Description
1	Piston and Rod Actuator	2	Unison Ring	3	Turbocharger Vanes

- The PCM uses driver demand, RPM, load and Exhaust Pressure (EP) sensor information to adjust VGT vane position.
- During cold start conditions, the PCM commands a high duty cycle to the VGT solenoid. This forces the vanes closed to create more backpressure, warming the engine faster.
- Duty cycle is constantly changing as operating conditions change.
- The actuator adjusts the vanes open to prevent turbocharger over-speed and increase component durability.
- The VGT adjusts to achieve a desired backpressure.

Exhaust Gas Recirculation (EGR) System

The 6.0L PowerStroke[®] diesel engine uses an EGR system.

- The EGR system allows a controlled amount of exhaust gasses to be routed back into the combustion chamber with intake air for the purpose of lowering combustion temperatures.
- Lower combustion temperatures reduce NOx emissions and noise.
- EGR system operation is controlled electronically by the PCM.
- During certain operating conditions, the PCM opens the EGR valve to allow cooled exhaust gases to flow into the intake manifold.

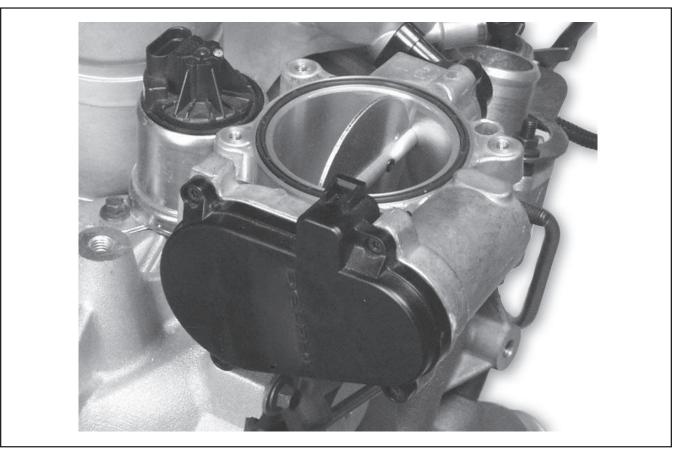
EGR Valve



Exhaust Gas Recirculation (EGR) Valve

- The EGR valve receives a duty cycle signal from the PCM and sends a variable voltage signal back to the PCM to indicate actual position.
- The EGR valve has two valves connected by a common shaft.
 - Cooled exhaust gases come to the center of the valve through a passage in the intake manifold.
 - When the valve is opened, it allows exhaust gases to evenly flow into the intake air stream from the top and bottom of the passage.
- With the EGR valve open, IAT2 temperature increases. Even with an EGR cooler, IAT2 slowly increases the longer the EGR valve is open.

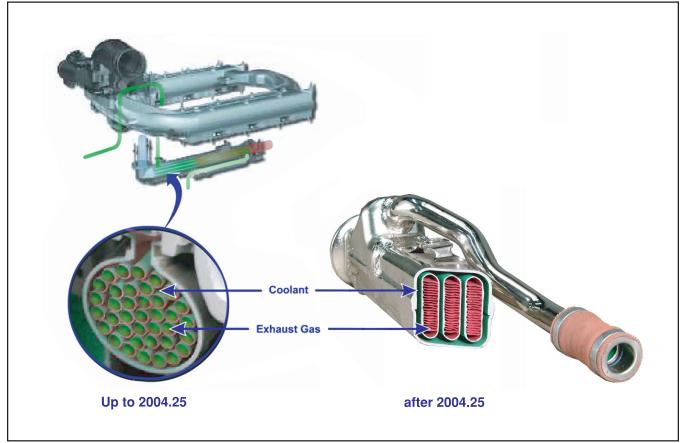
EGR Throttle Plate



EGR Throttle Plate

- The EGR system on the 6.0L PowerStroke[®] diesel engine uses a throttle body (some have a throttle plate).
 - An active throttle plate is only used on 2004.25 model year vehicles.
- The purpose of the throttle body assembly is to improve the flow of EGR gases to the intake manifold by lowering intake manifold pressure during EGR events.
- The throttle body houses a throttle plate, an actuator and position sensor.
- The PCM commands the actuator to reposition the throttle plate to modify intake manifold pressure and allow better EGR gas flow.
- The position sensor provides throttle plate position data to the PCM.
- When the ignition key is cycled and the ambient temperature is above 0°C (32°F), the PCM performs a self-test of the throttle plate and actuator.
 - The PCM commands the actuator to move the throttle plate once through its entire range of motion while monitoring position sensor feedback.
- The exhaust up-pipe in 2005 and later model year vehicles has a scoop to increase EGR flow, so the throttle plate was no longer required. In addition, intake manifold divider plates are used to help provide equal flow into both cylinder heads.

EGR Cooler



EGR Cooler

- The EGR system on the 6.0L PowerStroke® diesel engine uses an EGR cooler to lower the temperature of exhaust gasses before they are blended with intake air.
- The cooler is an air-to-liquid heat exchanger mounted to the engine under the intake manifold.
- The exhaust gas flows through several small tubes contained within the cooler housing.
- Engine coolant is also routed through the cooler housing.
- The exhaust gases are cooled when heat is transferred from the gas to the tubes, then into the surrounding engine coolant.
- Depending on conditions, the temperature drop across the cooler could be as much as 371°C (700°F).
- The cooled exhaust gases are then routed to the intake manifold through EGR valve.
- IAT2 slowly increases when the EGR valve is open.

EGR System PID Data



EGR Activity at Idle, Cruise and WOT (2004.25 Engine Shown)

- EGR may flow at idle to quiet the engine.
- The EGR Throttle Plate (EGRTP), if equipped, is not connected to the accelerator pedal.

LESSON ONE WORKSTATIONS

Workstation: Summary:

- 1 Service Publications navigation activity, in which students will navigate various Service Publications to answer the questions in the worksheet.
- 2 Hands-on activity at vehicle that requires students to use WDS to select PIDs, record and save a PID data session, and review the session to answer the questions in the worksheet. Students are not looking for a "bug" in this activity.
- 3 "Paper and pencil" activity in which students will analyze PID data in several WDS screenprints, and relate the readings in these prints to normal operation on the 6.0L PowerStroke[®] diesel engine.
- 4 Hands-on activity at the 6.0L PowerStroke[®] diesel engine on the stand. In this activity, students will disassemble and assemble the components necessary to access the high pressure oil pump.

WORKSTATION 1 SERVICE PUBLICATIONS NAVIGATION

DIRECTIONS: Complete Workstation 1 at the PC workstation, using the service publication files on the course CD-ROM.

SUMMARY: You are diagnosing a "No Start/Normal Crank" condition on a 2005 F-250 6.0L-equipped vehicle. You are looking for the Quick Test in the 2005 6.0L Diesel Powertrain Control/Emissions Diagnosis (PC/ED) manual.

- 1. In what section do you find the Quick Test Description?
- 2. According to the Quick Test Description, list the five specialized tests Quick Test is divided into:

- 3. Where do you start the actual Quick Test (QT) Steps?
- 4. List some of the preliminary checks and inspections you must perform before retrieving DTCs.

LESSON ONE 5. After properly preparing the vehicle for a Quick Test, you carry out the PCM Quick Test. If DTCs are present, go to:____ If no DTCs are present, go to: _____ 6. List the Diagnostic Pinpoint Tests and description associated with the following DTCs: P0336: P2623: U0105: P2288: 7. Assume you got a reading of 800 ohms in Pinpoint Test Step D3. What have you just verified? 8. What are the possible circuit failures that could trigger DTC P0336? 9. Your diagnosis of a Hard Start/No Start concern takes you to Section 4 of the PC/ED manual. What are you directed to test in the following steps? 10a:____ 10b/10c: 10d: _____ 10e: _____ 10f: 10g: _____ 10h: 10. What additional PID should be selected for "e" and "f"? 11. While in Step 10d above, you receive a zero (0) value. What step(s) are you directed to do next?

- 12. In what service publication would you find the Turbocharger Performance Test?
- 13. Where would you find Turbocharger Component Tests, such as the bearing clearance check?

What other turbocharger tests are available in this location?

- 14. Locate the Electronic Engine Controls diagram in the 2005 F-Super Duty Wiring Diagrams manual. On what cell does this diagram start?
- 15. What connector identification is used for the MAF sensor?
- 16. What components would be affected if the wire for CKT 570 was open between S106 and G101?

Note: Close all service publications before leaving this workstation.

ON-VEHICLE PID SELECTION, RECORDING AND ANALYSIS USING WDS/IDS

DIRECTIONS: Complete Workstation 2 at the VEHICLE workstation, following the steps on this worksheet.

SUMMARY: This activity allows you to select and view various 6.0L PowerStroke[®] diesel performance parameters under "normal" conditions. You are not diagnosing a customer concern in this activity.

Perform the following steps:

- 1. Perform all preliminary set up tasks for vehicle safety. (Block wheels, transmission in Park, set park brake.)
- Connect the WDS.
- Establish WDS session.
- Perform KOEO Self-Test and record any DTCs. Exit Self-Test when finished.
- Select Datalogger function. Select "Powertrain," then select "Engine."
- Press Erasure button.
- Select the PIDs listed on the next page and press "Save Parameter and Display Settings."
- View PID list and fill in KOEO values on the next page.
- Push Record button and start engine. This will give 15 seconds before the start event and 15 seconds after the start event of recording time.
- View PID list and fill in KOER values on the next page.
- Shut off engine.
- Name the file (Your name).
- Name description (i.e.: Normal_1, LowPower_2)
- Review recording and compare to written list.

WORKSTATION 2

	KOEO	KOER		KOEO	KOER
APP %			FUELPW		
B+			IAT (deg. F)		
BARO (psi)			IAT2 (deg. F)		
DTCCNT			ICP (psi)		
EBP (volt)			ICP (volts)		
EBP_A			ICP_DES		
EBP_DSD			INJ_TIM (degrees angle)		
EBP_G (psi)			IPR#		
ECT (deg. F)			LOAD		
EGRDC#			MAF (Num)		
EGRTP#			MAP (psi)		
EGRTP_V			MFDES		
EGRVP			MGP (psi)		
EOT (deg. F)			RPM#		
FICM_LPWR			SYNC		
FICM_MPWR			VGTDC#		
FICM_VPWR			VPWR		
FICMSYNC			VREF		
			VSS		

• Start engine and select live display.

2. Disconnect the ICP sensor. What happens to ICP PID values (ICP, ICPV, ICP DES)?

- 3. Why does the ICP remain at an almost normal level?
- Reconnect ICP sensor.
- 4. Command RPM to approximately 1200, then monitor and record the following PID values:

VGTDC#	IPR#	MGP
EGRDC#	EGRVP	EBP_A
LOAD		

- 5. Command VGT duty cycle to 0% and then up to 85%. What happens to the EBP_A PID?
 - @ 0% _____

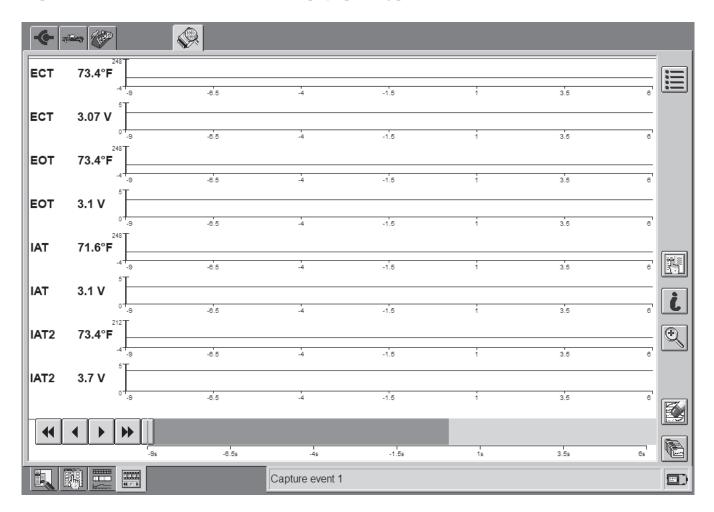
@ 85%

- 6. Command EGR open, then closed with VGT at 85%. What happens to the EBP A PID?
 - @ open _____
 - @ closed _____
- Release control of engine RPM.
- 7. Why do the two events in Questions 5 and 6 occur?
- Go to PID screen, select "Load Parameters" icon and highlight your file(s).
- Select "Delete File" icon, confirm and exit Datalogger.
- Perform a Power Balance Test, then exit.
- Perform a Relative Compression Test, then exit.
- 8. What would cause a good Relative Compression reading, but have one weak cylinder on the Power Balance Test?
- Clear DTCs and delete session.

WDS PID DATA ANALYSIS – 6.0L DIESEL SENSOR VALUE COMPARISON

DIRECTIONS: Complete Workstation 3 in the Student Reference Book using the WDS/IDS screens below.

SUMMARY: In this activity, you will analyze "normal" operation of 6.0L Powerstroke[®] diesel engine inputs and outputs, based on recorded WDS screens that display operating parameters.



PID	Description
ECT	Engine Coolant Temperature
ЕОТ	Engine Oil Temperature
IAT	Intake Air Temperature
IAT2	Intake Air Temperature 2

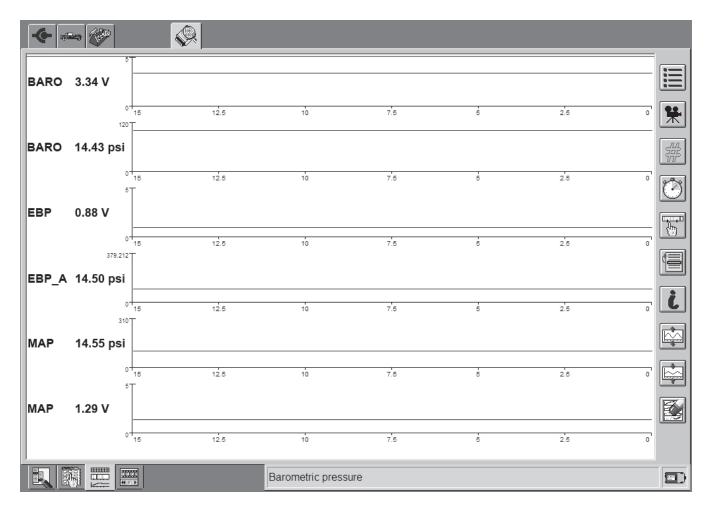
- 1. What can you determine about vehicle condition by the previous readings?
- 2. Do all the temperature sensor volt or temp PIDs match?

volts _____

temps _____

- 3. If you viewed the same four sensors under the same conditions, but one sensor's data was significantly different from the above readings, what could you assume?
- For the next question, assume you commanded the EGR valve open at an idle. When this is done, the IAT2 reading increases because hot exhaust gases are being directed into the intake manifold.
- 4. How can the above information be used for EGR diagnosis?

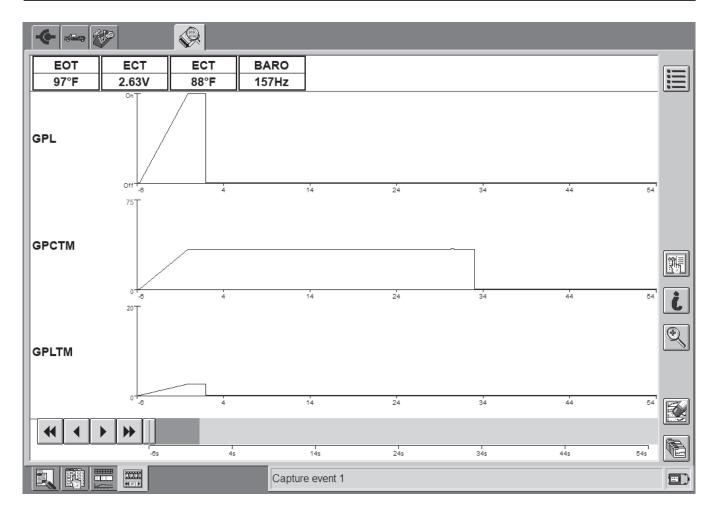
WORKSTATION 3



PID	Description
МАР	Manifold Absolute Pressure
BARO	Barometric Absolute Pressure
EBP	Exhaust Pressure (volts)
EBP_A	Exhaust Pressure (psi)

- 5. List the pressure PIDs (MAP, BARO and EBP) voltage values. Are the values equal (within +/- 0.5V)?
- 6. Are all the pressure values equal (within 1.5 psi)?
- 7. Under what operating conditions would the pressure values be different from each other?

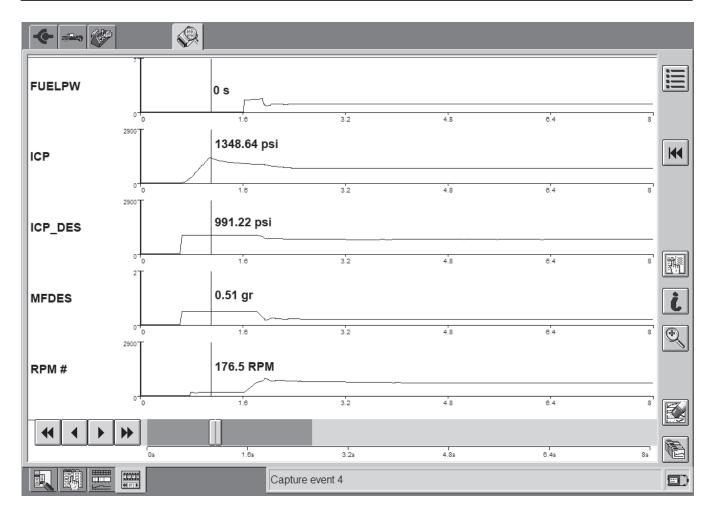
WORKSTATION 3



PID	Description	
GPL	Glow Plug Lamp	
GPLTM	Glow Plug Lamp Timer	
GPCTM	Glow Plug Control Time	
EOT	Engine Oil Temperature	
VPWR	Battery Voltage	

- 8. Assuming the key was cycled to the RUN position just before the beginning of the screen, did the PCM command the glow plugs and the glow plug lamp ON?
- 9. Why was the "ON" time for the Glow Plug Controller (GPCTM) longer than the time for the Glow Plug Lamp (GPL)?

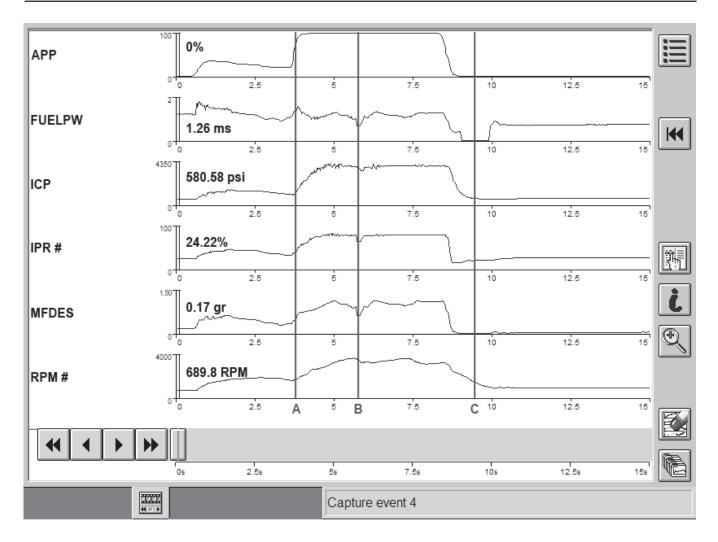
WORKSTATION 3



PID	Description	
ICP	Injection Control Pressure	
ICP_DES	Desired Injection Control Pressure	
MFDES	Mass Fuel Desired	
RPM	PM Revolutions Per Minute	

10. In the above screen, the engine is cranking but has not started. What is missing to start the engine?

11. How can the ICP be so much higher than ICP desired?



PID	Description	
APP	Accelerator Pedal Position	
FUELPW	Fuel Pulse Width	
ICP	Injection Control Pressure	
IPR#	Injection Control Pressure Regulator	
MFDES	Mass Fuel Desired	
RPM#	RPM# Revolutions Per Minute	

12. List the major events in the drive cycle shown above.

13. Why did the FUELPW increase at point A?

14. Why did FUELPW decrease at point B?

15. Why did the MFDES and FUELPW drop to 0 at point C?

HIGH PRESSURE OIL PUMP SERVICE ON 6.0L ENGINE

DIRECTIONS: Complete Workstation 4 at the ENGINE workstation, using the tools and service information available at the workstation.

SUMMARY: In this activity, you will disassemble the upper part of the engine as far as necessary to remove the high pressure oil pump, following the steps below. Answer the questions as you proceed.

- 1. Remove right valve cover, high pressure manifold fasteners and high pressure manifold from the right side of the engine. What is the torque specification for the T-30 Torx fastener?
- 2. When performing in-vehicle service, why would you NOT remove the high pressure stand pipe with the high pressure manifold?
- 3. Which plug in the high-pressure manifold has the tube under it?
- Continue disassembly until the turbocharger and drain tube are removed.
- 4. Are the VGT oil drain tube O-rings reusable?
- 5. What could happen if the metal circular gasket for the EGR cooler inlet is not reinstalled upon cooler installation?
- 6. Why would you loosen the oil filter cap to allow air into the housing before changing the oil?
- 7. Where are the sealing washers located on the fuel line banjo fitting?
- 8. Can the sealing washers be reused?
- Remove the IPR and high-pressure pump.
- 9. What is the purpose of the metallic foil on the IPR?

Use the Workshop Manual procedures to reassemble the engine for the next group.

NOTES:

LESSON TWO WORKSTATIONS

Workstation: Summary:

- 1 PID data analysis activity in which students will view and analyze a WDS recording from a 2003 6.0L-equipped Excursion to determine the cause of a "lack of power" concern.
- 2 Hands-on activity at vehicle that requires students to use WDS, Service Publications and other necessary tools to diagnose a "No Start" concern on the vehicle.
- 3 CMT activity in which students will diagnose the cause of an intermittent "lack of power" concern in the "virtual shop" and fill in any necessary answers on the worksheet.
- 4 Hands-on activity at the 6.0L PowerStroke[®] diesel engine on the stand. In this activity, students will: (1) locate potential leak points on the engine and identify sealing methods used, and (2) perform rocker arm service using the necessary special tools and Service Information.

POOR PERFORMANCE / LACK OF POWER USING PID DATA ANALYSIS

DIRECTIONS: Complete Workstation 1 at the PC workstation, using the recording file on the Classroom PC.

SUMMARY: You are diagnosing a "lack of power" condition on a 2005 Excursion.

- Open Toolbox, select DataLogger, and select the recording marked DRV4B. This is a recording made with a concern present.
- Move the scroll bar to the light acceleration portion of the recording and record any large variations PID values in the LIGHT ACCEL column versus NORMAL values.
- Move the scroll bar through the recording and record any large variations in PID values in the CRUISE (20s) column versus NORMAL values.
- Move the scroll bar to the peak of hard acceleration and record any large variations in PID values in the HARD ACCEL (44s) column versus NORMAL values.
- 1. Record PID values with large variations in the table below. Use the data to answer the questions on the following pages of this worksheet.

	CONCERN PRESENT		NORMAL			
PID	LIGHT ACCEL (2S)	CRUISE (20s)	HARD ACCEL (44s)	LIGHT ACCEL (2S)	CRUISE (20s)	HARD ACCEL (44s)
APP				18%	19.5%	74%
BARO				14.3 psi	14.3 psi	14.3 psi
ECT				188.6°F	188.6°F	190.4°F
LOAD				42.75%	38.43%	99.61%
EOT				188.6°F	188.6°F	190.4°F
RPM #				1143	1459	2846
EBP				1.6V	1.35V	3.6V
EGRDC #				7.2%	29.28%	43.31%
EGRVP				0.74V	1.04V	2.37V
ICP				885.2 psi	1000.8 psi	3617.8 psi
IPR #				32.42%	33.98%	77.34%
IAT				66.2°F	60.8°F	55.4°F
IAT2				107.6°F	104°F	95°F
MAP				15.22 psi	16.79 psi	38.68 psi
MGP				0.83 psi	2.46 psi	23.85 psi
MAF				1.98V	2.2V	4.23V
MFDES				.23 gr	.23 gr	.72 gr
VGTDC #				67.01%	54.89%	37.89%
VSS				2.82 mph	34.3 mph	49.87 mph

LESSON TWO

- 2. What does the MGP PID value from CONCERN PRESENT recording tell you about the performance of the engine?
- 3. Which PIDs were most affected by the concern?
- 4. Is the BARO PID value affected by the fault? Why or why not?
- 5. Is the EGRDC # PID value affected by the fault? Why or why not?
- 6. What conditions could cause the MGP PID value that you observed?
- 7. Is the VGTDC # PID value affected by the fault? Why or why not?
- 8. How does the VGT solenoid increase or decrease the exhaust pressure?

- 9. What does the EBP PID value from CONCERN PRESENT recording tell you about the operating condition of this EP sensor?
- 10. Which sensor is used by the PCM as an input to adjust the VGT solenoid duty cycle?
- 11. What component or system would you check further to locate the root cause of this concern?

LESSON TWO

WORKSTATION 2 NO START DIAGNOSIS ON-VEHICLE

DIRECTIONS: Complete Workstation 2 at the VEHICLE workstation. Use the tools and service information available at this workstation to diagnose the concern.

- Start in the PC/ED manual, Section 3.
- 1. The Symptom Chart Index sends you to QT. What are the results of QT?
- 2. Based on the above result, where in the PC/ED manual do you continue your diagnosis?
- 3. Look up the customer concern in the table indicated above. What chart is indicated for the concern?
- 4. Continue your diagnosis using the chart indicated above.
 - Perform Preliminary Checks.
 - What was the engine oil level and condition?
- 5. Check for sufficient clean fuel. For this Workstation, check sample on bench. In your dealership, how do you check for sufficient clean fuel?

LESSON TWO

- 6. Check for an intake restriction. What components must be inspected to ensure there is no intake restriction?
- 7. Check fuel pump pressure. What is the fuel pressure?

8.	8. Check Parameter Identification (PIDs).		
	B+ =		
	FICM_LPWR =		
	FICM_VPWR =		
	RPM# =		
	ICP =		
	ICPV =		
	IPR =		
	FUELPW =		
	FICMSYNC =		

9. What can you determine from the ICP pressure and the IPR command listed above?

- 10. What are the possible causes of the No Start? Discuss the answer with your instructor before continuing with exercise.
- 11. What is the least intrusive test to perform first?
- 12. Perform the above test. What could cause the results of this test?
- 13. What mechanical conditions could cause the cranking speed to be below 100 RPM?

14. If there was not an RPM reading, what would the PCM do with the IPR PID?

15. What do you think FICMSYNC value would be if the FICM_LPWR was zero?

LACK OF POWER DIAGNOSIS IN "VIRTUAL SHOP"

DIRECTIONS: Complete Workstation 3 at the CMT workstation, using ONLY the service publication files embedded on the CMT Program.

- 1. Select CMT "Scenario 1." You are diagnosing a "Lack of Power" condition on a 2005 6.0L-equipped vehicle. Steps already completed for you are listed on the Repair Order.
 - Retrieve the Repair Order on the CMT.
 - Go to PC/ED manual, Section 3 and perform the Preliminary Checks listed. List the steps below and the results for each step.

PRELIMINARY CHECK	RESULT

- 2. According to the PC/ED manual, what is the next step to perform?
- 3. Starting with the step above, fill in the remaining steps and results used to locate the root cause of this concern.

TEST STEP	RESULT

TEST STEP	RESULT

- 4. What is the cause of the concern?
- 5. What is the recommended repair?
- 6. What steps are required to complete service before returning the vehicle to the customer?

- 7. What special tools are recommended for the fuel pump pressure test?
- 8. What special tools are used to diagnose a fuel inlet restriction?

LEAK POINT IDENTIFICATION/ROCKER ARM SERVICE ON 6.0L ENGINE

DIRECTIONS (Part 1): Complete Workstation 4, Part 1 at the 6.0L ENGINE on the stand, using the Workshop Manual as necessary.

1. Complete the table below using the tagged components on the engine and the Workshop Manual. If the component has a leak point, identify the type of leak in the second column. Finally, identify the sealing method used (gasket, O-ring, sealant, etc.) in the third column.

No.	Component	Type of Potential Leak (If Applicable)	Sealing Method Used
1	CAC Tube	boost pressure	clamp
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			

DIRECTIONS (Part 2): Complete Workstation 4, Part 2 at the ENGINE workstation, using the tools and service information available at the workstation. Disassemble the engine components as far as necessary to remove and install one rocker arm, following the steps below. Answer the questions as you proceed.

- Remove one injector to access a rocker arm with Special Tool #303-1170.
- 2. When removing the injector before rocker arm service, a special tool is used to push the injector connector into the rocker area. What is the number of this tool?
- 3. When installing the Special Tool #303-1170 base assembly between the rocker arm bridges, how should the bolt be tightened?
- 4. Why should you remove the rocker arm fulcrum ball after removing the rocker arm?
- 5. Why is it important to make sure the dowel pins are in place before the front and rear engine covers are installed?
- Assemble the components you removed, following Workshop Manual procedures.

NOTES:

LESSON THREE WORKSTATIONS

Workstation:Summary:1PID data analysis activity in which students will view and analyze a WDS recording from a
2003 6.0L-equipped vehicle to determine the cause of a "lack of power" concern.

- 2 Hands-on activity at vehicle that requires students to use Service Publications, WDS, DVOM and other necessary tools to diagnose a "lack of power" concern.
- PID data analysis activity in which students will view and analyze a WDS recording from a
 2005 6.0L-equipped vehicle to determine the cause of a "rough run/surge" concern.
- 4 Hands-on activity at the 6.0L PowerStroke[®] diesel engine on the stand. In this activity, students will perform diagnosis of leaks and other concerns in the high pressure oil system, including use of the latest Block-Off tools.

LACK OF POWER DIAGNOSIS USING PID DATA ANALYSIS

DIRECTIONS: Complete Workstation 1 at the PC workstation, using the WDS recording file provided.

SUMMARY: In this activity, you will review a WDS recording for a "lack of power" concern, compare "CONCERN PRESENT" PID data to "Normal" PID data under various conditions, note any major differences in PID values, and determine possible causes for the difference(s) in PID values.

- 1. You are diagnosing a "lack-of-power" condition on a 2005 Excursion equipped with a 6.0L PowerStroke® diesel engine.
- Open Toolbox, select DataLogger, select Excursion, and then select the recording marked "DRV_4". This is a recording made with a concern present.
- Move the scroll bar to the light acceleration portion of the recording and record any large variations PID values in the LIGHT ACCEL column versus NORMAL values.
- Move the scroll bar through the recording and record any large variations in PID values in the CRUISE (20s) column versus NORMAL values.
- Move the scroll bar to the peak of hard acceleration and record any large variations in PID values in the HARD ACCEL (37s) column versus NORMAL values.
- Move the scroll bar and record any large variations in PID values in the COAST (50s) column versus NORMAL values.
- Use the data to answer the questions on the following page of this worksheet.

	CONCERN PRESENT			NORMAL				
	LIGHT		HARD		LIGHT		HARD	
PID	ACCEL	CRUISE	ACCEL	COAST	ACCEL	CRUISE	ACCEL	COAST
	(3s)	(20s)	(37s)	(50s)	(3s)	(20s)	(37s)	(50s)
APP					18%	19.5%	74%	0%
BARO					14.3 psi	14.3 psi	14.3 psi	14.3 psi
ECT					188.6°F	188.6°F	190.4°F	194°F
LOAD					42.75%	38.43%	99.61%	7.05%
EOT					185°F	186.8°F	188.6°F	190.4°F
RPM#					1143	1459	2846	890.5
EBP					1.6V	1.35V	3.6V	1.06V
EGRDC#					7.2%	29.28%	43.31%	26.35%
EGRVP					0.74V	1.04V	2.37V	0.88V
ICP					885.2 psi	1000.8psi	3617.8psi	649.2 psi
IPR#					32.42%	33.98%	77.34%	23.44%
IAT					66.2°F	60.8°F	55.4°F	55.4°F
IAT2					107.6°F	104°F	95°F	93.2°F
MAP					15.22 psi	16.79 psi	36.68 psi	14.9 psi
MGP					0.83 psi	2.46 psi	23.85 psi	0.43 psi
MAF					1.98V	2.2V	4.23V	1.68V
MFDES					.23 gr	.23 gr	.72 gr	.03 gr
VGTDC#					67.01%	54.89%	37.89%	57.41%
VSS					2.82 mph	34.3 mph	49.87mph	42.58mph

LESSON THREE

- 2. When comparing the two recordings, which PIDs are most affected by the concern?
- 3. Based on the MGP, IAT2 and MAF PID value, which subsystems are most affected by the concern?
- 4. Based on the MGP IAT2 and MAF PID values, which component would you check first for a concern?
- 5. What information leads you to believe that this component is the cause of the concern?

WORKSTATION 2 LACK OF POWER DIAGNOSIS ON-VEHICLE

DIRECTIONS: Complete Workstation 2 at the VEHICLE workstation. Use the PC/ED and tools (WDS or IDS, smoke machine, DMM and test light) available at this workstation to diagnose the concern.

SUMMARY: In this activity, you will use the necessary tools and service publications to diagnose a "lack of power" concern on-vehicle, perform on-vehicle tests according to service publication procedures, and determine root cause for the "lack of power" concern.

- 1. Go to QT1 in the PC/ED manual to begin your diagnosis.
- What effect would a leak in the exhaust system before the turbo have on the VGT system operation?
- 2. Where in the intake system could a leak cause a lack of power condition?
- 3. Complete the diagnosis of this concern, filling in your steps and results below:

Test Step	Result

LESSON THREE

4. What is the root cause of this concern?

- 5. What repair is required for this vehicle, based on your diagnosis?
- 6. What steps are required after completing the repair?

Return the workstation to the way you found it for the next group.

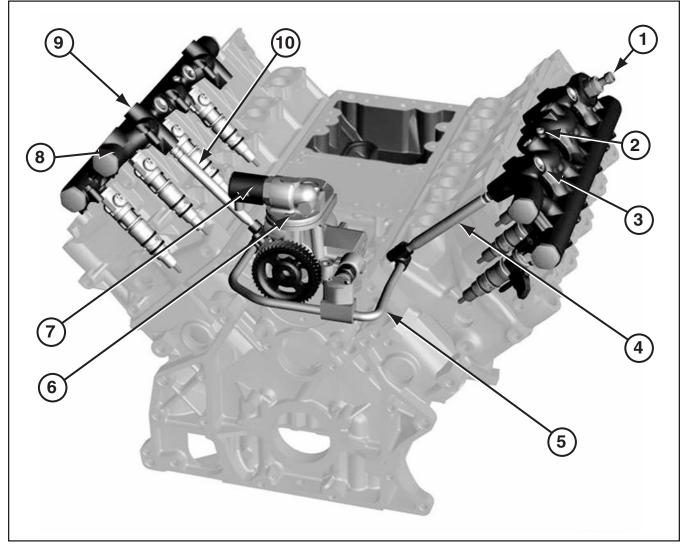
RUNS ROUGH DIAGNOSIS USING PID DATA ANALYSIS

DIRECTIONS: Complete Workstation 3 at the PC workstation, using the recording file on the course CD-ROM.

SUMMARY: You are diagnosing a "runs rough/surge" condition using a WDS recording.

- 1. Open a WDS session and view Previous Recording: ROUGHRUN.
- The graph view sizes may need to be adjusted for clarity. Be sure to look at the Power Balance portion of this recording, in addition to Datalogger.
- What bank is more affected by the concern?
- 2. At what RPM is the condition occurring?
- 3. What is the ICP voltage PID value and is it constant? (Graph view may need to be rescaled for clarity.)
- 4. How does ICP affect injector fuel delivery?
- 5. Based on the recording, what component in the high pressure oil system could cause the ICP to be erratic?
- 6. What is required to finish the repair?

WORKSTATION 4 HIGH PRESSURE OIL SYSTEM DIAGNOSIS ON 6.0L ENGINE



High Pressure Oil System

ltem	Description	ltem	Description
1	ICP Sensor	6	High Pressure Oil Pump
2	Access Plug for Air Adapter	7	IPR Solenoid
3	Check Valve	8	High Pressure Manifold
4	Stand Tube	9	Check Valve
5	Branch Tube	10	Stand Tube

DIRECTIONS: Complete Workstation 4 at the 6.0L ENGINE on a stand workstation.

SUMMARY: In this activity you will use the correct block-off tools and service procedures to diagnose leaks and other concerns in the high pressure oil system, and use the data gathered to determine what test results would indicate if the engine was in the vehicle.

LESSON THREE

- Normally, you would crank the engine to see if pressure builds. For this activity, with the engine on the stand, you will use shop air to check for leaks.
- When performing high pressure oil testing on-vehicle with the engine OFF, the IPR is open (bypassing oil) until commanded ON with the WDS. For this activity, use the 12V power supply and wire leads to command the IPR valve ON.
- 1. Remove the left valve cover and install an air line adapter to the high pressure manifold with the proper adapter. A leak may be apparent in either side of the engine.

If air is heard on the right or left side only, what can you determine?

- 2. If air is heard on both sides, what does this mean?
- If an air leak cannot be heard with confidence, then proceed with an isolation process.
- The PID for IPR duty cycle can be monitored on vehicle as you isolate components. A drastic change in the value will show a leak area.
- A high pressure block off tool is used to isolate each of the high pressure manifold(s) from the rest of the system.
- The block off tools vary for different model years and are identified in your student book. If the ICP sensor is not installed, install it and the electrical connector
- There are two block off tools: one is threaded for installing the ICP sensor into it, and the other is solid without a threaded hole.
- Remove the rear high pressure check valve from the high pressure manifold, and install the solid block off tool.
- 3. What would happen if you tried to use the block off tool in the front plug of the high pressure manifold?

[•] If on a vehicle, you would now crank the engine. If the engine started (on the unblocked four cylinders) or the ICP voltage increased, a leak point has been located. If no change occurred, you would continue on the right side.

LESSON THREE

- Replace the plug on the left side with the production fitting so high pressure oil will supply the high pressure manifold while the right manifold is isolated.
- Install the block off tool with the threaded hole into the high pressure manifold.
- 4. If performing this test on vehicle, why would you not be able to read ICP pressure at this time?
- Install ICP Sensor in tool.
- If you were on a vehicle, you would crank the engine at this time. If the engine starts, or if ICP pressure increases, a leak point has been found.
- If there is no change in ICP pressure, the next step is to install the block off tool in the left side high pressure manifold and retest.
- 5. If performing this test on a vehicle, can the engine start at this point? Why or why not?
- 6. What if ICP pressure now increases above 1000 psi while cranking?
- If there is still no change after these tests, the problem is likely a high pressure pump or a high pressure manifold that is cracked or broken. With the block off tools in place, an air test may show this problem even though it was not apparent earlier. With the valve covers off, it will be obvious if there is a leak.
- Check the O-rings at the branch tube-to-high pressure manifold connections before further engine disassembly.
- Install the valve cover and return workstation to its original condition.

NOTES:

LESSON FOUR WORKSTATIONS

Workstation: Summary:

- 1 PID data analysis activity in which students will view and analyze a WDS recording from a 2005 6.0L-equipped vehicle to determine the cause of a "lack of power" concern.
- 2 Hands-on activity at vehicle that requires students to use Service Publications, WDS, DVOM and other necessary tools to diagnose a "lack of power" concern.
- 3 CMT activity in which students will diagnose the cause of an intermittent "Cranks/No Start" concern in the "virtual shop" and fill in any necessary answers on the worksheet.
- 4 Hands-on activity at the 6.0L PowerStroke[®] diesel engine on the stand. In this activity, students will remove four fuel injectors from one bank, determine if there are concerns with any of the injectors, and answer questions on how to properly install the injectors per Service Information procedures.

LACK OF POWER DIAGNOSIS USING PID DATA ANALYSIS

DIRECTIONS: Complete Workstation 1 at the PC workstation, using the recording file on the course CD-ROM and the Service Information at the workstation.

SUMMARY: You are diagnosing a "lack of power" condition on a 2005 vehicle equipped with a 6.0L PowerStroke[®] diesel engine,

- Open WDS. Go to Previous Session and view VDR recording: 5EA08267. Use Recording #1 ONLY.
- Assume for this workstation that a rationality check was done at start up to ensure the temperature sensors are all within a close reading of each other to eliminate a faulty EOT sensor.
- 1. What do you see that is abnormal?
- 2. What is the ECT PID value compared to the EOT PID value?
- 3. What does this tell us?
- 4. Are the low power and high EOT readings connected?
- 5. How would you know if DTCs are set?
- 6. If the cooling system is performing properly, the coolant is at the proper temperature, and the oil is at an improper temperature, what can we assume?
- 7. What is likely causing the concern on this vehicle?
- 8. How would you complete the repair on this vehicle?

WORKSTATION 2 LACK OF POWER DIAGNOSIS ON-VEHICLE

DIRECTIONS: Complete Workstation 2 at the VEHICLE workstation. Use the PC/ED and tools (WDS, DMM and test light) available at this workstation to diagnose the concern.

SUMMARY: The vehicle at this workstation has a "lack of power" concern. The Preliminary Checks found in Symptom Chart 7 are listed below. Due to time restrictions in this classroom training session, assume that all the Preliminary Checks have been performed and no concerns were located. Review the Preliminary Checks before proceeding with Step 1.

Symptom Chart 7 Preliminary Checks:

- Confirm brakes are not dragging.
- Check for oil in coolant.
- Check engine oil level.
- Confirm acceptable SAE oil viscosity and API rating of oil.
- Confirm oil change within 12,070 km (7,500 miles).
- Check air intake system: check for intake restriction; check air filter restriction gauge/air filter.
- Check MAP sensor hose for leaks, blockage or disconnection.
- Check EP sensor tube for leaks, blockage or disconnection.
- Check intake system for leaks.
- Check for low boost condition
- Check for over boost condition
- Check for sufficient clean fuel.
- Check for air in fuel.
- Compare loaded weight of vehicle with performance expectations.
- Power monitor active.
- Transmission concerns.

1. Starting with QT3, record your diagnostic steps and results in the table below.

Diagnostic Steps	Results

- 2. Based on your results in the previous Pinpoint Test, what have you confirmed?
- 3. Where are the possible causes for the above condition?
- 4. What steps are required after completing the repair?

LESSON FOUR

WORKSTATION 3

CRANKS/NO START DIAGNOSIS IN "VIRTUAL SHOP"

DIRECTIONS: Complete Workstation 3 at the CMT (PC) workstation.

SUMMARY: In this activity, you will use the tools, tests and service publications in the virtual shop to diagnose an intermittent "cranks/no start" concern, perform tests in the virtual shop as required by service publication procedures, review test results to determine next steps, and determine the root cause of the intermittent "cranks/ no start" concern.

1. Select CMT Scenario 2 and review the repair order.

Have you verified the concern? If not, do so.

- 2. Navigate to the PC/ED manual: Section 3 (Symptom Charts). List the first two steps for this concern. Assume any on-vehicle inspections in the "Note" under QT1 are OK (no concerns located).
- 3. How do you determine which SSM should be checked first?
- 4. List the chafing points identified in the related SSM:

5. List the remaining steps you perform in the virtual shop to locate the cause of the concern:

Test Step	Result

- 6. Which concern did you find as the root cause of the problem?
- 7. Select the appropriate repair from the CMT screen, and write it below:
- 8. After making repairs, does the engine start?
- 9. What steps are required to complete the repair?

FUEL INJECTOR SERVICE AND INSPECTION ON 6.0L ENGINE

DIRECTIONS: Complete Workstation 4 at the ENGINE ON STAND workstation, following the steps on this worksheet.

1. Remove four fuel injectors from the designated bank of the classroom 6.0L PowerStroke[®] diesel engine. Evaluate each injector for installation and physical condition. Use the data from the inspections and Workshop Manual to fill in the chart and answer the questions below.

INJECTOR	2	4	6	8
INSPECTION RESULTS				
LIKELY SYMPTOM				
REQUIRED REPAIR				

2. What service can be performed on the high pressure oil D-ring in the top of the injector?

3. What is the injector hold-down bolt torque?

- **NOTE:** Remember that the classroom engine is a 2005 model. As of January, 2006, the injector hold-down bolt size changed and a T-45 Torx bit is required. The torque specification for these new hold-down bolts is 35 N•m (26 lb-ft).
- When you have completed all the questions on this worksheet see the instructor and then reinstall the injectors on the engine for the next group. Install the injectors in their original positions, with the concerns still present. Have the instructor check for proper installation before you move to the next Workstation.

NOTES:

DIESEL ENGINE PERFORMANCE

GLOSSARY OF ACRONYMS

GEOGOAI			
ABS	Anti-Lock Brake System		
API	American Petroleum Institute		
APS	Accelerator Position Sensor		
B+	Battery Voltage		
BARO	Barometric Absolute Pressure (PID)		
BP	Barometric Pressure		
BPP	Brake Pedal Position		
CAC	Charge Air Cooler		
CAN	Controller Area Network		
СКР	Crankshaft Position		
СКРО	Crankshaft Position Output		
CMP	Camshaft Position		
CMPO	Camshaft Position Output		
CMT	Classroom Multimedia Training		
DLC	Data Link Connector		
DMM	Digital Multi-Meter		
DTC	Diagnostic Trouble Code		
DTRM	Diesel Thermo Recirculation Module		
EBP	Exhaust Backpressure		
ECM	Engine Control Module		
ECT	Engine Coolant Temperature		
EGR	Exhaust Gas Recirculation		
EOP	Engine Oil Pressure		
ЕОТ	Engine Oil Temperature		
EPA	Environmental Protection Agency		
EP	Exhaust Pressure		
FICM	Fuel Injection Control Module		
FUELPW	Fuel Pulse Width		
GPCM	Glow Plug Control Module		
HEUI	Hydraulic Electronic Unit Injector		
HFCM	Horizontal Fuel Conditioning Module		
IAT	Intake Air Temperature		
IAT2	Intake Air Temperature 2		
IC	Integrated Circuit		
ICP	Injection Control Pressure		
IDS	Integrated Diagnostic Software		
IPR	Injection Pressure Regulator		
KOEO	Key On Engine Off		
KOER	Key On Engine Running		

DIESEL ENGINE PERFORMANCE

MAF	Mass Air Flow		
MAP	Manifold Absolute Pressure		
MGP	Manifold Gauge Pressure		
MM or mm	-		
M/Y	Model Year		
N•m	Newton Meters		
NOx	Nitrogen Oxides (or Oxides of Nitrogen)		
OASIS	Online Automotive Service Information System		
OEM	Original Equipment Manufacturer		
OSS	Output Shaft Speed		
PC-A	Pressure Control Solenoid A		
PC/ED	Powertrain Control/Emission Diagnosis		
РСМ	Powertrain Control Module		
PDC	Power Distribution Center		
PID	Parameter Identification		
PSI	Pounds per Square Inch		
PWM	Pulse Width Modulated		
QT	Quick Test		
RPM	Revolutions Per Minute		
SAE	Society of Automotive Engineers		
SSCC	Symptom-to-System-to-Component-to-Cause		
SSM	Special Service Message		
TCIL	Transmission Control Indicator Lamp		
TCM	Transmission Control Module		
TFT	Transmission Fluid Temperature		
TR-P	Transmission Range Position		
TRS	Transmission Range Sensor		
TSB	Technical Service Bulletin		
TSS	Turbine Shaft Speed		
VDR	Vehicle Data Recorder		
VGT	Variable Geometry Turbocharger		
VIN	Vehicle Identification Number		
VOP	Valve Opening Pressure		
VRef	Reference Voltage		
VSS	Vehicle Speed Sensor		
WBT	Web Based Training		
WDS	Worldwide Diagnostic System		
WIF	Water In Fuel		
WSS	Wheel Speed Sensor		
WOT	Wide Open Throttle		

COMPLETE RECOMMENDED 6.0L POWERSTROKE® DIESEL PID LIST

<u>PID</u>	NAME	PID VALUE
APP%	Accelerator Pedal Position (sensor)	Percentage
B+	Battery Voltage	Volts
BARO	Barometric Pressure	PSI
DTCCNT	Diagnostic Trouble Code Count	Number
EBP	Exhaust Backpressure (sensor)	Volts
EBP_A	Exhaust Backpressure Absolute	PSI
EBP_DES	Exhaust Backpressure Desired	PSI
EBP_G	Exhaust Backpressure Gauge	PSI
ECT	Engine Coolant Temperature (sensor)	Degrees Fahrenheit
EGRDC#	Exhaust Gas Recirculation Duty Cycle	Percentage (commandable)
EGRTP	Exhaust Gas Recirculation Throttle Position*	Percentage
EGRTP_V	Exhaust Gas Recirculation Throttle Position Voltage*	Volts
EGRVP	Exhaust Gas Recirculation Valve Position (sensor)	Volts
EOT	Engine Oil Temperature (sensor)	Degrees Fahrenheit
FICM_LPWR	Fuel Injection Control Module Logic Power	Volts
FICM_MPWR	Fuel Injection Control Module Main Power	Volts
FICM_VPWR	Fuel Injection Control Module Vehicle Power	Volts
FICMSYNC	Fuel Injection Control Module Synchronization	YES or NO
FUELPW	Fuel Pulse Width	milliseconds
IAT	Intake Air Temperature (sensor)	Degrees Fahrenheit
IAT2	Intake Air Temperature 2 (sensor)	Degrees Fahrenheit
ICP	Injection Control Pressure (sensor)	PSI
ICP V	Injection Control Pressure Voltage	Volts
ICP_DES	Injection Control Pressure Desired	PSI
INJ_TIM	Injection Timing	Degrees (angle)
IPR#	Injection Pressure Regulator	Percentage (commandable)
LOAD	Calculated Engine Load	Percentage
MAF	Mass Air Flow (sensor)	Grams per Second (g/s)
MAP	Manifold Absolute Pressure (sensor)	PSI
MFDES	Mass Fuel Desired	Grams or milligrams
MGP	Manifold Gauge Pressure	PSI
RPM#	Engine Revolutions Per Minute	Number (commandable)
SYNC	CKP/CMP Synchronization	YES or NO
VGTDC#	Variable Geometry Turbocharger Duty Cycle	Percentage (commandable)
VPWR	Vehicle Power	Volts
VREF	Reference Voltage	Volts
VSS	Vehicle Speed Sensor	MPH
*Active for 200	M 25 model year only. For other model years, this year	a will be zero (0)

*Active for 2004.25 model year only. For other model years, this value will be zero (0).

6.0L POWERSTROKE® DIESEL PID LIST

You may use the following to fill in the NORMAL PID values for your altitude and shop conditions.

<u>PID</u>	<u>KOEO</u>	KOER (Cold)	KOER (Operating Temp.)
APP%			
B+			
BARO			
DTCCNT			
EBP			
EBP_A			
EBP_DES			
EBP_G			
ECT			
EGRDC#			
EGRTP			
EGRTP_V			
EGRVP			
EOT			
FICM_LPWR			
FICM_MPWR	<u> </u>		
FICM_VPWR			
FICMSYNC			
FUELPW			
IAT			
IAT2			
ICP			
ICP V			
ICP_DES			
INJ_TIM			
IPR#			
LOAD			
MAF			
MAP			
MFDES			
MGP			
RPM#			
SYNC			
VGTDC#			
VPWR			
VREF			
VSS			

SPECIAL TOOLS USED IN THIS COURSE

N. AMERICAN #	<u>GLOBAL #</u>	TOOL NAME
014-00761	014-00761	Pressure Gauge Bar
078-00611	078-00611	Pressure & Vaccum Transducer (for use with IDS/VMM)
105-0025A	105-0025A	Flex Probe Kit
105-R0057	105-R0057	Digital Multi-Meter (DMM), or equivalent
218-00001	218-00001	Rotunda Smoke Machine Tester
303-755	303-755	Quick Release Coupling Disconnect Tool
303-756	303-756	Set of 2003-early 2004 Block Off Tools
303-765	303-765	Fuel Pressure Adapter
303-766	303-766	High Pressure Manifold Adapter
303-1071	303-1071	Set of 2004.25 Block Off Tools
303-1112	303-1112	IPR Service Tool
303-1115	303-1115	Injector Connector Release Tool
303-1163	303-1163	Set of 2005 Block Off Tools
303-1170	303-1170	Rocker Arm Service Tool
310-1135	310-1135	IPR Tester (need tester cable from this kit)
418-F224	418-F224	Worldwide Diagnostic System (WDS) (Integrated Diagnostic Software [IDS] may be used when available)
418-F242	418-F242	Pressure & Vacuum Adapter Kit (for use with IDS/VMM)

NOTES: