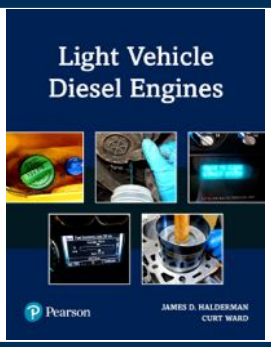
Light Vehicle Diesel Engines

First Edition



Chapter 6

Diesel Engine Condition Diagnosis

LEARNING OBJECTIVES (1 of 2)

6.1 Prepare for the Light Vehicle Diesel Engine (A9) ASE certification test content area "A" (General Diagnosis).

6.2 Discuss the importance of checking for diagnostic trouble codes (DTCs) and technical service bulletins (TSBs).

6.3 Discuss typical engine-related complaints and diesel engine smoke diagnosis.

6.4 Discuss the importance of visual checks.

6.5 Discuss engine noise diagnosis.

LEARNING OBJECTIVES (2 of 2)

6.6 Explain oil pressure testing and the purpose of oil pressure warning lamps.

6.7 Discuss the crankcase pressure test.

6.8 Explain compression testing, and compare wet and compression tests.

6.9 Describe the cylinder power balance test.

6.10 Discuss engine starting and charging system tests.

.

TYPICAL ENGINE RELATED COMPLAINTS (1 of 4)

- **Engine Mechanical-Related Complaints:**
  - Excessive oil consumption
  - Engine misfiring
  - Loss of power
  - Smoke from the engine or exhaust
  - Engine noises
- **Test Drive**
- **Vehicle History**

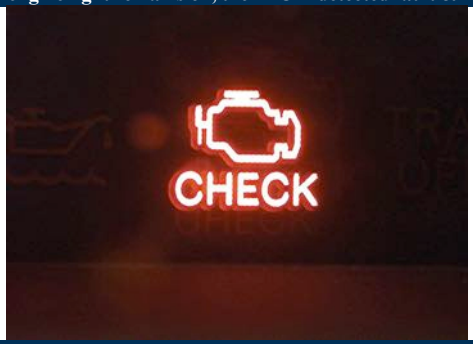
PEARSON

DIAGNOSTIC TROUBLE CODES & TECHNICAL SERVICE BULLETINS (2 of 4)

- **Diagnostic Trouble Codes (DTCs)**
  - ECM/PCM) detects faults
    - DTC can help pinpoint the fault to an area for
    - DTC present illuminates MIL

PEARSON

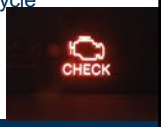
FIGURE 6–1 typical "Check Engine" light which should come on when ignition is first turned on as bulb check and then go out. If check engine light remains on, then PCM detected fault & DTC se



PEARSON

DIAGNOSTIC TROUBLE CODES & TECHNICAL SERVICE BULLETINS (3 of 4)

- **DTC Status**:
  - History DTC—store history DTC s for 40 trips
  - MIL Request—PCM has MIL on
  - Last Test Fail—only DTC failed last time
    - Test of system or sensor ran
  - Test Fail Since Code Cleared (SCC)—
    - DTC s reported test failed since the last time cleared
  - Not Run Since Code Cleared (SCC)—DTC not run
  - DTC Status—DTCs not run during drive cycle



PEARSON

DIAGNOSTIC TROUBLE CODES & TECHNICAL SERVICE BULLETINS (4 of 4)

- **Technical Service Bulletins: Strategy Diagnosis**
- **Scan Tool**
  - Check values of sensors
  - Verify normal action/reaction activity
  - When operating system

PEARSON

FIGURE 6–2 After checking for stored DTCs, wise technician checks service information for any technical service bulletins that may relate to the vehicle being serviced.

PEARSON

VISUAL INSPECTION

- **Thorough Visual Inspection Includes**
  - Overall inspection of vehicle
  - Oil Level and Condition
  - Coolant Level and Condition
  - Oil Leaks

PEARSON

FIGURE 6–3 Checking engine oil level and condition is almost always first step in diagnosis of any diesel engine diagnosis.

PEARSON

WARNING

If radiator is hot and radiator cap is removed, the drop in pressure above coolant will cause coolant to boil immediately and can cause severe burns when the coolant explosively expands upward and outward from the radiator opening, which can cause personal injury. Always wait until the engine cooling system has cooled to ambient temperature before removing cap.

PEARSON

FIGURE 6–4 Coolant condition can be easily checked using test strips.

PEARSON

FIGURE 6–5 Using black light to spot leaks after adding dye to oil. Fluorescent dye works best with clean oil.

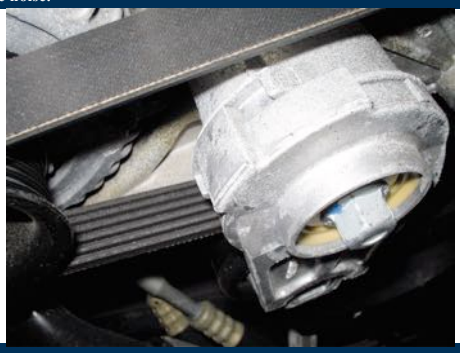
PEARSON

ENGINE NOISE/ VIBRATION DIAGNOSIS

- **Engine knocking noise difficult to diagnose**
  - Several items can cause deep engine knock include:
    - **Valves clicking**
    - **Torque converter**
    - **Cracked flex plate**
    - **Loose or defective drive belts or tensioners**
    - **Piston pin knock**
    - **Piston slap**
    - **Timing chain noise**
    - **Rod-bearing noise**
    - **Main-bearing knock**

PEARSON

FIGURE 6–6 accessory belt tensioner. Most tensioners have a mark that indicates normal operating location. If belt has stretched, this indicator mark will be outside of normal range. Anything wrong with belt or tensioner can cause noise.



PEARSON

CHART 6-1: Typical noises and possible causes.

TYPICAL NOISE	POSSIBLE CAUSES
Clicking noise—like the clicking of a ballpoint pen	1. Loose accessory mount (for air-conditioning compressor, alternator, power steering pump, etc.) 2. Loose rocker arm or valve bridges (crossheads) 3. Worn rocker arm pedestal 4. Exhaust leak
Clacking noise—like tapping on metal	1. Worn piston pin 2. Broken piston 3. Excessive valve clearance 4. Timing chain hitting the cover
Knock—like knocking on a door	1. Rod bearing(s) 2. Main bearing(s) 3. Thrust bearing(s) 4. Loose torque converter 5. Cracked flex plate (drive plate)
Rattle—like a baby rattle	1. Broken harmonic balancer 2. Loose accessory mounts 3. Loose accessory drive belt or tensioner
Clatter—like rolling marbles	1. Rod bearings 2. Piston pin 3. Loose timing chain
Whine—like an electric motor running	1. Alternator bearing 2. Drive belt 3. Power steering 4. Belt noise (accessory or timing)
Clunk—like a door closing	1. Engine mount 2. Drive axle shaft U-joint

CHART 6-1

PEARSON

CRANKCASE PRESSURE TEST (1 of 2)

- **Causes for Excessive Crankcase Pressure:**
  - Crankcase oil level too high.
  - Obstruction or damage to rocker cover breather
  - Defective turbocharger
  - Worn or damaged valve or cylinder
- **NOTE: Newer vehicles have pressure sensor in crankcase breathing element located in valve cover. Set DTC if there is restriction.**
- **Crankcase Pressure Test Procedure: Page 73**

PEARSON

FIGURE 6–7 crankcase breather being removed from valve cover of a 6.7 liter Cummins diesel engine.

PEARSON

FIGURE 6–8 gauge measures low positive and negative pressures in units of inches of water. (1 inch of mercury (in. Hg) equals 14 inches of water so this unit is very small.) Connect gauge to source that can measure crankcase pressure, usually at oil dipstick tube.

PEARSON

CRANKCASE PRESSURE TEST (2 of 2)

- **Newer Diesel Engines/Crankcase Pressure Test**
  - **See Page 73 of text**
  - Cummins 6.7L crankcase pressure sensor
    - Detect excessive blow-by, a restriction, or NO filter
    - DTC P04bd SETS
  - Ford 6.7L no longer lists crankcase pressure test
  - 6.6 Duramax does not list crankcase pressure test
    - Crankcase Depression Regulator (CDR) valve
    - Maintains crankcase pressure between
    - Approximately negative 6-16 inches of water running

PEARSON

Quick & Easy Crankcase Pressure Test

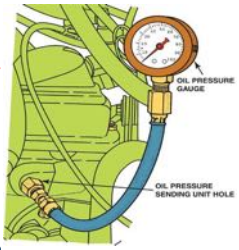
TECH TIP

With engine running, remove oil fill cap and then set it back down on the opening without threading it in. If the pressure causes it to whistle or blow off engine, pressure is too high. Not very scientific, but it works great.

PEARSON

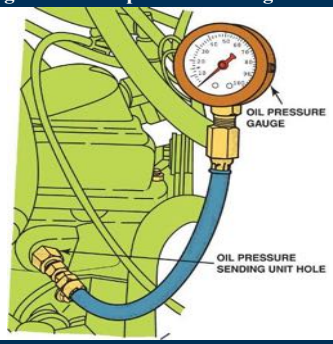
OIL PRESSURE TESTING

- **Proper Oil Pressure Important**
  - ***Low oil pressure can cause engine wear, and engine wear can cause low oil pressure.***
  - Main thrust or rod bearings are worn
  - Pressure reduced from leakage around bearings
  - **Oil Pressure Testing:**
    - **STEP 1** Operate engine until normal operating temperature achieved.
    - **STEP 2** With engine off, remove oil pressure sending unit or sender
    - **STEP 3** Start engine and observe gauge. Record oil pressure at idle and at 2500 RPM



PEARSON

FIGURE 6–9 measure engine oil pressure, remove oil pressure sending (sender) unit, usually located near the oil filter. Screw the pressure gauge into the oil pressure sending unit hole.



PEARSON

If the Oil Pressure Light Is Not On, Why Should I Check the Oil Pressure?

FREQUENTLY ASKED QUESTION

The red oil pressure warning lamp in dash usually lights when oil pressure is less than 4 to 7 PSI, depending on vehicle and engine. The oil light should not be on during driving. If the oil warning lamp is on, stop engine immediately. Always confirm oil pressure with a reliable mechanical gauge before performing engine repairs. Sending unit or circuit may also be defective.

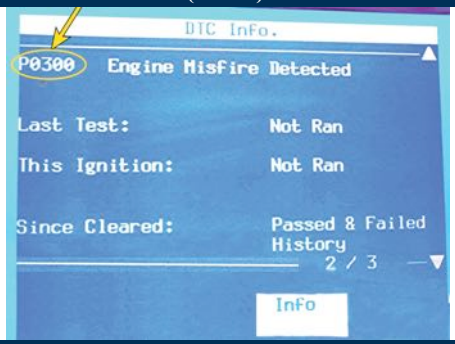
PEARSON

MISFIRE DIAGNOSIS

- **Engine Misfire**
  - Cylinder does not fire, or fire well enough
  - Contribute to operation of engine
  - Cylinder misfiring, speed drops
  - When misfire detected
  - PCM sets P0300, Turns on MIL
  - **Causes of Engine Mech Misfires: Pages 74-75 of text**
  - **Engine-Related Misfire Diagnosis: Page 75**

PEARSON

FIGURE 6–10 GM Tech 2 scan tool display showing a random misfire DTC (P0300) has been detected.



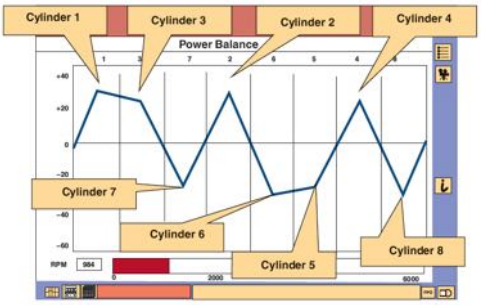
PEARSON

COMPRESSION TEST

- **Cranking Compression Test**
  - All cylinders must have equal compression
  - Low Compression Causes
    - Intake or exhaust valve
    - Piston rings (or piston, if there is a hole)
    - Cylinder head gasket
      - For best results, engine should be
      - Warmed to normal operating temperature
  - **Compression Test Process: Page 76**
  - **Wet Compression Test: Page 76**

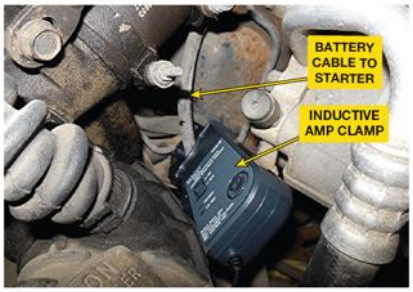
PEARSON

FIGURE 6–11 Ford IDS scan tool has graph function that allows technician to view data on cylinder contribution test visually, making diagnosis easier. Cylinders on bank 2 on Ford 6.7 Power Stroke (cylinders 7, 6, 5, & 8) are weak.



PEARSON

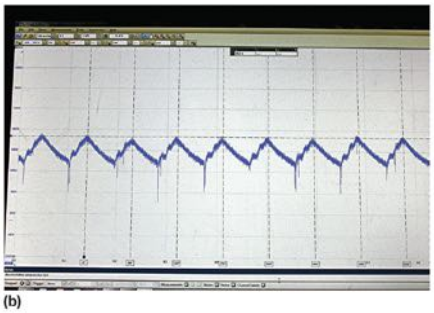
FIGURE 6–12 (a) relative compression test using an amp clamp around starter motor power cable & Pico scope.



(a)

PEARSON

FIGURE 6–12 (b) result is a waveform that displays current needed for each cylinder under compression. This test indicates that all cylinders are requiring same current to rotate starter motor, indicating that all cylinders have same relative compression.



(b)

PEARSON

FIGURE 6–13 diesel engine compression gauge being used to test compression on Duramax diesel engine.

PEARSON

ENGINE STARTING AND CHARGING DIAGNOSIS (1 of 8)

- **Automotive Battery**
  - Source of electrical power for
  - Starting and for electrical demands
  - that exceed alternator output
  - Battery also acts as a voltage stabilizer
  - For entire electrical system

PEARSON

ENGINE STARTING AND CHARGING DIAGNOSIS (2 of 8)

- **Batteries Rated**
  - According to amount of current
  - Can produce under specific conditions.
    - **Cold-cranking Amperes**
    - **Cranking Amperes**
    - **Marine Cranking Amperes**
    - **Ampere-hour Rating**
    - **Reserve Capacity**

PEARSON

QUESTION 1: ?

What does CCR stand for?

PEARSON

ANSWER 1:

Cold Cranking Amps:

The cold-cranking power of a battery is number of amperes that can be supplied at 0°F (-18°C) for 30 seconds while battery still maintains a voltage of 1.2 volts per cell or higher. This means that battery voltage would be 7.2 volts for a 12 volt battery and 3.6 volts for a 6 volt battery. Cold-cranking performance rating is called cold-cranking amperes (CCA).

What is CA or Cranking Amps? CA refers to the number of amperes that can be supplied by battery at 32°F (0°C). This rating results in a higher number than more stringent rating of CCA.

PEARSON

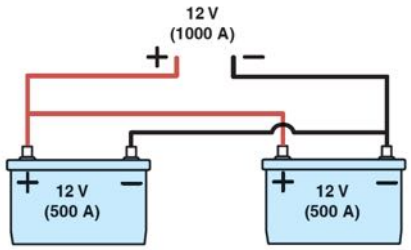
How Should You Test a Vehicle Equipped with Two Batteries?

FREQUENTLY ASKED QUESTION

Many vehicles equipped with diesel engine use 2 batteries. Usually electrically connected in parallel to provide additional current (amperes) at same voltage. To successfully test batteries, they should be disconnected and tested separately. If just 1 battery found to be defective, most experts recommend that both be replaced to help prevent future problems. Because 2 batteries are electrically connected, fault in 1 battery can cause good battery to discharge into defective battery, thereby affecting both even if just one battery is defective. FIGURE 6–14

PEARSON

FIGURE 6–14 Most light-duty diesel vehicles are equipped with two batteries connected in parallel as shown. Two 500 amperes, 12-volt batteries are capable of supplying 1,000 amperes at 12 volts, which is needed to start many diesel engines.



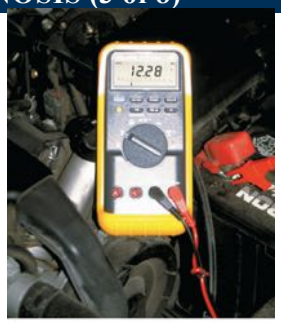
PEARSON

FIGURE 6–15 battery that measures 12.6 volts or higher after the surface charge has been removed is 100% charged.

PEARSON

ENGINE STARTING AND CHARGING DIAGNOSIS (3 of 8)

Voltmeter showing the battery voltage when the headlights were on (engine off) for one minute.



(a)

PEARSON

ENGINE STARTING AND CHARGING DIAGNOSIS (4 of 8)

- Headlights were turned off and battery voltage quickly recovered to indicate 12.6 volts
- Battery Load Test
  - Page 76

(b)

PEARSON

CHART 6-2: estimated state of charge of a 12-volt battery after surface charge has been removed. surface charge is removed by turning headlights on high beam for one minute, then turning the headlights off and waiting two minutes.

BATTERY VOLTAGE (V)	STATE-OF-CHARGE
12.6 or higher	100% charged
12.4	75% charged
12.2	50% charged
12.0	25% charged
11.9 or lower	Discharged

CHART 6-2

PEARSON

ENGINE STARTING AND CHARGING DIAGNOSIS (5 of 8)

- GM, Chrysler Corporation, Ford, and other OEMS
- Specify that **Conductance Tester** be used
- Test batteries still under factory warranty
- Tester uses its internal electronic circuitry
- Determine the state of charge and capacity
- By measuring voltage & conductance of plates

PEARSON

FIGURE 6–16 Midtronics tester that can not only test battery, but can also detect faults with starter & alternator.

PEARSON

ENGINE STARTING AND CHARGING DIAGNOSIS (6 of 8)

- **Conductance Tester Determines**
  - **Good battery, can return to service**
  - **Charge and retest**
    - Fully recharge battery and return to service
  - **Replace battery**
    - Battery not serviceable and should be replaced
  - **Bad cell—replace**
    - Battery not serviceable and should be replaced

PEARSON

Dead Batteries Can Freeze

TECH TIP

If a battery becomes discharged, electrolyte can freeze. This occurs because when a battery is discharged, the "acid" ($PbSO_4$) leaves electrolyte and is deposited on both negative and positive plates, leaving just water. Never attempt to charge or place into service a battery that is frozen. Often the case is spilt, requiring battery to be replaced. If a battery is found to be frozen, place the battery into a warm room with good ventilation and allowed it to thaw. If the case is not cracked, then it may be able to be restored to useful service if charged at a low rate for several hours. Test and recharge as needed.

PEARSON

QUESTION 3: ?

What is a battery conductance test?

PEARSON

ANSWER 3:

- GM, Chrysler Corporation, Ford, and other OEMS
- Specify that a conductance tester be used
- Test batteries still under factory warranty
- Tester uses its internal electronic circuitry
- Determine the state of charge and capacity
- By measuring voltage & conductance of plates

PEARSON

ENGINE STARTING AND CHARGING DIAGNOSIS (7 of 8)

- **Battery Electrical Drain Test**
  - Determines if some component or circuit
  - Causing drain on battery when everything is off.
  - Called ignition off-draw (IOD) or parasitic load test
  - Performed whenever one of following exists:
    - Battery is being charged or replaced
    - Battery is suspected of being drained

PEARSON

FIGURE 6–17 Clamp-on digital multimeter (DMM) used to check battery electrical drain. Meter reads over a half an ampere, which exceeds normal specification of 0.050A.

PEARSON

FIGURE 6–18 After connecting shut-off tool, start engine operate all accessories. Stop engine and turn off everything. Connect ammeter across shut-off switch in parallel. Wait 20 minutes. This time allows all electronic circuits to "time out" or shut down. Open switch—all current now will flow through ammeter. A reading greater than specified (usually > 50 milliamperes, or 0.05 ampere) indicates a problem that should be corrected.

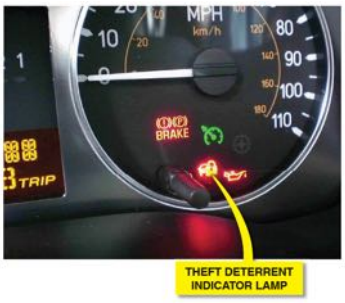
PEARSON

ENGINE STARTING AND CHARGING DIAGNOSIS (8 of 8)

- Cranking System Testing: Page 79
- Charging Voltage Testing: Page 79

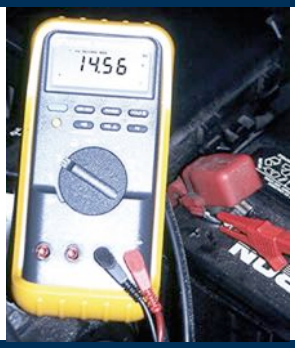
PEARSON

FIGURE 6–19 A theft deterrent indicator lamp of the dash. A flashing lamp usually indicates a fault in the system, and the engine may not start.



PEARSON

FIGURE 6–20 With engine running, the battery voltage should be between 13.5 and 15 volts.



PEARSON

Summary (1 of 2)

- The first step in diagnosing engine condition is to perform a thorough visual inspection, including a check of oil and coolant levels and their condition.
- Oil can be tested by a lab for wear metals and other conditions which may help the service technician become aware of engine faults before they become major.
- Many engine-related problems make a characteristic noise.

Summary (2 of 2)

- The oil pressure should be tested using a mechanical gauge.
- A compression test can be used to test the condition of valves and piston rings.
- Cylinder balance test, relative compression test, and cylinder contribution tests indicate whether all cylinders are working normally.
- Starting and charging system testing includes checking for voltage and determining the condition of the batteries.