

Light Vehicle Diesel Engines
First Edition

Light Vehicle Diesel Engines



Chapter 14
Hydraulically Actuated Electronic Unit Injector (HEUI) Systems

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ALWAYS LEARNING

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CURT WARD

LEARNING OBJECTIVES (1 of 2)

14.1 Prepare for the Light Vehicle Diesel Engine (A9) ASE certification fuel system diagnosis and repair area ("F").

14.2 Identify the components of a HEUI injection system.

14.3 Discuss the operation of a HEUI injector.

14.4 Explain the advantage of a HEUI injection system over a mechanical system.

14.5 Determine the need for service and repair of HEUI injection systems.

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HEUI SYSTEMS (1 of 5)

- **Hydraulically Actuated Electronic Unit Injector (HEUI)**
 - 7.3 liter and 6.0 liter Power Stroke engines made by
 - International Engine used in light- and medium-duty
 - Trucks made by Ford
 - Used from 1993 until end of the 2006
- **ADVANTAGES OF HEUI SYSTEM: Page 158**
- **DISADVANTAGES OF HEUI SYSTEM**

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HEUI SYSTEMS (2 of 5)

- **Ford/International IDI 6.9 L V8**
 - Introduced in 1983 became 7.3L IDI in 1988
 - 1994 7.3L with direct injection (DI)
 - DI version named “Power Stroke V8”
 - Common rail Hydraulically Actuated Electronic Unit Injection

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HEUI SYSTEMS (3 of 5)

- **DI Power Stroke**
 - Common-rail Fuel supply
 - Shared fuel supply “rail” that feeds all fuel injectors
 - **Fuel Injection Control Module (FICM)**
 - Provides high-power switching
 - Fuel injectors under PCM control
 - Caterpillar Called it **IDM (Injector Driver Module)**

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HEUI SYSTEMS (4 of 5)

- **High Pressure Fuel System**
 - HEUI system:
 - Required ultra-high fuel pressures
 - Developed right in injector
 - Power to run the fuel injector
 - Comes from engine-driven HEUI high-pressure oil pump

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HEUI SYSTEMS (5 of 5)

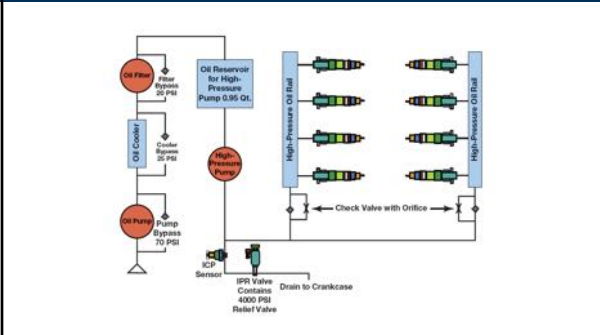
• Low Pressure/Fuel Supply System

- Verify there's adequate fuel pressure to start engine
 - Verify that there is fuel in tank
 - Measure fuel pressure at fuel filter housing test fitting with a 0-150 PSI gauge
 - Check or replace primary and secondary fuel filters
 - Check fuel pump power and ground circuits

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FIGURE 14–1 HEUI injection system uses high-pressure engine oil to pressurize the injector.



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Is the HEUI Injector Used Anywhere Else?

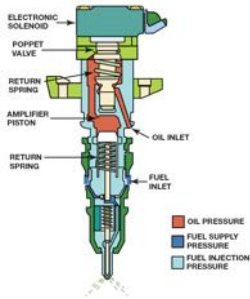
? FREQUENTLY ASKED QUESTION

Yes, Caterpillar manufactured its own version of the HEUI injector called the CAT HIB-300. It was used in medium- and heavy-duty on-road and off-road applications. International Truck used a version similar to the HEUI injector used by Ford on many of its engines until the 2011 model year.

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FIGURE 14–2 typical HEUI injector with oil and fuel pressure.



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CONTROL PRESSURE (1 of 3)

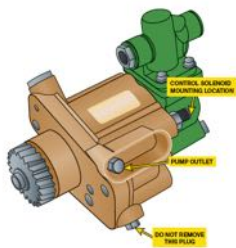
• **High-Pressure Pump**

- Injector uses oil from lubrication system pressurize fuel
- Electronically controlled high-pressure oil pump By ECM
- Deliver oil to the injectors at up to 4,000 PSI
- Oil is referred to as **Injection Control Pressure (ICP)**
- Inside injector, piston used to multiply oil pressure to
- 30,000 PSI in order to deliver fuel pressure needed
- **Figure 14-3**

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FIGURE 14–3 high-pressure oil pump provides the pressure needed for injector operation.



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CONTROL PRESSURE (2 of 3)

• HEUI Injector

- **Unit Injector:** all functions related to fuel delivery
 - Incorporated into single component
 - Pressurization, atomization, & distribution of fuel
- Made up of 3 main component areas.
 - **Solenoid** responsible for injection timing and quantity
 - **Piston** responsible for multiplying oil pressure
 - **Nozzle** responsible for injection pressure/rate

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CONTROL PRESSURE (3 of 3)

• Original injector designated HEUI-A

• HEUI-B injector

- First time, fuel to be delivered in pilot
- Main injection during single combustion event
- Multiplication piston barrel design
- Main Difference Between type A & B
- Change lowered combustion pressures
- Reduced NOx emissions
- Created quieter engine operation than previous models.

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Component Interchangeability Issues



TECH TIP

Although the components of HEUI are interchangeable, technician should be careful to use only the replacement parts designed for the specific application. Internal differences may effect fuel delivery, and have a negative effect on the operation of engine. Changes will also take the vehicle out of emissions compliance.

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INJECTOR TYPES (1 of 2)

• Injector History

- 3 generations of HEUI injectors
- Associated with Power Stroke engine
 - HEUI-A 7.3 Liter Power Stroke
 - HEUI-B 7.3 Liter Power Stroke
 - Generation II 6.0 Liter Power Stroke

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INJECTOR TYPES (2 of 2)

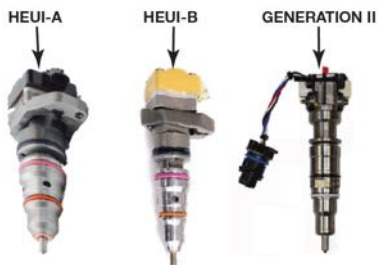
• HEUI Injector Features

- HEUI-A 1993–1995, single black solenoid, 2-wire
- HEUI-B type until late 2003, white solenoid, 2-wire
- A & B injectors require 115 volts and 8 amps of current
- Gen II type injector used 2003-2007
- Gen II type injector dual coils on & 4-wire connector
- Gen II injector operates on 48 volts and 20 amps
 - SEE CHART 14-1

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FIGURE 14-4 Common HEUI injectors.



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CHART 14-1: Comparison of 3 HEUI injectors used by Ford.

	HEUI-A	HEUI-B	GENERATION II
Engine	7.3L Power Stroke	7.3L Power Stroke	6.0L Power Stroke
Model Years Used	1993-1995	1996-2003	2003.5-2006
Operating Voltage	115 Volts	115 Volts	48 Volts
Operating Amperage	7-15 amps	7-15 amps	20 amps

CHART 14-1

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INJECTOR TYPES FIGURE 14-5 (1)

• **HEUI-A injection divided into 3 stages**

- **Fill** – During fill cycle, solenoid de-energized no high-pressure oil present in injector. Allows internal components to be in default position. Fuel from low-pressure system fills plunger cavity below multiplication piston

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INJECTOR TYPES FIGURE 14-5 (2)

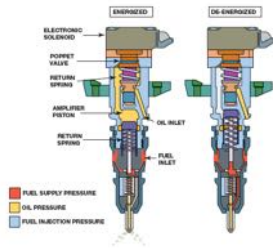
• **HEUI-A injection divided into 3 stages**

- **Injection** – During injection cycle, solenoid energized, allowing high-pressure oil to enter chamber above multiplication piston. Fuel below piston pressurized. high-pressure fuel travels through nozzle and injection begins

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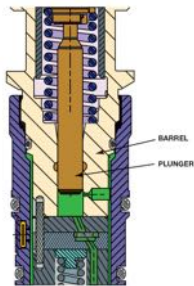
FIGURE 14-5 Line drawings of HEUI-A filling and injecting fuel.



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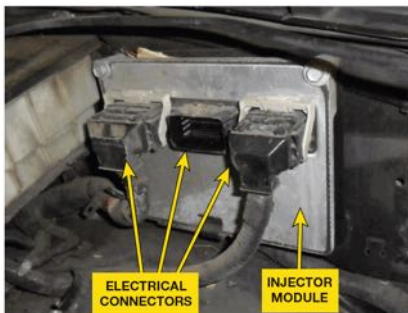
FIGURE 14-6 plunger and barrel of a HEUI-B injector.



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FIGURE 14-7 injector module is located on the fender near the brake booster.



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HEUI SERVICE AND DIAGNOSTICS (1 of 2)

- Correct grade & viscosity of oil critical
- Minimum level of antifoaming additive
 - Failure to have enough antifoam causes aeration
 - Aerated oil will not transmit pressure or motion
 - Oil filter MUST meet OEM specifications
- **High-Pressure Oil Leaks: Page 162**
- **High-Pressure Oil Pump Test: Page 162**
- **Injector Driver Module (IDM): Page 162**
 - FORD calls IDM **FICM** (Fuel Injection Control Module)
 - IDM is Caterpillar Term

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Engine Runs Rough after the Oil Pan Is Resealed (1 of 2)



REAL WORLD FIX

2002 Ford truck equipped with Power Stroke engine was running rough. The concern was verified and review of service history revealed a recent repair of engine oil leak. After a thorough inspection revealed no other concerns, oil and filter were changed to correct the problem. When the oil leak repair was completed, an antifoaming additive should have been added to the engine oil, or next oil change interval should have been shortened. Many RTV sealants release a chemical during curing process that depletes the effectiveness of the antifoam additive. The lack of the antifoam additive caused low pressure in the high-pressure oil system which resulted in the rough running that the customer complained about.

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Engine Runs Rough after the Oil Pan Is Resealed (2 of 2)



REAL WORLD FIX

- **Summary:**
- **Complaint**—The customer complained of a rough running concern after an engine oil leak was repaired.
- **Cause**—The engine oil antifoaming additive was depleted because of the chemicals given off by the RTV sealant during the curing process.
- **Correction**—The engine oil and filter were changed and the problem was resolved.

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Multiple Injector Driver Module Replacements (1 of 2)



REAL WORLD FIX

2004 Ford truck with Power Stroke has rough running concern. An inspection revealed that engine was misfiring on 4 cylinders. It was determined that injector driver module (IDM) had failed. Replacement injector driver module (IDM) was installed and misfire was still present. A further inspection revealed single injector was shorted to ground. Shorted injector and injector module were replaced, correcting misfire condition. Failure of module was caused by shorted injector. Shorted injector shared a common low-side driver with 3 other injectors, causing multiple cylinder misfire.

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Multiple Injector Driver Module Replacements (2 of 2)



REAL WORLD FIX

- **Summary:**
- **Complaint**—truck had a rough running condition.
- **Cause**—shorted injector was causing a misfire condition on four cylinders, and had damaged the injector driver module.
- **Correction**—shorted injector and the damaged injector driver module (IDM) were both replaced and the misfire condition was corrected

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CHART 14-2 scan tool data that indicates high-pressure oil desired as “Injection Control Pressure (ICP) and high-pressure pump control is shown as “Injection Control Duty Cycle”

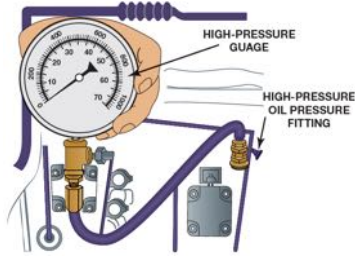
DATA PID	ACTUAL	MINIMUM	AVERAGE	MAXIMUM
FICM Logic Power	10.50 V	10.00 V	10.69 V	11.50 V
FICM Main Power	48.50 V	48.00 V	48.28 V	48.50 V
FICM Vehicle Power	10.50 V	10.50 V	11.01 V	11.50 V
Injection Control Pressure, Filtered	3.5850 MPa (514 PSI)	0.000 MPa (0 PSI)	2.7960 MPa (402 PSI)	3.7773 MPa (544 PSI)
Desired (commanded) Injection Control Pressure (ICP)	3.0482 MPa (438 PSI)	0.000 MPa (0 PSI)	6.7015 MPa (972 PSI)	9.0076 MPa (1308 PSI)
Injection Control Pressure-actual	0.836 V	0.205 V	0.664 V	0.870 V
Injection Control Pressure Duty Cycle	82.42%	14.84%	66.62%	82.42%
Engine Coolant Temperature	55°C	52°C	54°C	55°C
Intake Air Temperature	28°C	24°C	26°C	28°C
Air Flow Rate Inlet Mass Air Flow Sensor	15.23 g/s	0.00 g/s	11.37 g/s	20.80 g/s
Intake Manifold Absolute Pressure (14.2 PSI)	88 kPa (14.1 PSI)	97 kPa (14.1 PSI)	86 kPa (14.2 PSI)	89 kPa (14.4 PSI)
Engine RPM	281 RPM	0 RPM	232 RPM	383 RPM
Fuel Flow Rate	5.202 l/hr	0.000 l/hr	3.883 l/hr	7.135 l/hr

CHART 14-2

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FIGURE 14-8 pressure gauge is installed for testing high-pressure oil pump.



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HEUI SERVICE AND DIAGNOSTICS (2 of 2)

- FICM Module IDM)
 - Check wiring harness for chafing, locations:
 - Upper left valve cover or valve cover stud, near the FICM
 - Idler pulley under thermostat (routed around steering pump)
 - Left front valve cover hold-down bolts/studs
 - Exhaust pressure (EP) sensor bracket at thermostat
 - Right valve cover at glow plug control module (GPCM)
 - PCM harness at the battery box
 - **U0105 – Lost communication with FICM**
 - **P0611 – FICM performance fault**

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Summary (1 of 1)

- HEUI injection systems were the first generation of high pressure injection systems.
- HEUI injection systems allowed for injection control by something other than engine speed.
- High-pressure engine oil, provided by a high-pressure pump, is used to create injection pressure.
- The injector operating voltage can be 48 or 115 volts, depending on the model year.
- High-pressure oil leaks can lead to fuel contamination and a lack of power.

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