Light Vehicle Diesel Engines

Chapter 13 High-Pressure Common Rail Diesel Fuel System

Opening Your Class

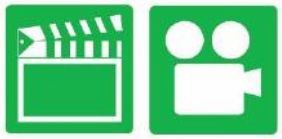
KEY ELEMENT	EXAMPLES
Introduce Content	This Light Vehicle Diesel Engines 1st text provides complete coverage of light duty diesel engine components, operation, and diagnosis. It correlates material to task lists specified by ASE and NATEF and emphasizes a problem-solving approach. Chapter features include Tech Tips, Frequently Asked Questions, and Real World Fixes: www.jameshalderman.com contains Videos, Animations, and Task Sheets for use in the lab and classroom.
Motivate Learners	Explain how the knowledge of how something works translates into the ability to use that knowledge to figure why the engine does not work correctly and how this saves diagnosis time.
State the learning objectives for the chapter or course you are about to cover and explain this is what they should be able to do as a result of attending this session or class.	Explain the chapter learning objectives to the students as listed: 1. Prepare for the Light Vehicle Diesel Engine (A9) ASE certification fuel system diagnosis and repair area "F" (Fuel System Diagnosis and Repair). 2. Describe the safety concerns related to working with high-pressure fuel systems. 3. Identify the components of a high-pressure common rail injection system. 4. Discuss the operation of a high-pressure common rail injector. 5. Determine the need for service and repair of a high pressure common rail injection systems.
Establish the Mood or Climate	Provide a ***WELCOME,*** Avoid put downs and bad jokes.
Complete Essentials	Restrooms, breaks, registration, tests, etc.
Clarify and Establish Knowledge Base	Do a round robin of the class by going around the room and having each student give their backgrounds, years of experience, family, hobbies, career goals, or anything they want to share.

NOTE: This lesson plan is based on the 1st Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

LINK CHP 13 Chapter Images USE BELOW LINK

http://www.jameshalderman.com/books_a9.html

NOTE: You can use Chapter Images or Power Point files: Though out Power Point Presentations, you will find questions and answers on slides that can be used for discussion.

ICONS	CH13 HPCR FUEL SYSTEM
	1. SLIDE 1 CH13 HPCR FUEL SYSTEM
	Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/ WEB SITE IS CONSTANTLY UPDATED
	**Light Diesel (111 Links)**
	http://www.jameshalderman.com/books_a9.html Crossword Puzzle (Microsoft Word) (PDF) Word Search Puzzle (Microsoft Word) (PDF)
	**SAFETY** Always be very careful when working on a Diesel engine that is running with air intake removed. Because most diesel ENGINES DO NOT USE a throttle plate, objects can very easily be sucked into engine, causing serious engine damage. MOST OEMs offer intake covers.
	2. SLIDE 2 EXPLAIN FIGURE 13–1 typical high-pressure common rail (HPCR) diesel fuel system.
	Diesel High Pressure Common Rail (View)(Download) Electronic Fuel Injector (View) (Download) Fuel Injector, Electronic-Control (View)(Download)
	**SAFETY** DUEL SYSTEM MAY BE UNDER EXTREME PRESSURE 30,000 PSI (2,086 BAR). DO NOT OPEN HIGH PRESSURE FUEL SYSTEM WITH ENGINE RUNNING. ENGINE OPERATION CAUSES HIGH-FUEL PRESSURE. HIGH-PRESSURE FUEL SPRAY CAN CAUSE SERIOUS INJURY OR DEATH. SEE FIGURE 13–2

ICONS	CH13 HPCR FUEL SYSTEM
	3. **SLIDE 3 EXPLAIN FIGURE 13–2** example of an under hood high-pressure fuel warning decal, warning of dangers related to system.
	**DISCUSSION: ADVANTAGES & DISADVATANGES OF HPCR SYSTEMS page 142 of text**
	4. **SLIDE 4 EXPLAIN FIGURE 13–3** high-pressure common rail supplies the fuel injectors with the same fuel pressure and act as a pulse dampener as they operate. 5. **SLIDE 5 EXPLAIN FIGURE 13–4** fuel rail pressure sensor provides feedback to PCM/ECM so high-pressure fuel pump can operate most efficiently. 6. **SLIDE 6 EXPLAIN FIGURE 13–5** typical fuel rail pressure sensor wiring diagram.
	**HANDS-ON TASK: :STUDENTS DOWNLOAD fuel rail pressure sensor wiring diagram & TRACE CONTROL CIRCUIT WITH HIGHLIGHTER.**
	7. **SLIDE 7 EXPLAIN FIGURE 13–6** high-pressure common rail supplies fuel injectors with same fuel pressure, and acts as a pulse dampener as they operate.
	8. **SLIDE 8 EXPLAIN FIGURE 13–7** fuel line is threaded onto transfer tube. Transfer tube allows the fuel to flow to the injector. Components must be precisely oriented and torqued to ensure system is sealed properly.
	**DISCUSS REAL WORLD FIX Case of the Loose Transfer Tubes (1 of 2)**
	**DISCUSS REAL WORLD FIX Case of the Loose Transfer Tubes (2 of 2)**
	9. **SLIDE 9 EXPLAIN FIGURE 13–9** return line allows a small amount of fuel from the injectors and the high-pressure pump to be returned to the tank.
	**DEMONSTRATION: SHOW STUDENTS HOW TO CHECK RETURN FLOW**

ICONS	CH13 HPCR FUEL SYSTEM
	**HANDS-ON TASK: CHECK RETURN FLOW**
	10. **SLIDE 10 EXPLAIN FIGURE 13–11** example of a multi-piston pump that uses a three-lobe cam as actuator. 11. **SLIDE 11 EXPLAIN FIGURE 13–12** example of how fuel is fed into pumping chamber and how it is delivered under high pressure. The lubrication circuit is also depicted. 12. **SLIDE 12 EXPLAIN FIGURE 13–13** volume-control valve (Fuel Pressure Control Valve) meters fuel from low-pressure system into high-pressure pump to minimize parasitic loss.
	**DISCUSSION: DISCUSS THE LOCATION OF THE DIFFERENT HIGH PRESSURE CONTROL DEVICES ON THE HIGH PRESSURE PUMPS & THEIR LOCATION** 14. **SLIDE 14 EXPLAIN FIGURE 13–14** cascade overflow valve is a serviceable component of the high-pressure pump that determines flow rate and allows for lubrication of internal pump components.
	**DEMONSTRATION: SHOW STUDENTS LOCATION OF HIGH PRESSURE CONTROL DEVICES ON THE HIGH PRESSURE PUMPS**
	**HANDS-ON TASK: USING POST-IT NOTES HAVE STUDENTS LABEL HIGH PRESSURE CONTROL DEVICES & OTHER EXTERNAL DEVICES ON A HIGH PRESSURE PUMP**
	**DISCUSS CHART 13-1 type of fuel injector used, sorted by manufacturer and model year.**
	15. **SLIDE 15 EXPLAIN FIGURE 13–15** Sequence of a solenoid high-pressure common rail injector going through an injection cycle.
	16. **SLIDE 16 EXPLAIN FIGURE 13–16** Sequence of piezoelectric high-pressure common rail injector going through a fuel cycle

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	**DEMONSTRATION: SHOW STUDENTS DIFFERENT HPCR FUEL INJECTORS BOTH SOLENOID & PIEZO OPERATED. Explain how to identify the types.**
	**HANDS-ON TASK: HAVE STUDENTS IDENTIFY THE TYPE OF HPCR INJECTOR USED ON A LAB VEHICLE**
	17. **SLIDE 17 EXPLAIN FIGURE 13–17** powertrain control module contains driver circuits and DC-DC converter needed to operate injectors.
	**DISCUSS WHICH OEMS & ENGINES USE EITHER A PCM OR ECM & WHY**
	**HANDS-ON TASK: HAVE STUDENTS IDENTIFY whether a LAB VEHICLE USES A PCM OR ECM**
	18. **SLIDE 18 EXPLAIN FIGURE 13–18** DC-DC converter in this example is used to create the 5 volts used for the v-reference signal. 19. **SLIDE 19 EXPLAIN FIGURE 13–19** DC converter is used to convert system voltage (14 volts) to the 42 volts needed for operation.
	**HANDS-ON TASK: USING THE INTERNET LOOK-UP THE TERM DC-DC CONVERTER & DEFINE IT**
	20. **SLIDE 20 EXPLAIN FIGURE 13–20** Cummins Clean Care kit. Kit is used to seal air management system during testing. 21. **SLIDE 21 EXPLAIN FIGURE 13–21** Cummins Clean Care kit. Kit is used to seal openings in fuel management system during testing
	**DEMONSTRATION: USING A CLEAN CARE KIT. KIT DEMO HOW TO OPEN & SEAL HPCR FUEL SYSTEM**

ICONS	CH13 HPCR FUEL SYSTEM
	**HANDS-ON TASK: STUDENTS USE CLEAN CARE KIT TO OPEN & SEAL HPCR FUEL SYSTEM**
	**DISCUSS REAL WORLD FIX Case of High-Pressure Fuel System Components Failure (1 of 2)** **DISCUSS REAL WORLD FIX Case of High-Pressure Fuel System Components Failure (2 of 2)**
	**SAFETY DUEL SYSTEM MAY BE UNDER EXTREME PRESSURE 30,000 PSI (2,086 BAR). DO NOT OPEN HIGH PRESSURE FUEL SYSTEM WITH ENGINE RUNNING. ENGINE OPERATION CAUSES HIGH-FUEL PRESSURE. HIGH-PRESSURE FUEL SPRAY CAN CAUSE SERIOUS INJURY OR DEATH. SEE FIGURE 13–2**
	22. **SLIDE 22 EXPLAIN FIGURE 13–22** Fuel system fluorescent dye is readily available. In many cases, the dye can be used for more than one system. 23. **SLIDE 23 EXPLAIN FIGURE 13–23** Using a black light, fluorescent dye is visible at the location of high-pressure fuel leak.
	**DEMONSTRATION: USING DYE & BLACK LIGHT TO LOCATE FUEL LEAKS**
	**HANDS-ON TASK: STUDENTS USE USING DYE & BLACK LIGHT TO LOCATE FUEL LEAKS**
	**DISCUSS REAL WORLD FIX Case of High-Pressure Fuel System Components Failure (1 of 2)** **DISCUSS REAL WORLD FIX Case of High-Pressure Fuel System Components Failure (2 of 2)**

ICONS	CH13 HPCR FUEL SYSTEM
	**DISCUSS REAL WORLD FIX Case of the Multiple Injector Washers (1 of 2)** **DISCUSS REAL WORLD FIX Case of the Multiple Injector Washers (2 of 2)**
	24. **SLIDE 24 EXPLAIN FIGURE 13–24** failure to install injector with its sealing washers properly can lead to leakage and system performance problems**.** 25. **SLIDE 25 EXPLAIN FIGURE 13–25** calibration code must be programmed into PCM when injector is replaced. The calibration allows PCM to make the proper adjustments to fuel delivery of that cylinder, resulting in smoother operating engine. 26. **SLIDE 26 EXPLAIN FIGURE 13–26** scan tool shows list of calibration codes that are programmed into powertrain control module for that vehicle. A technician can compare those values to actual injectors to ensure they were properly programmed
	**DEMONSTRATION: LOCATING INJECTOR calibration code**
	**HANDS-ON TASK: HAVE STUDENTS LOCATE INJECTOR CALIBRATION CODE AND COMPARE CODES ON SCAN TOOL WITH THOSE ON THE ENGINE.**
	27. **SLIDE 27 EXPLAIN FIGURE 13–27** pump and its gear are aligned with cam gear to ensure there are no abnormal engine vibrations in engine as pump generates high rail pressures.
	**DEMONSTRATION: TIMING HPCR PUMP TO ENGINE**
	**HANDS-ON TASK: HAVE STUDENTS TIME HPCR PUMP TO ENGINE.**

ICONS	CH13 HPCR FUEL SYSTEM
	**DISCUSS FREQUENTLY ASKED QUESTION: What Is Needed to Install a New High-Pressure Pump?** **DISCUSS FREQUENTLY ASKED QUESTION: How Do I Inspect the Pump-Line-Nozzle (PLN-E) Fuel Systems on Older Diesel Engines?** 28. **SLIDE 28 EXPLAIN FIGURE 13–28** A typical pop tester used to check the spray pattern of a diesel engine injector
	**DEMONSTRATION: DEMO HOW TO CHECK AN OLDER INJECTOR ON A POP TESTER**
	**HANDS-ON TASK: HAVE STUDENTS CHECK AN OLDER INJECTOR ON A POP TESTER**