

# Light Vehicle Diesel Engines

## Chapter 8 Diesel Engine Assembly

### 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: <a href="http://www.jameshalderman.com">www.jameshalderman.com</a> 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: <ol style="list-style-type: none"> <li>1. Prepare for the Light Vehicle Diesel Engine (A9) ASE certification test content area "B" (Cylinder Head Diagnosis and Repair) and "C" (Engine Block Diagnosis and Repair).</li> <li>2. Explain short block and cylinder head preparation.</li> <li>3. Discuss final short block assembly.</li> <li>4. Describe camshaft installation and piston/rod installation.</li> <li>5. Explain cylinder head installation procedure.</li> <li>6. Discuss torque-to-yield (TTY) head bolts.</li> <li>7. Explain valve train assembly and final assembly of an engine</li> </ol>
Establish the Mood or Climate	Provide a <b>WELCOME</b> , 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 1<sup>st</sup> Edition Chapter Images found on Jim's web site @ [www.jameshalderman.com](http://www.jameshalderman.com)

**LINK CHP 06 Chapter Images: USE BELOW LINK**

[http://www.jameshalderman.com/books\\_a9.html](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	CH08 DIESEL ENGINE ASSEMBLY
          	<p><b>1. SLIDE 1 CH08 DIESEL ENGINE ASSEMBLY</b></p> <p>Check for <b>ADDITIONAL VIDEOS &amp; ANIMATIONS</b>  @ <a href="http://www.jameshalderman.com/">http://www.jameshalderman.com/</a>  <b>WEB SITE IS CONSTANTLY UPDATED</b></p> <p><b><u>Light Diesel (111 Links)</u></b></p> <p><a href="http://www.jameshalderman.com/books_a9.html">http://www.jameshalderman.com/books_a9.html</a>  <b>Crossword Puzzle (Microsoft Word) (PDF)</b>  <b>Word Search Puzzle (Microsoft Word) (PDF)</b></p> <p><b><u>SAFETY</u></b> Always be very careful when working on a Diesel engine that is running with air intake removed. Because most diesel <b>ENGINES DO NOT USE</b> a throttle plate, objects can very easily be sucked into engine, causing serious engine damage. <b>MOST OEMs offer intake covers.</b></p> <p>2. <b>SLIDE 2 EXPLAIN FIGURE 8–1</b> Deburring all sharp edges is an important step to achieve proper engine assembly.</p> <p>3. <b>SLIDE 3 EXPLAIN FIGURE 8–2</b> thread chaser (top) is preferred tool to clean threaded holes because it cleans without removing metal compared to a tap (bottom).</p> <p><b><u>DEMONSTRATION:</u></b> Have a block prepared to show students various levels of bore prep</p> <p><b><u>DEMONSTRATION:</u></b> Show students difference between thread chaser and tap.</p> <p><b><u>HANDS-ON TASK:</u></b> Have students use both thread chasers &amp; taps to clean threads. Compare threaded holes cleaned with chaser to those cleaned with a tap.</p>

## ICONS



## CH08 DIESEL ENGINE ASSEMBLY

4. **SLIDE 4 EXPLAIN FIGURE 8-3** This Cummins 6.7-liter inline six-cylinder diesel engine uses many cup plugs to block off coolant openings.

**DISCUSSION:** Have students discuss why it is so important to keep engines clean when assembling. (**Answer:** One example is valve stem clearance. Valve stem clearance is only 0.0015" to 0.003." It would not take a very large piece of dust or lint to stop oil flow.)





5. **SLIDE 5 EXPLAIN FIGURE 8-4** Sealer should be applied to the cup plug before being driven into the block
6. **SLIDE 6 EXPLAIN FIGURE 8-5** Screw-type puller being used to install a new cam bearing. most cam bearings are crush fit. The full round bearing is forced into the cam bearing bore. most vehicle manufacturers specify that the cam bearings be installed "dry" without lubrication to help prevent them from spinning, which would cause the bearing to block the oil feed hole.

**When assembling an engine, never stop midway through a step. Always complete step you are on before taking a break or going home.**

**When installing oil gallery plugs, be sure to check that the plug doesn't interfere with an intersecting gallery. This could starve part of the engine of oil.**

**HANDS-ON TASK: Have students clean oil galleries and install gallery plugs.**

**After installing cam bearings, check for alignment of oil holes & oil galleries. This can be done with short piece of stiff wire. Marking the oil hole in the cam bearing & oil gallery with a felt marker can make cam bearing installation easier.**

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	<p>7. <b>SLIDE 7 EXPLAIN FIGURE 8-6</b> Typical main bearing set. Note that the upper halves are grooved for better oil flow and the lower halves are plain for better load support. This bearing set uses the center main bearing for thrust control. Notice that the upper bearing set has the holes for oil, whereas the lower set does not.</p>
	<p>8. <b>SLIDE 8 EXPLAIN FIGURE 8-7</b> width of plastic gauging strip determines oil clearance of main bearing. An alternate method of determining oil clearance includes careful measurement of crankshaft journal and bearings after they are installed, and the main housing bore caps are torqued to specifications. Most main and rod bearing clearance falls within 0.001 and 0.002 inch.</p>
	<p><b><u>DEMONSTRATION:</u> Show students how to measure bearing clearance</b></p>
	<p><b><u>HANDS-ON TASK</u> Have students prep measure bearing clearance</b></p>

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9. **SLIDE 9 EXPLAIN FIGURE 8-8** Lip-type rear main bearing seal in place in the rear main bearing cap. The lip should always be pointing toward the inside of the engine.

### **EXPLAIN TECH TIP: “One to Two”**

10. **SLIDE 10 EXPLAIN FIGURE 8-9** Fogging oil is used to cover bare metal parts when the engine is being stored to prevent corrosion.

### **EXPLAIN TECH TIP: Fogging Oil and Assembly Lube**








11. **SLIDE 11 EXPLAIN FIGURE 8-10** Engine assembly lube is recommended to be used on engine parts during assembly.










12. **SLIDE 12 EXPLAIN FIGURE 8-11** feeler gauge is used to check **piston ring gap**.

### **DEMONSTRATION: Show students how to adjust ring gap.**

### **HANDS-ON TASK Have students’ measure ring gap on an assigned engine**

13. **SLIDE 13 EXPLAIN FIGURE 8-12 (A)** Cummins 6.7-liter 6-cylinder piston showing that word “**FRONT**” is marked on top
14. **SLIDE 14 EXPLAIN FIGURE 8-12 (B)** Duramax diesel engine uses an **arrow on top of piston** to indicate the front of the engine.
15. **SLIDE 15 EXPLAIN FIGURE 8-13** on V-type engines that use paired **rod journals**, side of rod with large chamfer should face toward crank throw (outward).
16. **SLIDE 16 EXPLAIN FIGURE 8-14** One method of **piston ring installation** showing the location of ring gaps. Always follow the manufacturer’s recommended method for the location of ring gaps and for ring gap spacing.

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      	<p>17. <b>SLIDE 17 EXPLAIN FIGURE 8–15</b> This style of <b>ring compressor</b> uses a ratchet to contract the spring band and compress the rings into their grooves</p> <p>18. <b>SLIDE 18 EXPLAIN FIGURE 8–16</b> This pliers-like tool is used to close the metal band around the piston to compress the rings. An assortment of bands is available to service different size pistons.</p> <p><b><u>DEMONSTRATION:</u> Show students how to measure a connecting rod “big end” using inside micrometer.</b></p> <p><b><u>HANDS-ON TASK</u> Have students prep pistons for installation.</b></p> <p><b><u>DEMONSTRATION:</u> Show students how to use a piston ring compressor.</b></p> <p><b><u>DEMONSTRATION:</u> Show students how to install piston rings</b></p> <p><b>Pushing the piston in with a hammer handle is easier on the rings than tapping it in.</b></p> <p>19. <b>SLIDE 19 EXPLAIN FIGURE 8–17 INSTALLING PISTON</b> using a ring compressor to hold the rings into the ring grooves of the piston and then using a hammer handle to push the piston into the bore. Connecting rod stud protectors have been installed to help prevent possible damage to the crankshaft during piston installation</p> <p>20. <b>SLIDE 20 EXPLAIN FIGURE 8–18</b> connecting <b>ROD SIDE CLEARANCE</b> measured with feeler gauge.</p> <p>21. <b>SLIDE 21 EXPLAIN FIGURE 8–19</b> Typical cylinder head tightening sequence.</p> <p><b>On an engine with two rods per crank throw, be sure to install both rods on a given throw before torquing them. This helps prevent rods from binding on crank.</b></p>

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	<b>EXPLAIN TECH TIP: Watch Out for Wet and Dry Holes</b>
	<b>EXPLAIN TECH TIP NOTE: Apply oil to a shop cloth and rotate bolt in cloth to lubricate the threads. This procedure lubricates threads without applying too much oil</b>
	22. <b>SLIDE 22 EXPLAIN FIGURE 8–20</b> The maximum <b>clamping force</b> is achieved when the bolt is stretched to its yield point.
	23. <b>SLIDE 23 EXPLAIN FIGURE 8–21</b> To ensure consistent clamp force (load), many manufacturers are recommending <b>torque-angle or torque-to-yield</b> method of tightening head bolts. The torque angle method specifies tightening fasteners to a low-torque setting and then giving an additional <b>angle of rotation</b>
	24. <b>SLIDE 24 EXPLAIN FIGURE 8–21</b> Notice that difference in clamping force is much smaller than it would be if just a torque wrench with dirty threads were used.
	<b><u>DEMONSTRATION:</u> Show difference between standard and torque-to-yield head bolts.</b>
	<b><u>HANDS-ON TASK</u> Have students install cylinder head that uses torque-to-yield head bolts</b>
	<b><u>DISCUSSION:</u> Have students discuss why torque-to-yield head bolts must be replaced every time they are removed.</b>
	25. <b>SLIDE 25 EXPLAIN FIGURE 8–22</b> Torque angle can be measured using a special adaptor.
	26. <b>SLIDE 26 EXPLAIN FIGURE 8–23</b> an electronic torque wrench showing number of degrees of rotation. These very accurate torque wrenches can be programmed to display torque or number of degrees of rotation.
	<b><u>HANDS-ON TASK</u> Have students install &amp; and torque cylinder head (s).</b>
	

**ICONS****CH08 DIESEL ENGINE ASSEMBLY****DISCUSS FREQUENTLY ASKED QUESTION:  
What Do Markings on Head Gasket Mean?**

27. **SLIDE 27 EXPLAIN FIGURE 8–24** A **head gasket** from the left cylinder head on a Duramax V-8 diesel engine. The “L” means it is for the left head and the hole in the slot indicates its thickness.
28. **SLIDE 28 EXPLAIN FIGURE 8–25** special holding fixture is required when installing the camshafts on the Fiat Chrysler 3.0 liter V-6 diesel engine to keep them aligned and in the proper position before the timing chain is installed
29. **SLIDE 29 EXPLAIN FIGURE 8–26** timing gears on Duramax diesel engine can be seen through an opening in timing cover for the high-pressure pump to camshaft. Duramax diesel HP Pump is timed so that fuel pressure regulator (FPR) solenoid commands at same time as piston strokes, which helps reduce vibration and noise.
30. **SLIDE 30 EXPLAIN FIGURE 8–27** **valve lash** being checked on a Duramax diesel engine. Always follow vehicle manufacturer’s specified procedures.
31. **SLIDE 31 EXPLAIN FIGURE 8–28** 1/8 to 3/16 inch (3 to 5 mm) bead of RTV silicone on a parting surface with silicon going around the bolt hole

**DEMONSTRATION: Show how to adjust valve lash on a DURAMAX engine****HANDS-ON TASK Have students adjust valve lash on a DURAMAX engine****DISCUSS FREQUENTLY ASKED QUESTION:  
What is “Torque Paint”? Figure 8-29**

32. **SLIDE 32 EXPLAIN FIGURE 8–29** Torque paint applied to the head of the fastener indicates that it has been properly torqued to factory specification
33. **SLIDE 33 EXPLAIN FIGURE 8–30** Using a hammer to straighten the gasket rail surface of the oil pan before installing a new gasket. When the retaining bolts are



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	tightened, some distortion of sheet metal covers occurs. If the area around the bolt holes is not straightened, leaks can occur with the new gasket.