Light Vehicle Diesel Engines

Chapter 5 Diesel Engine Cooling System

Opening Your Class

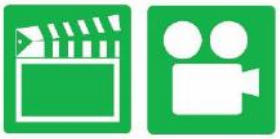
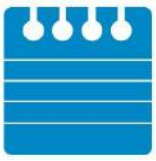
KEY ELEMENT	EXAMPLES
Introduce Content	This Light Vehicle Diesel Engines 1st text provides complete coverage of light duty diesel engine components, operation, and diagnosis. It correlates material to task lists specified by ASE and NATEF and emphasizes a problem-solving approach. Chapter features include 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, which translates into more money.
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 on the second SLIDE. 1. Prepare for the Light Vehicle Diesel Engine (A9) ASE certification test content area "D" (Lubrication and Cooling Systems Diagnosis and Repair). 2. Discuss diesel engine cooling system operation. 3. Explain the purpose and function of the thermostat. • Discuss radiator design and construction. 4. Describe the purpose and function of water pumps. 5. Discuss cooling fans operation and diagnosis. 6. Describe cooling system diagnostic procedures. • Discuss coolant fundamentals. 7. Compare the different types of coolant. 8. Discuss coolant freezing/boiling temperatures. 9. Discuss coolant testing and replacement issues.
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 05 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	CH05 DIESEL ENGINE COOLING SYSTEM
	**1. SLIDE 1 CH5 DIESEL ENGINE COOLING SYSTEM** **2. SLIDES 2-3 EXPLAIN Objectives & KEY TERMS**
	**Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE REGULARLY UPDATED**
	**Light Diesel (111 Links)**
	**http://www.jameshalderman.com/books_a9.html** **Crossword Puzzle (Microsoft Word) (PDF)** **Word Search Puzzle (Microsoft Word) (PDF**
	**3. SLIDE 3 EXPLAIN FIGURE 5–1** an engine block heater uses 110-volt AC household current to warm the coolant in the water jacket of this Duramax V-8 diesel engine. The heater replaces a core plug in side of block.
	**EXPLAIN TECH TIP**
	**DISCUSSION: Have students discuss heat generated in an engine. Ask: "If one-third of the heat is removed through the cooling system, and one-third is removed through the exhaust system, what is the other one-third used for?" (Answer: Pushing pistons down.)**
	**Engines that do not reach proper operating temperature may leave water in oil, which can cause engine failures, such as bearing failure.**
	**DISCUSSION: Discuss with students how improper coolant temperature can harm fuel economy. Why does temperature affect fuel economy? (ANS: Changes fuel vaporization rate)**
	**4. SLIDE 4 EXPLAIN** Cooling System Operation & **EXPLAIN FIGURE 5-2** Coolant circulates through water jackets in engine block and cylinder head.

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	**DISCUSSION:** Have students discuss possible reasons that older engines were less likely to have engine failure from overheating. (The reason is that heavy steel blocks and heads displaced heat better and were able to take higher temperatures without damage due to amount of metal.)
	**ON-VEHICLE Task:** Research applicable vehicle and service information, vehicle service history, service precautions, and technical service bulletins
	5. **SLIDE 5 EXPLAIN FIGURE 5-3** cross section of a typical wax-actuated thermostat showing the position of wax pellet and spring. 6. **SLIDE 6 EXPLAIN FIGURE 5-5 (a)** When the engine is cold, the coolant flows through the bypass. 7. **SLIDE 7 EXPLAIN FIGURE 5-5 (b)** When thermostat opens, the coolant can flow to the radiator
	**DISCUSS CHART 5–11 temperature of coolant depends on rating of thermostat**
	8. **SLIDE 8 EXPLAIN FIGURE 14-6** thermostat stuck in open position caused engine to operate too cold. If a thermostat is stuck closed, can cause engine to overheat.
	**BYPASS around closed thermostat allows small part of coolant to circulate within engine, past thermostat during warm-up. It is small passage that leads from engine side of thermostat to inlet side of water pump. It allows some coolant to bypass thermostat even when thermostat is open. Bypass opening may be cast or drilled into engine and/or water pump parts.**
	**DEMONSTRATION: Show students a bypass hose and where it is located on different engines.**
	**DISCUSSION: Discuss with students why the bypass hose is so important. Why is it important? (ANS: Allows for rapid engine warm up)**

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	**Removing a thermostat may cause overheating issues because coolant flows so quickly that it cannot absorb the heat.**
	9. **SLIDE 9 EXPLAIN FIGURE 5–6** Scan tool can be used to monitor the engine coolant temperature (ECT). 10. **SLIDE 10 EXPLAIN FIGURE 5–7** Some diesel engines, such as this Duramax, use 2 thermostats that have slightly different temperature ratings so caution should be used to install specified thermostat in correct position.
	**Thermostat Operation ANIMATION: http://www.jameshalderman.com/animations.html#a1**
	**When checking a thermostat for an overheating condition, be sure the thermostat is installed correctly.**
	**DISCUSSION: Discuss with students the 3 methods of testing thermostats & positive and negatives of each.**
	**DEMONSTRATION: Using the hot water method, show how a thermostat opens and closes.**
	HANDS-ON TASK: Have students perform thermostat testing
	**When replacing thermostat, be sure sensing pellet is facing engine block.**
	**ON-VEHICLE TASK: Inspect, test, remove and replace thermostat and gasket/seal.**
	11. **SLIDE 11 EXPLAIN Figure 5-8** tubes and fins of radiator core. 12. **SLIDE 12 EXPLAIN FIGURE 5-9 (a)** radiator may be either a down-flow or a crossflow type. 13. **SLIDE 13 EXPLAIN FIGURE 5-9 (b)** radiator may be either a down-flow or a crossflow type.

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       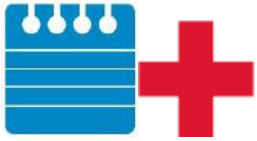	14. **SLIDE 15 EXPLAIN FIGURE 5-10** Many vehicles equipped with automatic transmission use a transmission fluid cooler installed in one of radiator tanks. **Older steel radiators could often be repaired. Most newer radiators cannot be repaired, due to cost, & must be replaced** **DEMONSTRATION: Show students different styles of radiators.** **DISCUSSION: Discuss the importance of heat transfer. What are 3 forms of heat transfer from Physics Class? (ANS: Conductance, Convection, & Radiation. Radiators despite their name, generally transfer the bulk of their heat via convection, not by thermal radiation. Convection is transfer of heat from one place to another by movement of fluids. Convection is usually the dominant form of heat transfer in liquids and gases)** **ON-VEHICLE TASK: Remove and replace radiator** 15. **SLIDE 15 EXPLAIN FIGURE 5-11** pressure valve maintains system pressure and allows excess pressure to vent. Vacuum valve allows coolant to return to the system from the recovery tank **EXPLAIN FREQUENTLY ASKED QUESTION** **What Does the 1.1 on Radiator Cap Mean?** **RADIATOR PRESSURE CAP ANIMATION: www.myautomotivelab.com http://media.pearsoncmg.com/ph/chet/chet_myautomotivelab_2/animations/A1_Animation/Chapter14_Fig_14_14/index.htm** **Pressure Cap Operation ANIMATION: http://www.jameshalderman.com/animations.html#a1** **SAFETY TIP: Always remove a pressure cap slowly using rags or heavy gloves for protection. A hot cooling system can spray**

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	coolant or steam under pressure. Even a cold system may have pressure that can spray coolant into eyes or damage paint. Overheating transmissions can cause engine overheating issues.
	
	**DEMONSTRATION: Demonstrate how a pressure cap vents at the pressure listed.**
	**Show RADIATOR PRESSURE CAP ANIMATION:** **www.myautomotivelab.com** http://media.pearsoncmg.com/ph/chet/chet_myautomotivelab_2/animations/A1_Animation/Chapter14_Fig_14_14/index.htm
	16. **SLIDE 16 EXPLAIN** Coolant Recovery Systems & **EXPLAIN FIGURE 5-12** level in the coolant recovery system raises and lowers with engine temperature. 17. **SLIDE 17 EXPLAIN FIGURE 5–13** Some vehicles, such as this FORD F-250 pickup truck equipped with a 6.7 liter power stoke diesel engine, use expansion tank, which is located at the highest level of cooling system
	**DEMONSTRATION: Show students different types of coolant recovery bottles**
	**DISCUSSION: Discuss with students why the recovery bottle is important to longevity of the cooling system's effectiveness.**
	**Collapsed hoses may be caused by pressure cap not venting correctly.**
	**ON-VEHICLE NON- Task: Inspect and replace engine cooling and heater system hoses**
	18. **SLIDE 18 EXPLAIN Water Pumps & EXPLAIN FIGURE 5-15** Coolant flow through impeller & scroll of coolant pump for a V-type

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	19. **SLIDE 19 EXPLAIN FIGURE 5-16** bleed weep hole in the water pump allows coolant to leak out of the pump and not be forced into the bearing. If the bearing failed, more serious damage could result. 20. **SLIDE 20 EXPLAIN FIGURE 5-17** cutaway of a typical water pump showing long bearing assembly and seal. The weep hole is located between seal and bearing. If the seal fails, then coolant flows out of the weep hole to prevent the coolant from damaging the bearing.
	**DISCUSSION: Discuss water pump operation with students**
	**DEMONSTRATION: Show students different variations of a water pump.**
	**DEMONSTRATION: Show students water pump weep hole.**
	**Be sure to install the serpentine belt correctly when replacing water pump; otherwise, pump may turn backwards.**
	**ON-VEHICLE Task: Inspect, test, remove, and replace water pump.**
	**DISCUSSION: Discuss with students differences in coolant flow systems.**
	**DEMONSTRATION: Show students different head gasket designs and the coolant passages through them.**
	21. **SLIDE 21 EXPLAIN Cooling Fans & EXPLAIN FIGURE 5-18** typical electric cooling fan assembly showing the radiator and related components. 22. **SLIDE 22 EXPLAIN FIGURE 5-19** typical engine-driven thermostatic spring cooling fan.
	

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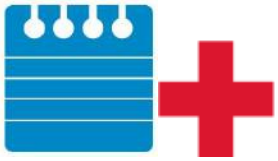
	**Show CLUTCH FAN & HOSES** **VIDEO: 1.5 MINUTES** **www.myautomotivelab.com** http://media.pearsoncmg.com/ph/chet/chet_mylabs/akamai/template/video640x480.php?title=Clutch%20Fan%20and%20Hoses&clip=pandc/chet/2012/automotive/Auto_Parts_Specialist/Exp5.mov&caption=chet/chet_mylabs/akamai/2012/automotive/Auto_Parts_Specialist/xml/Exp5.xml **SAFETY: Electrical cooling fans can come on unexpectedly. Always keep hands and objects clear of them. Spring-type fans should spin freely on a cold engine.**
	**DEMONSTATION: Show students how to remove and replace a cooling fan assembly.**
 	**ON-VEHICLE TASK: Inspect and text fans(s) (electrical or mechanical), fan clutch, fan shroud, and air dams.**
	**DEMONSTRATION: Show students how fan shroud helps direct airflow through radiator.**
	**23. SLIDE 23 EXPLAIN Cooling System Testing** **24. SLIDE 24 EXPLAIN FIGURE 5-20** heavily corroded radiator from a vehicle that was overheating. A visual inspection discovered that the corrosion had eaten away many of the cooling fins, yet did not leak. This radiator was replaced and it solved the overheating problem
	**25. SLIDE 25 EXPLAIN Cooling System Testing & EXPLAIN FIGURE 5-21** Pressure testing cooling system. Hand operated pressure tester applies pressure equal to radiator cap pressure. The pressure should hold; if it drops, this indicates a leak somewhere in cooling system. An adapter is used to attach pump to cap to determine if radiator can hold pressure, & release it when pressure rises above max rated pressure setting. **26. SLIDE 26 EXPLAIN FIGURE 5–22** Use dye specifically made for coolant when checking for leaks using a black light..
	**If using a dye to leak test, it may be necessary to remove the blower resistor to access the heater core for inspection.**

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	**DEMONSTRATION: Show students how dye illuminates with a black light.**
	**ON-VEHICLE TASK Perform cooling system pressure and dye tests to identify leaks; check coolant condition and level; inspect and test radiator, pressure cap, coolant recovery tank, and heater core; determine necessary action**
	**ON-VEHICLE TASK Identify causes of engine overheating**
	**DISCUSSION: Discuss proper coolant disposal procedures.**
	**DEMONSTRATION: Show students proper procedure for using a coolant exchange machine.**
	**Air pockets around thermostat can cause thermostat to malfunction, causing an overheating condition.**
	27. **SLIDE 27 EXPLAIN FIGURE 5-25** Havoline was the first company to make and market OAT coolant. General Motors uses the term DEX-COOL
	**DEMONSTRATION: Show students examples of coolant colors. Explain that coolant spills should be cleaned up immediately since they are very slick and can be hazardous.**
	**SAFETY TIP: Never leave open coolant containers where animals can reach them. Animals enjoy sweet taste of coolant & drink it. Coolant can kill pets. Even embittered coolant should not be left around animals. Even though animals may not like taste of this coolant and so may not drink it, they still may lick it and become ill.**
	**DISCUSSION: Discuss how the mixing of types of coolants may harm the system. Discuss with students some examples of manufacturer issues**

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    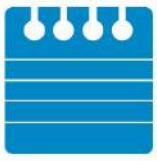   	**with DEX-COOL. Who was the first OEM to use DEX-COOL?** **EXPLAIN FREQUENTLY ASKED QUESTION** **What Pet Friendly Anti-Freeze?** **28. SLIDE 28 EXPLAIN FIGURE 5-26** Not all embittered coolant is labeled embittered. **EXPLAIN FREQUENTLY ASKED QUESTION** **Why Use Premixed Coolant When Water is So Cheap? (1 of 2)** **29. SLIDE 29 EXPLAIN FIGURE 5–27 (**1) Cavitation starts when bubble is created by slight movement of cylinder wall causing low pressure area. (2) When cylinder wall moves outward during power stroke, bubble starts reducing due to increased pressure being exerted on it. (3) bubble begins collapsing. (4) When bubble collapses, coolant forced against side of cylinder wall with enough force to erode surface of cooling jacket. **30. SLIDES 30 EXPLAIN FIGURE 5–28** Test strip can be used to determine pH and percentage of glycol of coolant. Percentage of glycol determines freezing and boiling temperatures, as shown on bottle that contains test strips **Electrolysis in cooling system can create corrosion that destroys components from the inside out** **HANDS-ON TASK: Have students use test strips to verify the coolant condition** **EXPLAIN TECH TIP Ignore the Wind Chill Factor** **31. SLIDE 31 EXPLAIN FIGURE 5–29** Using a refractometer is an accurate method to check the freezing point of coolant **32. SLIDE 32 EXPLAIN FIGURE 5–30** meter that measures the actual pH of the coolant can be used for all

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     	coolants, unlike many test stripes that cannot be used to test the pH of red or orange coolants **<u>DEMONSTRATION:</u> Show students how to test for electrolysis in cooling system.** **Coolant colors vary even within OEMS models. Color has no bearing on the service life of the coolant. Most OEMS recommend using distilled water, not tap water, in cooling systems. Distilled water does not have all the chemicals that can harm your cooling system.** 33. **SLIDE 33 EXPLAIN FIGURE 5–31** Galvanic activity is created by two dissimilar metals in contact with a liquid, in this case coolant. **<u>ON-VEHICLE TASK</u> Inspect and test coolant; drain and recover coolant; flush and refill cooling system with recommended coolant; bleed air as required PAGE 30** **<u>SEARCH INTERNET (2 HOURS OUTSIDE WORK):</u> Have students research the Internet to find out which coolants are organic acid technology types besides DEX-COOL. Have students research which states require embittered coolant other than California and Oregon. Have them share their findings in class.**