Automotive Engines
Chapter 26 Cylinder Head & Valve Guide Service
Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This engine systems course or class provides complete coverage of the components, operation, design, and troubleshooting. 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, Real World Fixes, Videos, Animations, and NATEF Task Sheet references.
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 NEXT SLIDE. 1. Prepare for ASE Engine Repair (A1) certification test content area "B" (Cylinder Head and Valve Train Diagnosis and Repair). 2. Identify combustion chamber types. 3. List the steps necessary to recondition a cylinder head. 4. Describe how to inspect and measure valve guides. 5. Discuss valve guide repair options.
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.

ICONS	Chapter 26 Cylinder Head Service
	**1. SLIDE 1 CH26 CYLINDER HEAD/VALVE GUIDE SVC** **2. SLIDES 2-3 EXPLAIN Objectives & KEY TERMS**
	**Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE IS UPDATED REGULARLY**
	**4. SLIDE 4 EXPLAIN Introduction** **5. SLIDE 5 EXPLAIN Cylinder Heads**
	**DEMONSTRATION: Show major components of cylinder head**
	**6. SLIDE 6 EXPLAIN FIGURE 26-1** seats and guides for the valves are in cylinder head as well as camshaft and the entire valve train if it is an overhead camshaft design. **7. SLIDE 7 EXPLAIN FIGURE 26-2** wedge-shaped combustion chamber showing squish area where air-fuel mixture is squeezed, causing turbulence that pushes mixture toward spark plug. **8. SLIDE 8 EXPLAIN FIGURE 26-3** Locating spark plug in center of combustion chamber reduces distance flame front must travel. **9. SLIDE 9 EXPLAIN FIGURE 26-4** combustion chamber of the 5.7 liter Chrysler Hemi cylinder head shows the two spark plugs used to ensure rapid burn for best power and economy with lowest possible exhaust emissions.
	**10. SLIDE 10 EXPLAIN FREQUENTLY ASKED QUESTION** **11. SLIDE 11 EXPLAIN FREQUENTLY ASKED QUESTION**
	12. SLIDE 12 EXPLAIN FIGURE 26-5 shrouded area around the intake valve causes the intake mixture to swirl as it enters the combustion chamber. **13. SLIDE 13 EXPLAIN FIGURE 26-6** A typical cross flow cylinder head design, where the flow into and out of the combustion chamber is from opposite sides of head.

ICONS	Chapter 26 Cylinder Head Service
	**DEMONSTRATION: Show examples of combustion chamber design.**
	**HANDS-ON TASK: Have students research LRC how changes to the squish area turbulence in a cylinder.**
	**DISCUSSION: Ask the students how the quench area might affect emissions from engine.**
	14. **SLIDE 14 EXPLAIN FIGURE 26-7** Method for measuring the valve opening space. 15. **SLIDE 15 EXPLAIN FIGURE 26-8** Comparing the valve opening areas between a two and three-valve combustion chamber when the valves are open. 16. **SLIDE 16 EXPLAIN FIGURE 26-9** Typical four-valve head. The total area of opening of two small intake valves and two smaller exhaust valves is greater than the area of a two-valve head using much larger valves. The smaller valves also permit the use of smaller intake runners for better low-speed engine response. 17. **SLIDE 17 EXPLAIN FIGURE 26-10** Four valves in a pentroof combustion chamber. 18. **SLIDE 18 EXPLAIN INTAKE AND EXHAUST PORTS**
	19. **SLIDE 19 EXPLAIN TECH TIP**
	20. **SLIDE 20 EXPLAIN FIGURE 26-11** Audi five-valve cylinder head, which uses three intake valves and two exhaust valves
	**DISCUSSION: Ask the students why intake valve is larger in diameter than exhaust valve.**
	**DEMONSTRATION: Show students cylinder head with four valves per cylinder & cylinder head with two valves per cylinder.**

ICONS	Chapter 26 Cylinder Head Service
	**DISCUSSION: Ask the students what benefits are of four valves per cylinder as opposed to only two valves per cylinder.**
	21. **SLIDE 21** EXPLAIN TECH TIP
	22. **SLIDE 22** EXPLAIN **FIGURE 26-12** intake manifold & combustion chamber design both work together to cause air-fuel mixture to swirl as enters combustion chamber. 23. **SLIDE 23** EXPLAIN **FIGURE 26-13** A port-injected engine showing the straight free-flowing intake and exhaust ports.
	**DISCUSSION: Ask students why porting, a common modification in past, might not be a wise thing to do on modern cylinder head designs. (ANS: might restrict air flow in modern head designs)**
	**HANDS-ON TASK: Using service information, give students a list of vehicles that have an optional 5-valve cylinder & let students determine which engines are available with configuration.**
	24. **SLIDE 24** EXPLAIN Cylinder Head Passages & EXPLAIN **FIGURE 26-14** cutaway head showing the coolant passages in green. 25. **SLIDE 25** EXPLAIN **FIGURE 26-15** Coolant flows through the cylinder head, and the passages are sealed by the head gasket. 26. **SLIDE 26** EXPLAIN Cylinder Head Passages
	**DEMONSTRATION: Show coolant passages in the cylinder head.**
	**DEMONSTRATION: Show oil flow and return passages in the cylinder head.**
	**DEMONSTRATION: Show examples of products and machines that can be used to decarbonize an engine**

ICONS	Chapter 26 Cylinder Head Service
	**ON-VEHICLE NATEF TASK (A1A2)** Research applicable vehicle and service information, such as internal engine operation, vehicle service history, service precautions, and technical service bulletins. (P-1) PAGES 16 & 20
	**DEMONSTRATION:** show correct procedure for disassembling cylinder head for service
	**Show ANIMATION: CYLINDER HEAD BOLT LOOSENING SEQUENCE www.myautomotivelab.com** http://media.pearsoncmg.com/ph/chet/chet_myautomotivelab_2/animations/A1_Animation/Chapter26_Fig_26_17/index.htm
	27. **SLIDE 27** EXPLAIN **FIGURE 26-16** Overhead camshafts may be (a) held in place with bearing caps, (b) supported by towers, or (c) fitted into bearing bores machined directly into head. 28. **SLIDE 28** EXPLAIN **FIGURE 26-17** Always follow specified loosening sequence to prevent valve spring tension from bending the camshaft. 29. **SLIDE 29** EXPLAIN **FIGURE 26-18** Pushrods can be kept labeled if stuck through a cardboard box. Individual parts become worn together. Using cardboard is crude but effective material to keep all valve train parts together and labeled exactly as they came from engine
	**Always keep the push rods and rocker arms in order. You can create a system by using a piece of cardboard and labeling it with a marker. Punch holes in cardboard to hold pushrods.**
	30. **SLIDE 30** EXPLAIN **FIGURE 26-19** Cylinder heads should be checked in 5 planes for warpage, distortion, bend, and twist. 31. **SLIDE 31** EXPLAIN **FIGURE 26-20** precision ground straightedge &feeler gauge used to check head flatness.
	**DEMONSTRATION: Show the students how to properly clean the cylinder head and use a straightedge & feeler gauge to check cylinder head for flatness.**
	**HANDS-ON TASK: Have the students use a cylinder head, feeler gauge, and straightedge to check a cylinder head for warpage.**

ICONS	Chapter 26 Cylinder Head Service
	**ON-VEHICLE NATEF TASK:** Clean & visually inspect a cylinder head for cracks; check gasket surface areas for warpage and surface finish; check passage condition. PAGE 112
	**Show VIDEO: Cylinder Head Warpage** **www.myautomotivelab.com** http://media.pearsoncmg.com/ph/chet/chet_mylabs/akamai/template/video640x480.php?title=Checking%20fo%20Cylinder%20Head%20Warpage&clip=pandc/chet/2012/automotive/Engines/A1T2.mov&caption=chet/chet_mylabs/akamai/2012/automotive/Engines/xml/A1T2.xml
	32. **SLIDE 32 EXPLAIN FIGURE 26-21** Warped overhead camshaft cylinder head. If the gasket surface is machined to be flat, the camshaft bearings will still not be in proper alignment. The solution is to straighten the cylinder head or to align bore the cam tunnel 33. **SLIDE 33 EXPLAIN** Cylinder Head Resurfacing & **EXPLAIN FIGURE 26-22** cast-iron cylinder head being resurfaced using a surface grinder. 34. **SLIDE 34 EXPLAIN FIGURE 26-23** graph showing a typical rough surface as would be viewed through a magnifying glass. RA is an abbreviation indicating the average height of all peaks and valleys.
	35. **SLIDE 35 EXPLAIN TECH TIP**
	**DEMONSTRATION:** If your shop is equipped with cylinder head resurfacing equipment, show the students how to grind or mill cylinder head. If you do not have the equipment (most don't), you might consider a field trip to an engine machine shop to familiarize students with process.
	**DISCUSSION:** Ask the students why the surface finish is important
	**HANDS-ON TASK:** Using service information and some specific vehicles, have the student's research whether OEM recommends resurfacing cylinder heads or requires them to be replaced if they are warped excessively.

ICONS	Chapter 26 Cylinder Head Service
	**36. SLIDE 36 EXPLAIN** Intake Manifold Alignment & **EXPLAIN FIGURE 26-24** material that must be removed for good manifold fit. **37. SLIDE 37 EXPLAIN FIGURE 26-25** Using an intake manifold template to check for the proper angles after the cylinder heads have been machined.
	**DEMONSTRATION: On a V-type engine block, show students how machining heads may affect the sealing of the intake manifold.**
	**38. SLIDE 38 EXPLAIN Valve Guides** **39. SLIDE 39 EXPLAIN FIGURE 26-26** integral valve guide is simply a guide that has been drilled into the cast-iron cylinder head. **40. SLIDE 40 EXPLAIN FIGURE 26-27** All aluminum cylinder heads use valve guide inserts. **41. SLIDE 41 EXPLAIN FIGURE 26-28** Valve guides often wear to a bell-mouth shape to both ends due to the forces exerted on the valve by valve train components.
	**DISCUSSION: Ask the students why an aluminum head might have a larger valve stem-to-guide clearance than a cast iron head.**
	**DEMONSTRATION: Show the students examples of cylinder heads with integral and pressed-in valve guides**
	**42. SLIDE 42 EXPLAIN FIGURE 26-29** small-hole gauge and a micrometer are being used to measure the valve guide. The guide should be measured in 3 places: at top, middle, and bottom. **43. SLIDE 43 EXPLAIN FIGURE 26-30** diameter of valve stem is being measured using a micrometer. The difference between inside diameter of valve guide and diameter of valve stem is valve guide-to-stem clearance. **44. SLIDE 44 EXPLAIN FIGURE 26-31** Measuring valve guide-to-stem clearance with a dial indicator while rocking stem in direction of normal thrust. Reading on dial indicator should be compared to specifications because it does not give guide-to-stem clearance directly. Valve is usually held open to its maximum operating lift.

ICONS	Chapter 26 Cylinder Head Service
	**Show VIDEO: CHECKING VALVE STEM-to-GUIDE CLEARANCE: 1 Minute www.myautomotivelab.com** http://media.pearsoncmg.com/ph/chet/chet_mylabs/akamai/template/video640x480.php?title=Checking%20valve%20Stem-To-Guide%20Clearance&clip=pandc/chet/2012/automotive/Engines/A1T5.mov&caption=chet/chet_mylabs/akamai/2012/automotive/Engines/xml/A1T5.xml
	**DEMONSTRATION: Show the students how to measure valve guide clearance using a small hole gauge & micrometer & a dial indicator**
	**45. SLIDE 45 EXPLAIN TECH TIP**
	**46. SLIDE 46 EXPLAIN FREQUENTLY ASKED QUESTION** **47. SLIDE 47 EXPLAIN FREQUENTLY ASKED QUESTION** **48. SLIDE 48 EXPLAIN FREQUENTLY ASKED QUESTION**
	**49. SLIDE 49 EXPLAIN FIGURE 26-32** Sectional view of a knurled valve guide.
	**ON-VEHICLE NON-NATEF TASK: Inspect valve guides for wear, check valve stem-to-guide clearance; determine necessary action**
	**ANIMATION: VALVE GUIDE REMOVAL www.myautomotivelab.com** http://media.pearsoncmg.com/ph/chet/chet_myautomotivelab_2/animations/A1_Animation/Chapter26_Fig_26_33/index.htm
	**50. SLIDE 50 EXPLAIN Valve Guide Replacement** **51. SLIDE 51 EXPLAIN FIGURE 26-33** Valve guide replacement procedure. **52. SLIDE 52 EXPLAIN FIGURE 26-34** type of fixture required to bore guide to accept thin-walled insert sleeve. **53. SLIDE 53 EXPLAIN FIGURE 26-35** Trimming top of the thin-walled insert. **54. SLIDE 54 EXPLAIN FIGURE 26–36** Installed spiral bronze insert bushing
	**55. SLIDE 55 EXPLAIN TECH TIP**

ICONS	Chapter 26 Cylinder Head Service
	**HANDS-ON TASK:** Have the students use service information to locate the valve guide clearance for a variety of engines.
	**DEMONSTRATION:** Show the students how to replace a valve guide insert using the proper tools and following OEM recommendations.
	**HANDS-ON TASK:** Have the students replace the valve guide on a cylinder head with replaceable valve guide using the proper tools and equipment & meeting OEM specifications.
	**DEMONSTRATION:** Show the students the proper procedure to install a valve guide insert.
	**HANDS-ON TASK:** On a cylinder head and with proper tools, have the students install valve guide insert, meeting OEM specifications
	**SEARCH INTERNET:** Have the students search the Internet to determine advantages of the hemi design combustion chamber as opposed to the wedge design.
	**Talk through SUMMARY and questions**
	**HOMEWORK:** complete Ch26 crossword puzzle: http://www.jameshalderman.com/links/book_engine_theory_serv_7/cw/crossword_ch_26.pdf