Automotive Technology 6th Edition
Chapter 30 Cylinder Head & Valve Guide Service
Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This Automotive Technology 6th text provides complete coverage of automotive components, operation, design, and troubleshooting. It correlates material to task lists specified by ASE and ASEEducation (NATEF) and emphasizes a problem-solving approach. Chapter features include Tech Tips, Frequently Asked Questions, Case Studies, Videos, Animations, and ASEEducation (NATEF) Task Sheets.
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: 1. Explain the design and construction of cylinder heads. 2. Discuss intake and exhaust ports. 3. Discuss cylinder head passages and cylinder head servicing. 4. Explain aluminum cylinder head straightening, cylinder head resurfacing, and intake manifold alignment. 5. Explain valve guides and the procedure for valve guide replacement.
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 6th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

DOWNLOAD Chapter 30 Chapter Images: From

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

NOTE: You can use Chapter Images or possibly Power Point files:

ICONS	CH30 Cylinder Head
	**1. SLIDE 1 CH30 CYLINDER HEAD/VALVE GUIDE SVC**
	**Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE IS CONSTANTLY UPDATED**
	**http://www.jameshalderman.com/automotive_principles.html** **DOWNLOAD** **Crossword Puzzle (Microsoft Word) (PDF)** **Word Search Puzzle (Microsoft Word) (PDF)**
	**VALVE TRAIN SERVICE** **Videos**
	**DEMONSTRATION: Show major components of cylinder head**
	2. **SLIDE 2 EXPLAIN Figure 30-1** seats and guides for valves are in the cylinder head as well as camshaft and the entire valve train if it is an overhead camshaft design. 3. **SLIDE 3 EXPLAIN Figure 30-2** wedge-shaped combustion chamber showing squish area where air-fuel mixture is squeezed, causing turbulence that pushes mixture toward spark plug.

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	**DISCUSS FREQUENTLY ASKED QUESTION:** **What Is Carbon Knock?** Carbon knock was a common occurrence in older engines that were equipped with carburetors and high compression ratios. As carburetors aged, the mixture would tend to be richer than normal, due to a leaking needle and seat, as well as a fuel-saturated float. This richer mixture would often cause carbon deposits to form in the combustion chamber. During light load conditions when the spark advance was greatest, a spark knock would occur, caused by a higher compression ratio due to the carbon deposits. This knocking was often very loud, sounding like a rod bearing noise, because in some cases the carbon deposits actually caused physical contact between the piston and the carbon. Many engines were disassembled in the belief that the cause of the knocking sound was a bearing, only to discover that the bearings were okay. Carbon knock can still occur in newer engines, especially if there is a fault in the fuel system that would allow a much richer-than-normal air-fuel mixture, causing excessive carbon deposits to form in the combustion chamber. Often a decarbonization using chemicals will correct the knocking.

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	4. **SLIDE 4 EXPLAIN Figure 30-3** Locating spark plug in center of combustion chamber reduces distance flame front must travel. 5. **SLIDE 5 EXPLAIN Figure 30-4** 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. 6. **SLIDE 6 EXPLAIN Figure 30-5** shrouded area around the intake valve causes the intake mixture to swirl as it enters the combustion chamber. 7. **SLIDE 7 EXPLAIN Figure 30-6** A typical cross flow cylinder head design, where the flow into and out of the combustion chamber is from opposite sides of head.
	**EXPLAIN TECH TIP: Unshroud the Intake Valve for More Power: If an engine is being rebuilt for high performance, most experts recommend that the shrouded section around the intake valve be removed. This operation increases the airflow and, therefore, the power that the engine can achieve, especially at higher engine speeds. This process is often called unshrouding.**
	**DEMONSTRATION: Show examples of combustion chamber design.**
	**HANDS-ON TASK: Have students research how changes to the squish area will affect turbulence in a cylinder.**
	**DISCUSSION: Ask the students how the quench area might affect emissions from engine.**

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	8. **SLIDE 8 EXPLAIN Figure 30-7** Method for measuring the valve opening space. 9. **SLIDE 9 EXPLAIN Figure 30-8** Comparing the valve opening areas between a two and three-valve combustion chamber when the valves are open. 10. **SLIDE 10 EXPLAIN Figure 30-9** 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. 11. **SLIDE 11 EXPLAIN Figure 30-10** Four valves in a pentroof combustion chamber.
	**EXPLAIN TECH TIP: Horsepower Is Airflow** **To get more power from an engine, more air needs to be drawn into the combustion chamber. One way to achieve more airflow is to increase the valve and port size of the cylinder heads along with a change in camshaft lift and duration to match the cylinder heads. One popular, but expensive, method is to replace the stock cylinder heads with high-performance cast-iron or aluminum cylinder heads. Some vehicle manufacturers, such as Audi, go to great expense to design high-flow rate cylinder heads by installing five-valve cylinder heads on some of their high performance engines. • SEE FIGURE 30–11.**
	12. **SLIDE 12 EXPLAIN Figure 30-11** 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.**

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	**DEMONSTRATION: Show students cylinder head with four valves per cylinder & cylinder head with two valves per cylinder.**
	**DISCUSSION: Ask the students what benefits are of four valves per cylinder as opposed to only two valves per cylinder.**
	13. **SLIDE 36 EXPLAIN Figure 30-12** intake manifold & combustion chamber design both work together to cause air-fuel mixture to swirl as enters combustion chamber. 14. **SLIDE 14 EXPLAIN Figure 30-13** 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.**
	15. **SLIDE 15 EXPLAIN Figure 30-14** cutaway head showing the coolant passages in green. 16. **SLIDE 16 EXPLAIN Figure 30-15** Coolant flows through the cylinder head, and the passages are sealed by the head gasket
	**DEMONSTRATION: Show coolant passages in the cylinder head.**
	**DEMONSTRATION: Show oil flow and return passages in the cylinder head.**

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	**DEMONSTRATION: Show examples of products and machines that can be used to decarbonize an engine**
 	**ON-VEHICLE ASEEDUCATION TASK Research applicable vehicle and service information, such as internal engine operation, vehicle service history, service precautions, and technical service bulletins. (P-1)**
	**DEMONSTRATION: show correct procedure for disassembling cylinder head for service**
	17. **SLIDE 17 EXPLAIN Figure 30-16** 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. 18. **SLIDE 18 EXPLAIN Figure 30-17** Always follow specified loosening sequence to prevent valve spring tension from bending the camshaft. 19. **SLIDE 19 EXPLAIN Figure 30-18** Pushrods can be kept labeled if stuck through a cardboard box. Individual parts become worn together. Using cardboard is a 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.**
	20. **SLIDE 20 EXPLAIN Figure 30-19** Cylinder heads should be checked in 5 planes for warpage, distortion, bend, and twist. 21. **SLIDE 21 EXPLAIN Figure 30-20** precision ground straightedge &feeler gauge used to check head flatness.

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	**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.**
	**ON-VEHICLE ASEEDUCATION TASK Clean & visually inspect a cylinder head for cracks; check gasket surface areas for warpage and surface finish; check passage condition (P-1)**
Education Foundation	
	22. **SLIDE 22 EXPLAIN Figure 30-21** 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. 23. **SLIDE 23 EXPLAIN Figure 30-22** cast-iron cylinder head being resurfaced using a surface grinder. 24. **SLIDE 24 EXPLAIN Figure 30-23** 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.

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	**EXPLAIN TECH TIP: The Potato Chip Problem** **Most cylinder heads are warped or twisted in the shape of a typical potato chip (high at the ends and dipped in the center). After a cylinder head is ground, the surface should be perfectly flat. A common problem involves grinding the cylinder head in both directions while it is being held on the table that moves to the left and right. Most grinders are angled by about 4 degrees. The lower part of the stone should be the cutting edge. If grinding occurs along the angled part of the stone, then too much heat is generated. This heat warps the head (or block) upward in the middle. The stone then removes this material, and the end result is a slight (about 0.0015 inch) depression in the center of the finished surface. To help prevent this from happening, always feed the grinder in the forward direction only (especially during removal of the last 0.003 inch of material).**
	**OPTIONAL 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.**

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	**25. SLIDE 25 EXPLAIN Figure 30-24** material that must be removed for good manifold fit. **26. SLIDE 26 EXPLAIN Figure 30-25** 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.**
	**27. SLIDE 27 EXPLAIN Figure 30-26** integral valve guide is simply a guide that has been drilled into the cast-iron cylinder head. **28. SLIDE 28 EXPLAIN Figure 30-27** All aluminum cylinder heads use valve guide inserts**.** **29. SLIDE 29 EXPLAIN Figure 30-28** Valve guides often wear to a bell-mouth shape to both ends due to the forces exerted on the valve by the 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**
	**30. SLIDE 30 EXPLAIN Figure 30-29** 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.

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	31. **SLIDE 31 EXPLAIN Figure 30-30** 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. 32. **SLIDE 32 EXPLAIN Figure 30-31** Measuring valve guide-to-stem clearance with a dial indicator while rocking stem in direction of normal thrust. The reading on dial indicator should be compared to specifications because it does not give the guide-to-stem clearance directly. The valve is usually held open to its maximum operating lift.
	**DEMONSTRATION: Show the students how to measure valve guide clearance using a small hole gauge & micrometer & a dial indicator**

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	**DISCUSS FREQUENTLY ASKED QUESTION: What Is Valve Guide Knurling? In an old and now outdated process known as valve guide knurling, a tool is rotated as it is driven into the guide. The tool displaces the metal to reduce hole diameter of the guide. Knurling is ideally suited to engines with integral valve guides (guides that are part of the cylinder head and are nonremovable). It is recommended that knurling not be used to correct wear exceeding 0.006 inch (0.15 mm). In the displacing process, knurling tool pushes a small tapered wheel or dull threading tool into the wall of the guide hole. This makes a groove in the wall of the guide, similar to a threading operation without removing any metal. The metal piles up along the edge of the groove just as dirt would pile up along the edge of a tire track as the tire rolled through soft dirt. (The dirt would be displaced from under the wheel to form a small ridge alongside the tire track.) • SEE FIGURE 30–32. The knurling tool is driven by an electric drill and an attached speed reducer that slows the rotating speed of the knurling tool. The reamers that accompany the knurling set will ream just enough to provide the correct valve stem clearance for commercial reconditioning standards. The valve guides are honed to size in the precision shop when precise fits are desired. Clearances of knurled valve guides are usually one-half of the new valve guide clearances. Such small clearance can be used because knurling leaves so many small oil rings down the length of the guide for lubrication.**

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	**33. SLIDE 33 EXPLAIN FIGURE 30–32** Sectional view of a knurled valve guide.
	**EXPLAIN TECH TIP: Tight Is Not Always Right** **Many engine manufacturers specify a valve stem-to-guide clearance of 0.001 to 0.003 inch (0.025 to 0.076 mm). However, some vehicles, especially those equipped with aluminum cylinder heads, may specify a much greater clearance. For example, many Chrysler 2.2 and 2.5 liter engines have a specified valve stem-to-guide clearance of 0.003 to 0.005 inch (0.076 to 0.127 mm). This amount of clearance feels loose to those technicians accustomed to normal valve stem clearance specifications. Although this large amount of clearance may seem excessive, remember that the valve stem increases in diameter as the engine warms up. Therefore, the operating clearance is smaller than the clearance measured at room temperature. Always double-check factory specifications before replacing a valve guide for excessive wear.**
 Education Foundation	**ON-VEHICLE ASEEDUCATION TASK Inspect valve guides for wear, check valve stem-to-guide clearance; determine necessary action**
	**34. SLIDE 34 EXPLAIN Figure 30-33** Valve guide replacement procedure. **35. SLIDE 35 EXPLAIN Figure 30-34** A type of fixture required to bore the valve guide to accept a thin-walled insert sleeve. **36. SLIDE 36 EXPLAIN Figure 30-35** Trimming top of the thin-walled insert. **37. SLIDE 37 EXPLAIN Figure 30-36** Installed spiral bronze insert bushing.

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	**EXPLAIN TECH TIP: Right Side Up: When replacing valve guides, it is important that the recommended procedures be followed. Most manufacturers specify that replaceable guides be driven from the combustion chamber side toward the rocker arm side. For example, big block Chevrolet V-8 heads (396, 402, 427, and 454 cu. in.3) have a 0.004 inch (0.05 mm) taper (small end toward the combustion chamber). Other OEMS, however, may recommend driving the old guide from the rocker arm side to prevent any carbon buildup on the guide from damaging the guide bore. Always check the OEM recommended procedures before attempting to replace a valve guide.**
	**HANDS-ON TASK: Have the students use service information to locate the valve guide clearance for a variety of engines.**
	**OPTIONAL DEMONSTRATION: Show the students how to replace a valve guide insert using the proper tools and following OEM recommendations.**
	**OPTIONAL 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.**
	**OPTIONAL 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**

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	**SEARCH INTERNET: Have the students search the Internet to determine advantages of the hemi design combustion chamber as opposed to the wedge design.**