Automotive Technology 6th Edition
Chapter 34 ENGINE BLOCKS
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 construction of engine blocks. 2. Explain the procedure for engine block service. 3. Explain block preparation for assembly.
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

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

ICONS	CH34 ENGINE BLOCK
	**1. SLIDE 1 CH34 ENGINE BLOCKS** **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** **Videos** **DISCUSSION: DISCUSS difference between cast iron and forged iron. Cast iron is poured into a mold; forged iron is shaped using force and heat.** 2. **SLIDE 2 EXPLAIN Figure 34-1** cylinder block usually extends from the oil pan rails at the bottom to the deck surface at the top. 3. **SLIDE 3 EXPLAIN Figure 34-2** An expansion (core) plug is used to block the opening in the cylinder head or block the holes where the core sand was removed after the part was cast. 4. **SLIDE 4 EXPLAIN Figure 34-3** A Styrofoam casting mold used to make the five cylinder engine blocks for the Chevrolet Colorado and the Hummer H3. The brown lines are glue used to hold the various parts together. Sand is packed around the mold and molten aluminum is poured into the sand which instantly vaporizes the Styrofoam. The aluminum then flows and fills the area of the mold. **Displacement & Compression Ratio (View) (Download)** **DISCUSSION: Ask students to discuss how engine blocks were made before the aid of computers. Castings were produced by hand to make the molds.**

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	**DISCUSS FREQUENTLY ASKED QUESTION: *What Is Compacted Graphite Iron?* Compacted graphite iron (CGI) has increased strength, ductility, toughness, and stiffness compared to gray iron. If no magnesium is added, the iron will form gray iron when cooled, with the graphite present in flake form. If a very small amount of magnesium is added, more and more of the sulfur and oxygen form in the molten solution, and the shape of the graphite begins to change to compacted graphite forms. Compacted graphite iron is used for bedplates and many diesel engine blocks. It has higher strength, stiffness, and toughness than gray iron. The enhanced strength has been shown to permit reduced weight, while still reducing noise vibration and harshness. Compacted graphite iron is commonly used in the blocks of diesel and some high-performance engines.** **5. SLIDE 5 EXPLAIN Figure 34-4** Cast-iron dry sleeves are used in aluminum blocks to provide a hard surface for rings. **6. SLIDE 6 EXPLAIN Figure 34-5** A dry sleeve is supported by the surrounding cylinder block. A wet sleeve must be thicker to be able to withstand combustion pressures without total support from the block. **7. SLIDE 7 EXPLAIN Figure 34-6** A bedplate is a structural part of the engine which is attached between the block and the oil pan and supports the crankshaft. **8. SLIDE 8 EXPLAIN Figure 34-7** Casting numbers identify the block. **9. SLIDE 9 EXPLAIN Figure 34-8** deck is the machined top surface of the block.
	**DISCUSS FREQUENTLY ASKED QUESTION: *What Are FRM-Lined Cylinders?* Fiber-reinforced matrix (FRM) is used to strengthen cylinder walls in some Honda/Acura engines. FRM is ceramic material similar to that used to construct insulators of spark plugs. The lightweight**

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	material has excellent wear resistance and good heat transfer properties, making it ideal for use as a cylinder material. FRM inserts are placed in the mold and the engine block is cast over them. The inserts are rough and can easily adhere to engine block. The inserts are then bored and honed to form the finished cylinders. FRM blocks were first used in a production engine on the Honda S2000 and are also used on turbocharged Acura RDX sport utility vehicle. **DISCUSSION: Have students discuss why it is easier to modify an older engine than a modern engine. Have them explain reasoning behind their answers.** 10. **SLIDE 10 EXPLAIN Figure 34-9** Cutaway of a Chevrolet V-8 block showing all of the internal passages. **Some OEMS have different designs for same engine. For example, Ford has a 4.6 L engine; however, 2 different engine plants build 2 engine. It is common for a technician to order parts based on where engine was built.** **DISCUSSION: Ask students to discuss what would cause oil galleries to become clogged. If a vehicle does not have regular oil changes, the oil can stick to engine parts and cause problems as it thickens up.** 11. **SLIDE 11 EXPLAIN Figure 34-10** Typical oil gallery plugs on the rear of a Chevrolet small block V-8 engine. 12. **SLIDE 12 EXPLAIN Figure 34-11** Small block Chevrolet block. Note the left-hand dipstick hole and a pad cast for a right-hand dipstick.  **EXPLAIN TECH TIP: *What Does LHD Mean?* The abbreviation LHD means left-hand dipstick, which is commonly used by rebuilders and remanufacturers in their literature, describing Chevrolet small block V-8 engines. Before about 1980, most small block Chevrolet V-8s used an oil dipstick pad on the left**

side (driver's side) of the engine block. Starting in about 1980, when oxygen sensors were first used on this engine, the dipstick was relocated to the right side of the block. Therefore, to be assured of ordering or delivering correct engine, knowing the dipstick location is critical. An LHD block cannot be used with the exhaust manifold setup that includes the oxygen sensor without major refitting, or the installing of a different style of oil pan that includes a provision for an oil dipstick. Engine blocks with the dipstick pad cast on the right side are, therefore, coded as right-hand dipstick (RHD) engines. NOTE: Some blocks cast around the year 1980 are cast with both right- and left-hand oil dipstick pads, but only one is drilled for the dipstick tube.

- **SEE FIGURE 34–11.**

13. **SLIDE 13 EXPLAIN Figure 34-12** Two-bolt main bearing caps provide adequate bottom end strength for most engines.
14. **SLIDE 14 EXPLAIN Figure 34-13** High-performance and truck engines often use four-bolt main bearing caps for greater durability.
15. **SLIDE 15 EXPLAIN Figure 34-14** Some engines add to the strength of a four-bolt main bearing cap by also using cross bolts through bolt on the sides of the main bearing caps.
16. **SLIDE 16 EXPLAIN Figure 34-15** girdle is used to tie all of the main bearing caps together.

DISCUSSION: Ask students to discuss which engines would most likely use a girdle and why. Girdles are more likely to be used to support the bottom of aluminum engines because of the weaker strength of the metal.

Most current engines have aluminum cylinder heads. To save even more weight, manufacturers have started to use plastic for intake manifolds, which is a performance advantage due to smoothness of material.

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	17. **SLIDE 17 EXPLAIN Figure 34-16** main bearing bores of a warped block usually bend into a bowed shape. The greatest distortion is in the center bores. 18. **SLIDE 18 EXPLAIN Figure 34-17** When main bearing caps bow downward, they also pinch in at parting line. 19. **SLIDE 19 EXPLAIN FIGURE 34-18** The main bearing bore alignment can be checked using a precision straightedge and a feeler gauge. **DISCUSS FREQUENTLY ASKED QUESTION:** ***What Is a Seasoned Engine?*** **A new engine is machined and assembled within a few hours after the heads and block are cast from melted iron. Newly cast parts have internal stresses within the metal. The stress results from the different thicknesses of the metal sections in the head. Forces from combustion in the engine, plus continued heating and cooling, gradually relieve these stresses. By the time the engine has accumulated 20,000 to 30,000 miles (32,000 to 48,000 km), the stresses have been completely relieved. This is why some engine rebuilders prefer to work with used heads and blocks that are stress relieved. Used engines are often called "seasoned" because of the reduced stress and movement these components have as compared with new parts.** **DEMONSTRATION: how to inspect an engine block and locate casting marks** **HANDS-ON TASK: Have students inspect an engine block and locate casting marks. See if they can find any identification markings and what surfaces are machined.** 20. **SLIDE 20 EXPLAIN Figure 34-19 (a)** precision arbor can be used to check the main bearing bore alignment. 21. **SLIDE 21 EXPLAIN Figure 34-19 (b)** If the sleeve can be inserted into all of the main bearing bores, then they are aligned. 22. **SLIDE 22 EXPLAIN Figure 34-20 (a)** Checking the

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	flatness of the block deck surface using a straightedge and a feeler gauge. 23. **SLIDE 23 EXPLAIN Figure 34-20 (b)** To be sure that the top of the block is flat, check block in six locations as shown. **Together with a straightedge, a flashlight can be used to quickly check for warpage. If light bleeds through, then check block with a feeler gauge to measure warpage.** **DEMONSTRATION: Show different types of measuring tools needed to rebuild an engine. Some examples are Plastigage™, dial bore gauge, inside expandable gauges, micrometer, feeler gauge, and straightedge.** **DISCUSSION: Ask students to discuss some causes of engine failure. Three main causes are overheating, lubrication issues, and detonation.** **Improper detorquing can cause warpage. Be sure to follow the service manual when removing engine parts.** 24. **SLIDE 24 EXPLAIN Figure 34-21** Grinding the deck surface of the block. 25. **SLIDE 25 EXPLAIN Figure 34-22** Cylinders wear in a taper, with most of the wear occurring at the top of the cylinder where the greatest amount of heat and pressure are created. The ridge is formed because the very top part of the cylinder is not contacted by the rings **ON-VEHICLE ASEEDUCATION TASK Cylinder Block Specification Measurement, Research applicable vehicle and service information**
Education Foundation	26. **SLIDE 26 EXPLAIN Figure 34-23** Using a dial bore gauge to measure the bore diameter at the top just below the ridge (maximum wear section) and at the bottom below the ring travel (minimum wear section). The difference between these two measurements is the amount of cylinder taper. Take the measurements in line with the crankshaft and then repeat the measurements at right angles to the centerline of the block in each cylinder to determine out-of-round.

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	**DISCUSS FREQUENTLY ASKED QUESTION: *How Do I Determine What Oversize Bore Is Needed?*** **An easy way to calculate oversize piston size is to determine the amount of taper, double it, and add 0.010 inch (Taper * 2 + 0.010 inch = Oversize piston). Common oversize measurements include:** **• 0.020 inch** **• 0.030 inch** **• 0.040 inch** **• 0.060 inch** **Use caution when boring for an oversize measurement larger than 0.030 inch due to potential engine damage caused from too thin cylinder walls.**
	**DISCUSS FREQUENTLY ASKED QUESTION: *What Is a Boring Hone?*** **Many shops now use "boring" hones instead of boring bars. Boring hones have the advantages of being able to resize and finish hone with only one machine setup. Often a diamond hone is used and rough honed to within about 0.003 inch of the finished bore size. Then a finish hone is used to provide the proper surface finish.** **DEMONSTRATION: Working with aluminum is different from working with iron. Show students this by using an iron sanding pad to clean an engine part. Grind an iron engine part and then an aluminum part. Show them possible damage that can be caused by using wrong pad. Aluminum sanding pads are usually made of plastic to avoid removing any metal.** **DISCUSSION: Ask students whether breaking in an engine is still necessary. ANS: Usually engines are broken in to seat the new rings against the machined cylinder walls.** **DISCUSSION: Ask students why OEMs no longer stress breaking in an engine when buying a new vehicle. ANS: Most OEMs do not want to add extra**

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	steps to the process of purchasing a new vehicle. Also, the engine building process for new engines is far more precise than it used to be. This allows straighter bores that line up with the piston rings. **DEMONSTRATION: Show why assembly lube should be used when rebuilding an engine. Place some assembly lube in a glass of oil to show the students that it will dissolve.** 27. **SLIDE 27 EXPLAIN Figure 34-24** A cylinder boring machine is used to enlarge cylinder bore diameter so a replacement oversize piston can be used to restore a worn engine to useful service or to increase the displacement of the engine in an attempt to increase power output. 28. **SLIDE 28 EXPLAIN Figure 34-25** dry cylinder sleeve can also be installed in a cast-iron block to repair a worn or cracked cylinder. 29. **SLIDE 29 EXPLAIN Figure 34-26** assortment of ball-type deglazing hones. This type of hone does not straighten wavy cylinder walls. 30. **SLIDES 30 EXPLAIN Figure 34-27** After boring, the cylinder surface is rough, pitted, and fractured to a depth of about 0.001 in. **DISCUSSION: Ask students to discuss why a honing stone, and not a blade, is used when machining a block. ANS: Metal is never cut into; rather it is ground away.** **DISCUSSION: Ask the students to discuss the reasons why iron is used instead of steel when casting a block. ANS: Steel is a variation of iron that includes carbon; however, there is very little benefit in using steel for an engine block compared to iron & casting is easier with iron than with steel.** **DISCUSSION: Ask students to discuss which gaskets need to be changed when boring and honing a cylinder. ANS: Head gaskets need to be the right size for the cylinders.** **DEMONSTRATION: Show what a hone looks like and how it operates.**

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	31. **SLIDE 31 EXPLAIN Figure 34-28** Honing enlarges the cylinder bore to the final size and leaves a plateau surface finish that retains oil. 32. **SLIDE 32 EXPLAIN Figure 34-29** torque plate being used during a cylinder honing operation. Thick piece of metal is bolted to block & simulates forces exerted on block by head bolts when the cylinder head is attached.
	**EXPLAIN TECH TIP:** ***Always Use Torque Plates*** **Torque plates are thick metal plates that are bolted to the cylinder block to duplicate the forces on the block that occur when the cylinder head is installed. Even though not all machine shops use torque plates during the boring operation, the use of torque plates during the final dimensional honing operation is beneficial. Without torque plates, cylinders can become out-of-round (up to 0.003 inch) and distorted when the cylinder heads are installed and torqued down. Even though the use of torque plates does not eliminate all distortion, their use helps to ensure a truer cylinder dimension. • SEE FIGURE 34–29.** **When ordering parts like rod bearings, be sure to determine whether bearings are undersize or oversize. Then know how to order the right bearing size. Usually, when you need a thicker bearing, you will order an undersize bearing, stating that crankshaft has been machined down.**
	33. **SLIDE 33 EXPLAIN Figure 34-30** crosshatched pattern holds oil to keep the rings from wearing excessively, and also keeps the rings against the cylinder wall for a gas-tight fit. 34. **SLIDE 34 EXPLAIN FIGURE 34-31A** The surface finish tool is being held against the cylinder wall. 35. **SLIDE 35 EXPLAIN FIGURE 34-31B** The reading indicates the Ra or roughness of cylinder. 36. **SLIDE 36 EXPLAIN Figure 34-32** Using a tapered sanding cone to remove the sharp edges at the top of the cylinders created when the block was machined.
	**EXPLAIN TECH TIP:** ***Bore to Size, Hone for Clearance*** **Many engine rebuilders and remanufacturers bore the**

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	cylinders to the exact size of the oversize pistons that are to be used. After the block is bored to a standard oversize measurement, the cylinder is honed. The rigid hone stones, along with an experienced operator, can increase the bore size by 0.001 to 0.003 inch (one to three thousandths of an inch) for the typical clearance needed between the piston and the cylinder walls. For example: • Actual piston diameter = 4.028 inches • Bore diameter = 4.028 inches • Diameter after honing = 4.03 inches • Amount removed by honing = 0.002 inch NOTE: The minimum amount recommended to be removed by honing is 0.002 inch, to remove the fractured metal in the cylinder wall caused by boring.
	**DISCUSS CHART 34-1 Grit size numbers and their dimensions in inches and millimeters.**
	After machining an engine block, it is common to paint outside and non-gasket parts of engine. This makes engine attractive and protects it from rust. Be sure not to paint any of machined surfaces. **Improper detorquing can cause warpage. Be sure to follow the service manual when removing engine parts.**
	**EXPLAIN TECH TIP:** ***Install Lifter Bore Bushings*** Lifter bores in a block can be out-of-square with the camshaft, resulting in premature camshaft wear and variations in the valve timing from cylinder to cylinder. To correct for this variation, the lifter bores are bored and reamed oversize using a fixture fastened to the block deck to ensure proper alignment. Bronze lifter bushings are then installed and finish honed to achieve the correct lifter-to-bore clearance. • SEE FIGURE 34–33. The lifter bores should be “honed” with a ball-type hone. This should be done even if they are “in-line”

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	and do not need bushings. This is often overlooked by technicians and can lead to lifter problems later on, causing lifters to stick on the bores. **37. SLIDE 37 EXPLAIN FIGURE 34-33** High-performance engine builders will install bronze sleeves in lifter bores. **38. SLIDE 38 EXPLAIN Figure 34-34** Notice on this cutaway engine block that some of the head bolt holes do not extend too far into the block and dead end. Debris can accumulate at the bottom of these holes and it must be cleaned out before final assembly. **39. SLIDE 39 EXPLAIN Figure 34-35** tread chaser or bottoming tap should be used in all threaded holes before assembling the engine. **DISCUSSION: Ask students to discuss pros and cons of having an all-aluminum engine. What would they personally choose for their own vehicles? Aluminum would be lighter overall and is repairable in some cases if block is damaged. However, metal would need to be thicker and cost would be significantly more** **DEMONSTRATION: Working with aluminum is different from working with iron. Show students this by using an iron sanding pad to clean an engine part. Grind an iron engine part and then an aluminum part. Show them the possible damage that can be caused by using the wrong pad. Aluminum sanding pads are usually made of plastic to avoid removing any metal.** **ON-VEHICLE ASEEDUCATION TASK Inspect engine block for visible cracks, passage condition, core and gallery plug condition, and surface warpage; determine necessary action.** **ON-VEHICLE ASEEDUCATION TASK Inspect and measure cylinder walls/sleeves for damage, wear, and ridges; determine needed action**
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	**ON-VEHICLE ASEEDUCATION TASK Deglaze and clean cylinder walls** **SEARCH INTERNET: use Internet to research experimental engines and their designs. Have them choose 3 engine designs for their superior characteristics.** **SEARCH INTERNET: Engine blocks can be modified to have a bigger displacement. Have students use Internet to research what engines can have the largest oversize bore by percentage.**